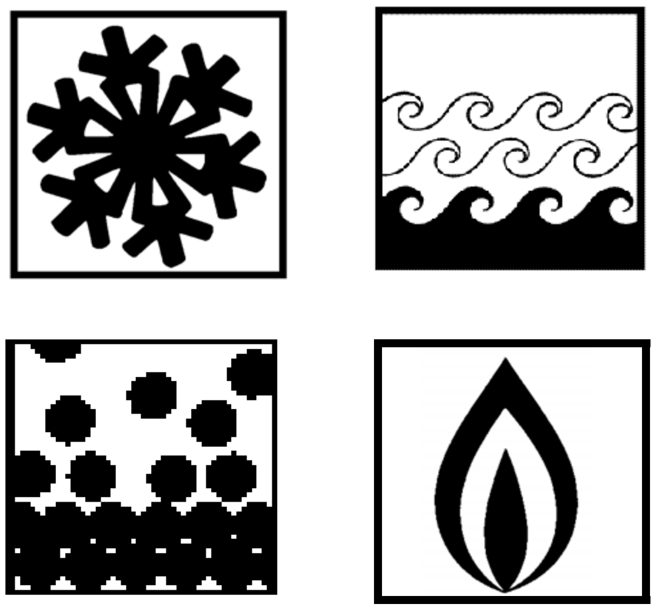
United States
Department of
Agriculture

Marketing and
Regulatory
Programs

Animal and
Plant Health
Inspection
Service

Plant Protection
and Quarantine

Treatment Manual



Acknowledgement

The Department of Pesticide Regulation (DPR) thanks the United States Department of Agriculture (USDA) for permission to use excerpts from their Plant Protection and Quarantine (PPQ), Treatment Manual. DPR compiled the excerpted material to produce this abridged Treatment Manual to serve as reference material that can be used to prepare for various California commercial pesticide applicator certification examinations administered by DPR's Certification and Training Program. This abridged Treatment Manual contains the complete table of contents with strike out edits showing the excluded treatment information. If someone desires the complete PPQ Treatment Manual or any of the excluded treatment information line out in the table of contents, it is available for viewing or downloading as PDF files from the following USDA website:
http://www.aphis.usda.gov/ppq/manuals/port/Treatment_Chapters.htm

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Update Record

Record the transmittal number and the date you received the update in the appropriate columns.

Transmittal Number	Date Received	Transmittal Number	Date Received

Important

The information herein is supplied with the understanding that no discrimination is intended and that listing of commercial products, necessary to this manual, implies no endorsement by the authors or Plant Protection and Quarantine (PPQ) of APHIS, USDA. Criticism of products or equipment not listed is neither implied nor intended.

Due to constantly changing laws and regulations, PPQ can assume no liability for the suggested use of chemicals contained herein. (Pesticides should be used according to the label directions on the pesticide container.)

NOTICE

If you are missing updates or manual parts, contact Distribution in Riverdale, Maryland. (Phone 1-301-734-4474; Fax 1-301-734-8455)

Contents

Treatment Manual

Tables

Treatment Manual

Figures

Treatment Manual

1 Introduction

Treatment Manual

Contents

Purpose

The procedures and treatment schedules listed in this manual are administratively authorized for use in Plant Protection and Quarantine (PPQ). The treatment of listed commodities prevents the movement of agricultural pests into or within the United States. An officer may determine that other commodities require treatment to prevent similar pest movement.

Important

Do not treat unlisted commodities until consulting and receiving approval from the Center for Plant Health Science & Technology (CPHST) in Raleigh, North Carolina.

Also, approval from CPHST must be obtained each time a treatment schedule is used that is not an approved schedule from this manual.

Restrictions

Treatment recommendations listed in this manual are based on uses authorized under provisions of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended. Directions appearing on the label, Section 18 Emergency Exemptions, and manual instructions must be followed. Nevertheless, some treatments may damage commodities.

PPQ personnel may not make any warranty or representations, expressed or implied, concerning the use of these pesticides.

The occasional use of registered trade names in this manual does not imply an endorsement of those products or of the manufacturers by the U.S. Department of Agriculture, Animal and Plant Health Inspection Service (USDA, APHIS).

Scope

This manual covers all treatments for import, export, and those domestic plant pests which are of quarantine significance. This manual is broadly divided into ten sections:

- Chemical Treatments
- Nonchemical Treatments
- Residue Monitoring
- Treatment Schedules
- Certifying Facilities
- Emergency Aid and Safety
- Equipment
- Glossary
- Appendixes
- Index

Each section is tabbed and contains a Table of Contents, an Overview, and where appropriate, a Methods and Procedures section. The Overview is a broad, general description of what is covered in the section. Methods and Procedures cover the “how to” of that particular activity as well as procedural and reference material for performing tasks associated with each activity.

The Appendixes contain information directly associated with treatment activities, but are placed in the back so they do not interfere with the flow of procedural instructions.

Users

This manual is used primarily by PPQ officers, Headquarters personnel, and State cooperators involved in conducting treatments. The secondary users of this manual are other government agencies, fumigators, pest control operators, foreign governments, and other interested parties.

Related Documents

The following documents are related to the treatment manual:

- Pesticide labels and labelling
- Material Safety Data Sheet (MSDS)
- APHIS Safety and Health manual
- Federal Insecticide, Fungicide, Rodenticide Act as amended
- Plant Import manuals (Propagative and Nonpropagative)
- Code of Federal Regulations (CFR)
  - Title 7 (Agriculture)
  - Title 46 (Shipping) Chapter 1, Part 147—Interim Regulations for Shipboard Fumigation
- Occupational Safety and Health Administration (OSHA) treatment manual

Application

This manual serves both as a field manual for employees conducting treatments and as a reference for PPQ officers, program managers, and staff officers. Under APHIS policy, only certified pesticide applicators may conduct or monitor treatments. This manual will also serve as a reference for researching the types of treatments available for imports and to answer questions from importers, industry, and foreign countries.

How to Use This Manual

Review the content of this manual to get a feel for the scope of material covered. Glance through the section that you will be using and familiarize yourself with the organization of information. Major headings such as Chemical Treatments and subheadings such as Fumigants will be tabbed. Each section is divided by tabs so when you want to find information on taking residue samples, you would turn to the tab labeled “Residue Monitoring” and check the Table of Contents for the page number.

Use the Table of Contents which follows each tab to quickly find information. If the Table of Contents is not specific enough, then turn to the Index to find the topic and page number.

Reporting Problems

If you want to suggest an improvement or identify a problem with the content of this manual, complete and mail the “Comment Sheet” at the back of this manual. If the problem is urgent, call John Patterson at the Professional Development Center at (240) 629-1934. If you disagree with the guidelines or policies contained in this manual, contact Quarantine Policy, Analysis and Support (QPAS) through channels.

Conventions

The following are terms that are widely recognized and used throughout this manual:

DANGER	Indicates that people can easily be hurt or killed
WARNING	Indicates that people could possibly be hurt or killed
CAUTION	Indicates that people could possibly be endangered and slightly hurt
NOTICE	Indicates a possibly dangerous situation, goods might be damaged
Important	Indicates helpful information

EXAMPLE: indicates additional information that helps to clarify the content in the manual

Treatment schedules which are FIFRA Section 18 Exemptions (such as the sample below) are followed by an “Important” note to help you determine the current exemption status.

Temperature	Dosage Rate (lb/1,000 ft^3)	Minimum Concentration Readings (ounces) At:			
		0.5 hrs	2 hrs	3 hrs	3.5 hrs
90 °F or above	2 lbs	26	19	19	—
80-89 °F	2.5 lbs	32	24	24	—
70-79 °F	3 lbs	38	29	24	—
60-69 °F	3 lbs	38	29	—	24

Important

Do not use this treatment schedule if its FIFRA Section 18 Exemption has expired. For the current exemption status, call your local State Plant Health Director (SPHD).

2

Treatment Manual

Chemical Treatments

Overview

Contents

The Chemical Treatments section of this manual is organized by chemicals tabbed as follows:

- Fumigants
- Aerosols and Micronized Dust

Use the Contents in this section to quickly find the information you need. The subjects listed in the Contents are also marked on the tabs in this manual. If the Contents is not specific enough, then turn to the Index to find the topic and its page number.

2

Treatment Manual

Chemical Treatments

Fumigants

Contents

Introduction

Fumigation is the act of releasing and dispersing a toxic chemical so it reaches the target organism in a gaseous state. Chemicals applied as aerosols, smokes, mists, and fogs are suspensions of particulate matter in air and are not fumigants.

The ideal fumigant would have the following characteristics:

- Highly toxic to the target pest
- Nontoxic to plants and vertebrates (including humans)
- Easily and cheaply generated
- Harmless to foods and commodities
- Inexpensive
- Nonexplosive
- Nonflammable
- Insoluble in water
- Nonpersistent
- Easily diffuses and rapidly penetrates commodity
- Stable in the gaseous state (will not condense to a liquid)
- Easily detected by human senses

Unfortunately, no one fumigant has all the above properties, but those used by APHIS and PPQ have many of these characteristics.

The toxicity of a fumigant depends on the respiration rate of the target organism. Generally, the lower the temperature, the lower the respiration rate of the organism which tends to make the pest less susceptible. Fumigation at lower temperatures requires a higher dosage rate for a longer exposure period than fumigation at higher temperatures.

Fumigants vary greatly in their mode of action. Some kill rapidly while others kill slowly. In sublethal dosages, some fumigants may have a paralyzing effect on the pest while others will not allow the pest to recover. Some fumigants have no effect on commodities while others are detrimental even at low concentrations. Commodities vary in their sorption of fumigants and in the effort required to aerate the commodities after fumigation.

Due to the reduction in number of labeled fumigants, there is seldom a choice in selecting fumigants. When there is a choice, factors such as the commodity to be treated, pest and stages present, type of structure, and cost should be considered in selecting a fumigant.

The only authorized fumigants are the following:

- Methyl bromide (MB)
- Sulfuryl fluoride (SF) (Vikane)
- Phosphine (PH) (There are two chemicals used for phosphine, AP—aluminum phosphide and MP—magnesium phosphide)

Much of the information on fumigants is based on MB with modification as needed for the other fumigants.

Monitoring of Quarantine Treatments

Monitoring of program fumigations is performed to ensure that effective fumigant concentration levels are maintained throughout the treatment to prevent the introduction of quarantine pests. Quarantine fumigations employing restricted use pesticides require careful monitoring to assure efficacy and personal safety, to maintain pesticide residues within acceptable limits, and to preserve commodity quality. These requirements are included in the fumigant label, and it is a violation of Federal law to use fumigants and pesticides in a manner inconsistent with its labeling.

Nonperishable Commodities in Temporary Enclosures

PPQ officers will provide onsite monitoring from introduction of the fumigant through completion of the 2 hour gas concentration readings. Half hour and 2 hour readings are required for these treatments. These readings and general observations permit the officer to determine how a particular treatment is progressing and to make necessary corrections to the enclosure or fumigant concentration level.

Perishable Commodities in Temporary Enclosures

The monitoring officer will remain on the site through the entire fumigation of perishable commodities. Continuous monitoring allows the officer to alert the pest control operator at any time to implement necessary corrective measures. Due to the nature of the commodity and the length of treatment, onsite monitoring of yam and chestnut fumigations may be interrupted after the 2 hour reading when efficacy and safety considerations warrant.

These instructions do not prevent the officer from leaving the immediate fumigation site for brief periods when it is necessary and safe to do so. The pest control operator must be notified of the PPQ officer's intended absence. These absences would ordinarily be limited to 20 minutes and do not constitute a break in service. These practices are in place in many locations and will require only minor modifications in other areas.

Fumigation Guidelines

The following fumigation guidelines are in common usage throughout this manual:

- Dosage rate is based on 1,000 cubic feet of enclosure space, whether chamber, tarpaulin, van, freight car, ship hold, etc. Dosage should be calculated from the volume of the tarped fumigation enclosure.
- Dosages are listed by weight in the Treatment Schedules. If liquid measures are needed, convert from weight to volume by using the conversion figures.
- Ounces per 1,000 cubic feet (oz/1000 ft^3) is equal to milligrams per liter (mg/liter) and is equal to grams per cubic meter (g/m^3).
- Volume of commodity being treated should not exceed two-thirds of enclosure volume unless otherwise specified in a schedule.
- Specified vacuum should be held throughout the exposure period.
- Blowers or fans should be operated as follows:
  - for propagative material (T200-series schedules), the entire period of exposure, whether NAP or vacuum
  - under tarpaulin (and vacuum fumigation for other than propagative material), fans should operate for 30 minutes after gas introduction, or until T/C readings indicate uniform gas distribution
  - for all bulk material, forced recirculation is required, check for uniform gas distribution by taking T/C readings at four or five locations including at least three from the commodity

Important

Phosphine fumigations do not require fans.

- In this section, all NAP treatments that refer to chamber fumigations should be conducted in USDA-approved chambers. (See Section 6, **Certification of Vacuum Fumigation Chambers**).
- Methyl bromide treatment schedules are indicated as "MB." MB generally refers to any methyl bromide label. Specific MB label restrictions are noted in this manual for the "Q" label. Always check the label of the fumigant to be sure the commodity is listed on the label. Commodities that are not listed on the fumigant's label are not authorized for fumigation with the manufacturer's gas.

Physical Properties of Fumigants

Fumigant	Chemical Formula	Boiling Point	Specific Gravity[1]	Flammability Limits in Air
Methyl Bromide	CH_3Br	3.6 °C 40.1 °F	3.27	Normally nonflammable. Flame propagation at 13.5 to 14.5% by volume only in the presence of an intense source of ignition.
Phosphine	PH_3	–87.4 °C –126 °F	1.214	1.79% by volume
Sulfuryl fluoride	SO_2F_2	–55.2 °C –67 °F	2.88	Nonflammable

1 Air = 1, anything greater is heavier than air.

Fumigant	Odor	Effects on Metals	General
Methyl Bromide	No odor at low concentration. Strong musty or sweet at high concentrations.	Reacts with aluminum, may damage electronic equipment	Discharged from cylinders, 1.5 lb cans
Phosphine	Garlic-like or carbide due to impurities	Copper, brass, gold and silver severely damaged; electronic equipment damaged. Other metals slightly affected in high humidity.	Evolved from aluminum phosphide or magnesium phosphide preparations
Sulfuryl fluoride	None	Non-corrosive	Discharged from cylinders

2

Treatment Manual

Chemical Treatments

Fumigants • Methyl Bromide

Contents

Properties and Use

Methyl bromide (MB) (CH_3Br) is a colorless, odorless, nonflammable fumigant. MB boils at 38.5 °F and has a very low solubility in water. As a gas, MB is three times heavier than air. As a liquid at 32 °F, 1 pound of MB is equivalent to 262 ml. For ease in transportation and handling, MB is compressed and stored in metal cylinders as a liquid.

MB is an effective fumigant for treating a wide variety of plant pests associated with a wide variety of commodities. MB is the most frequently used fumigant in quarantine fumigations. MB may also be used to devitalize plant material. MB is effective in treating the following pests:

- Insects (all life stages)
- Mites and ticks (all life stages)
- Nematodes (including cysts)
- Snails and slugs
- Fungi (such as oak wilt fungus)

MB is effective over a wide range of temperatures (40 °F and above). In general, living plant material tolerates the dosage rate specified, although the degree of tolerance varies with species, variety, stage of growth, and condition of the plant material. MB accelerates the decomposition of plants in poor condition.

Since MB is three times heavier than air, it diffuses outward and downward readily, but requires fans to ensure upward movement and equal gas distribution. Fan circulation also enhances penetration of

MB into the commodity. A volatilizer is used to heat the liquid MB in order to speed up its conversion to a gas. Once the gas is evenly distributed, it maintains that condition for the duration of the treatment unless an outside event such as excessive leakage occurs.

“Q Labels” and Section 18 Exemption Treatment Schedules

Methyl bromide fumigants, except those with “Q” labels, may be subject to requirements of the FIFRA Section 18 Quarantine Exemption. When commodities intended for food or feed are fumigated with methyl bromide under the FIFRA Section 18 Quarantine Exemption, one additional EPA *requirement* must be met: PPQ must monitor aeration by sampling the gas concentration to determine when a commodity may be released.

In this manual, fumigation schedules under the FIFRA Section 18 Quarantine Exemption are followed by an “Important” note to help you determine the current exemption status. For example:

Important

Do not use this treatment schedule if its FIFRA Section 18 Exemption has expired. For the current exemption status, call your local State Plant Health Director (SPHD).

CAUTION

Always use the label of the fumigant to determine if the commodity can be treated. Fumigation schedules in this publication are intended to clarify and expand commercial labels for methyl bromide. The EPA only authorizes fumigation for commodities that are listed on the label of the gas being used for the fumigation. Also, to comply with State requirements, a fumigant must be registered in the State where it is being used. If you are uncertain that a fumigant is registered in a state where the fumigation is being performed, contact a major port in that state or the Oxford Plant Protection Laboratory.

To better accommodate the requirements of quarantine and regulatory fumigations with methyl bromide, the Animal and Plant Health Inspection Service (APHIS) and the Great Lakes Chemical Corporation have developed a premium 100 percent methyl bromide fumigant that is only intended for quarantine and regulatory use. This methyl bromide fumigant is provided by several companies and generally referred to as a "Q label". It is labeled for many uses which were previously covered by FIFRA Section 18 Exemptions. Additional features of the "Q label" include the following:

- Fumigation for rodents and warm blooded pests is allowed at temperature down to 20 ° F.
- Use of additional fumigant to maintain the required concentration is allowed.
- The commodity must be allowed to aerate for at least one hour before completely removing the tarp. However, the aeration procedures described in this manual require a longer period than required on the label, and must be followed. Be sure that the fumigator is placed under a compliance agreement, and that he follows the aeration procedures outlined in this manual.

Although there is some overlap in the "Q label" and other methyl bromide labels, substitution of the products may result in non-compliance. Use the Treatment Manual to determine when a "Q" labeled fumigant must be used:

- When the treatment schedule is marked MB, any methyl bromide fumigant may be used for the fumigation if the commodity is on the fumigant label.

Important

When the treatment schedule is marked MB ("Q" label only), the fumigation is restricted to methyl bromide "Q" labels. This restriction is based on the "Q" label replacement of FIFRA Section 18 exemptions.

- A few schedules restrict the use of a label based on temperature range. In this case, the specific temperature range is marked and noted ("Q" label only).

Always read and follow the "Q label" label and use directions. The "Q-label" allows fumigation of certain commodities and pests at sites and rates that are not allowed under other labels. The label is purposely flexible to handle unforeseen emergencies and other special situations formerly covered by FIFRA Section 18 label exemptions.

Although the use of "Q label" fumigants eliminates the requirements for residue and aeration monitoring, the "Q label" requires fumigations using the product be conducted under the monitoring of a state or federal agency. Monitoring does not necessarily require the actual presence of a regulatory agent during the entire fumigation, but does mean that the monitoring agent be able to certify that the fumigant was done in compliance with the label and other requirements.

To show that the fumigation using the "Q" label was monitored by a regulatory agent, the fumigator should record the name, title, telephone number and mailing address of the monitoring regulatory agent(s) in his restricted use pesticide application records, even if the same information is recorded on other documents (e.g., phytosanitary certificate).

Leak Detection and Gas Analysis

Use a thermal conductivity (T/C) unit to measure gas concentration levels in tarpaulins and chambers. The halide detector is used primarily to check for leaks around tarpaulins, chambers, application equipment, and as a safety device around the fumigation site. Colorimetric tubes, which are supplied by the fumigator, are used to measure gas concentration levels during aeration.

During a fumigation, a fumigant is volatilized in a chamber at atmospheric pressure, a positive pressure is created, which may then be continuously reduced by leakage of the air-fumigant mixture. Because PPQ approved chambers must be sufficiently tight to retain the fumigant during the exposure period, chambers should be tested for leakage before they are used for fumigation.

Effects of Temperature and Humidity

MB is effective at the same temperatures plants are generally handled (usually 40 °F and above). In general, increases in temperature give a corresponding increase in the effectiveness of MB. All treatment schedule temperatures are listed with the corresponding dosage rate. Follow the dosage rates listed. A Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Section 3 registration (the labeled rate of MB provided), or a Section 18 Exemption must be in effect at the time of treatment.

For live plant material which is actively growing or with leaves, maintain a high percentage of humidity (above 75 percent) in the chamber by placing wet sphagnum or excelsior in the chamber or by wetting the chamber walls and floor. Protect actively growing or delicate plants from the direct air flow of fans. Do not add any moisture to the chamber when fumigating seeds. Too much moisture on the material to be fumigated may prevent the fumigant from reaching some of the pests.

Penetration and Aeration of Boxes and Packages

Plastic Wrappings and Impermeable Papers

Plastic wrappings such as cellophane, films, and shrink wrap, and papers that are waxed, laminated, or waterproofed are not readily permeable and must be perforated, removed, or opened before fumigation. If wrappings are perforated to facilitate fumigation, holes should be at least 3/16-inch in diameter every 3 square inches or 1/4-inch in diameter every 4 square inches over the entire surface of the wrapping. Also acceptable are plastic wraps containing numerous pinholes (at least 49 per square inch). These holes enhance permeability through the plastic fruit trays, which are frequently used for transport of fruit.

Important

Inform prospective importers that the wrappings on their shipments may have to be perforated to PPQ specifications, removed, or opened if PPQ requires fumigation. If wrappings on shipments are designed to satisfy PPQ requirements for fumigation readily, importers could save time and money. Shippers may send samples of prospective wrapping materials (a piece at least 12in X 12in) to Oxford Plant Protection Laboratory for evaluation.

Kraft Paper and Corrugated Cartons

Kraft paper is permeable to MB and does not need to be removed prior to fumigation. Corrugated cartons are also permeable to MB and unless impermeable liners are present, aeration will be satisfactory, although it will be slower in closed boxes.

Wooden Boxes

Although MB penetrates wooden boxes, aeration of tight boxes may be slow, particularly if sorptive packing materials are present. To aid in aeration, have the lids removed and boxes placed on their sides prior to fumigation. If removing lids is not practical, then increase the aeration time.

Sorption

Sorption is the process of chemically or physically binding free MB on or within the fumigated commodity. Sorption makes the fumigant unavailable to kill the plant pest. There are three types of sorption—absorption, adsorption, and chemisorption. Sorption rate is high at first, then gradually reduces to a slow rate. Sorption increases the time required for aeration.

Commodities known or believed to be highly sorptive should not be fumigated in chambers unless concentration readings can be taken to ensure the required minimum concentration is met. Additional readings may be necessary in order to properly monitor gas concentration sorptive commodities in chambers.

For tarpaulin fumigation, additional T/C unit readings are necessary to monitor concentration of gas to determine the rate of sorption. The following is a partial list of commodities known to be highly sorptive:

- bales of burlap
- myrobalan
- carpet backing
- pistachio nuts
- cinnamon quills
- polyamide waste
- cocoa mats
- polystyrene foam (Styrofoam)
- cotton
- potato starch
- flour and finely milled products
- rubber (crepe or crude)
- gall nuts
- vermiculite
- hardboard (Masonite™)
- wood products (unfinished)
- incense
- wool (raw, except pulled)

Call the Oxford Plant Protection Laboratory if you are concerned about the sorptive properties of other commodities. (Telephone: 919-693-5151)

Residual Effect

MB may adversely affect the shelf life of fresh fruits and vegetables, the viability of dormant and actively growing plants, and the germination of seed. Although MB may adversely affect some commodities, it is a necessary risk in order to control pests. Some dosage rates are near the maximum tolerance of the commodity, so care must be exercised in choosing the proper treatment schedule and applying the treatment.

MB may also adversely affect nonplant products. In general, articles with a high sulfur content may develop “off-odors” on contact with MB. In some commodities the odors are difficult or impossible to remove by aeration. If possible or practical, remove from the area to be fumigated any items that are likely to develop an undesirable odor.

Ordinarily, the following items should *not* be fumigated:

- Any commodity which is not listed on the label or lacks a FIFRA Section 18 Exemption
- Any commodity which lacks a treatment schedule
- Automobiles
- Baking powder
- Blueprints
- Bone meal
- Butter, lard, or fats, unless in airtight containers
- Charcoal (highly sorptive)
- Cinder blocks or mixed concrete and cinder blocks
- Electronic equipment
- Feather pillows
- Felt
- Furs
- High protein flours (soybean, whole wheat, peanut)
- Horsehair articles
- Leather goods, particularly kid leather
- Machinery with milled surfaces
- Magazines and newspapers (made of wood pulp)
- Magnesium articles (subject to corrosion)
- Paper with high rag or sulfur content
- Photographic chemicals and prints (not camera film or X-rays)
- Natural rubber goods, particularly sponge rubber, foam rubber, and reclaimed rubber including pillows, mattresses, rubber stamps, and upholstered furniture
- Rug pads

- Silver polishing papers
- Woolens (especially angora), soft yarns, and sweaters; viscose rayon fabrics
- Yak rugs

2

Treatment Manual

Chemical Treatments

Fumigants • Methyl Bromide • Tarpaulin Fumigation

Contents

Methods and Procedures

The procedures covered in this section provide PPQ Officers and commercial fumigators with the methods, responsibilities, and precautions for tarpaulin fumigation.

Materials Needed

PPQ Officer Provides

- Calculator (optional)
- Colorimetric tubes (Draeger/Kitagawa)
- Desiccant (Drierite®)
- Forms (PPQ Form 429 and APHIS Form 2061 if necessary)
- Halide leak detector
- Self-contained breathing apparatus (SCBA) or supplied air respirator to be used by PPQ officer
- Tape measure (as back-up for fumigator)
- Thermal conductivity unit[1], [2]
- Thermometer (as back-up for fumigator)

Fumigator Provides

- Auxiliary pump for purging long gas sample tubes
- Carbon dioxide filter (Ascarite®)
- Colorimetric tubes (Draeger/Kitagawa)
- Desiccant (Drierite®, anhydrous calcium sulfate)

1 If fumigating oak logs or lumber for export, the unit must be capable of reading 400 oz.
2 T/C unit must be calibrated annually by the Center for Plant Health Science & Technology (CPHST) in Raleigh, North Carolina. If requested, CPHST will calibrate a commercial fumigator's T/C unit.

- Electrical wiring (grounded, permanent type), three prong extension cords
- Exhaust blower and ducts
- Fans (circulation, exhaust, and introduction)
- Framework and supports
- Gas introduction line
- Gas sampling tubes (leads)
- Heat supply
- Insecticides and spray equipment
- Loose sand
- Measuring Tape
- Methyl bromide
- Padding
- Sand or water snakes or adhesive sealer
- Scales or dispensers
- Self-contained breathing apparatus (SCBA) or supplied air respirator
- Tape
- Tarpaulin and supports (See **page-2-4-13** for specifications)
- Thermal conductivity unit[3], [4]
- Thermometer
- Volatilizer
- Warning signs
- Tape measure
- Thermometer

Preparing to Fumigate

Step 1—Selecting a Treatment Schedule

Select a treatment schedule to effectively eliminate the plant pest without damaging the commodity being fumigated.

3 If fumigating oak logs or lumber for export, the unit must be capable of reading 400 oz.
4 T/C unit must be calibrated by the Center for Plant Health Science & Technology (CPHST) in Raleigh, North Carolina. If requested, CPHST will calibrate a commercial fumigator's T/C unit.

Turn to the Treatment Schedule Index and look up the available treatment schedule(s) by commodity (example—apples, pears, or citrus) or by pest (example—Mediterranean fruit fly). Some commodities may have several treatment schedules. The "Fumigants—Methyl Bromide" section on Residual Effects lists those commodities which may be damaged by MB. Each treatment schedule lists the target pest or pest group (e.g., *Ceratitis capitata*, surface feeders, wood borers...), commodity, or both pest and commodity. If there is no schedule, contact the Center for Plant Health Science & Technology (CPHST) in Raleigh, North Carolina, to see if a schedule is available under a FIFRA Section 18 Exemption. If a treatment is required, go to **Table 2-4-1**.

TABLE 2-4-1: Determine Reporting Requirements

If a treatment is required:	Then:
As a result of a pest interception	GO to Step 2
As a condition of entry	GO to Step 3

Step 2—Issuing a PPQ Form 523 (Emergency Action Notification)

When an intercepted pest is identified and confirmed by a PPQ Area Identifier as requiring action, issue a PPQ Form 523 (Emergency Action Notification) to the owner, broker, or representative. Be sure to list all treatment options when completing the PPQ Form 523 (Emergency Action Notification). Follow instructions in Appendix 1 for completing and distributing the PPQ Form 523 (Emergency Action Notification).

Step 3—Determining Section 18 Exemptions and Sampling Requirements

After selecting the treatment schedule, you will be able to determine which treatment schedules are FIFRA Section 18 Exemptions by the presence of broad, bold, vertical lines on the borders of the treatment schedule table listed in the reference. Some treatment schedules are only FIFRA Section 18 Exemptions at specific temperature ranges. Check the treatment schedule and temperature to determine if the fumigation will be a FIFRA Section 18 Exemption.

Food or Feed Fumigations

Residue monitoring by taking samples of the commodity prior to the start of the fumigation and after aeration is no longer required.

Step 4—Selecting a Fumigation Site

Consider the following factors in selecting a fumigation site:

- A well-ventilated, sheltered area
- Ability to heat area (in colder areas)
- An impervious surface

- A nonwork area which can be effectively marked and safeguarded or isolated
- Electrical power supply
- Water supply
- A well-lighted area
- Aeration requirements

A Well-Ventilated, Sheltered Area

Select sites which are well-ventilated and in a sheltered area. A well-ventilated site is required for exhausting gas before and when the tarpaulin is removed from the stack. Most piers and warehouses have high ceilings and a number of windows/doors which can be used for ventilation. Some gas will escape from the tarpaulin even in the best conditions. Avoid areas where strong drafts are likely to occur.

In warehouses, an exhaust system must be provided to exhaust MB to the outside of the building. Ensure that the exhausted gas does not reenter the building nor endanger people working outdoors.

When treatments are conducted in a paticular location on a regular basis, a permanent site should be designated. At such sites, the fan used to remove the fumigant from the enclosure during aeration must be connected to a permanent stack extending above the roof level.

If fumigations are conducted outside, select a site that is semi-sheltered such as the leeward side of a warehouse, pier, or building that offers some protection from strong winds.

Ability to Heat Area

When cooler temperatures (below 40 °F) are expected, the site must be heated to maintain commodity temperatures above 40 °F. Take the ambient temperature 12 inches above the floor.

NOTICE

> Do not use flame or exposed electrical element heaters under the tarpaulin during treatment because MB may cause the formation of hydrogen bromide. Hydrogen bromide (hydrobromic acid) is a highly corrosive chemical which can cause damage to the heater and to surrounding materials including the commodity. Hot air or radiator type heaters can be used for heating under tarpaulins. When using space heaters to heat warehouses, there must be adequate ventilation.

An Impervious Surface

Select an asphalt, concrete, or tight wooden surface—not soil, gravel, or other porous material. If you must fumigate on a porous surface, cover the surface with asphalt (tar) paper or plastic tarpaulins. For large fumigations, covering the surface is not usually practical because pallets must be rearranged and heavy equipment used to move the commodity. On docks, wharfs, and piers, check for cracks, holes, and manhole covers which will allow the MB to escape through the floor. Have all cracks, holes, and manhole covers sealed with plastic or asphalt paper.

A Nonwork Area

Select a secure area where traffic and people are restricted from entering and which is isolated from people working. You want a nonwork area to help prevent accidents such as a forklift piercing a tarpaulin and for other safety reasons. Consider either the entire structure area or an area which extends 30 feet from the tarpaulin and is separated by a physical barrier such as ropes, barricades, or walls as the fumigation area. If a wall of gas-impervious material is less than 30 feet from the tarpaulin, the wall may serve as the edge of the secured area. Some states, for example California, require a 100 foot buffer zone. Place placards clearly in sight of all who come near. Placards must meet label requirements regarding specific warnings, information, and language. Placards generally include the name of the fumigant, the fumigation date, time, and the name of the company conducting the fumigation. Restrict access to the fumigation area to the fumigator's employees and PPQ employees monitoring the treatment. Use rope or marker tape to limit access within 30 feet of the enclosure. Do not allow motor vehicles (includes forklifts) to operate within 30 feet of the enclosure during the fumigation and aeration periods. The area outside the 30-foot perimeter is usually regarded as a safe distance from the tarpaulin. Gas concentrations exceeding 5.0 ppm (TLV for MB) are seldom recorded by gas monitoring, except during aeration. PPQ Officers that work within the 30-foot primeter must wear (and use) respiratory protection (SCBA), unless the gas levels are safe to breath and validated as safe by gas monitioring. The 30-foot perimeter is not specifically mentioned on the MB label, but is required for PPQ Officers. When space is tight, it is permissible to overlap two adjoining 30-foot perimeters. However, there must be sufficient space for a person wearing SCBA to walk between the tarpaulins.

Electrical Power Supply

An adequate electrical source must be available to run the circulation fans and the T/C unit. A separate line should be available for the T/C unit. Electrical outlets must be ground and conveniently located in relation to the fumigation area. Do *not* use generators as a power source, except under emergency conditions.

Water Supply

A water supply is necessary for safety purposes. Water is necessary for washing off MB if the liquid form is spilled on someone. Water is also used to fill the volatilizer. If no permanent water is present on site, the fumigator must provide a portable, 5-gallon supply of clean water.

Well-Lighted Areas

The area should have adequate lighting for safety purposes and for ease in reading T/C units, thermometers, and for determining whether a tarpaulin has holes or tears.

Aeration Requirements

Assuming that you've already restricted access and secured the fumigation area, you now must restrict access to the area where the exhaust duct extends beyond the enclosure. Before you start a fumigation, make sure the exhaust duct is located in a safe place.

During the first 10 minutes of aeration, there should be no people within 200 feet down wind of the exhaust duct outlet. If the exhaust duct is not used, then the requirement for a 200 foot down-wind buffer zone does not necessarily apply. However, personnel in the immediate area should be aware that a release of fumigant gas is about to take place and given the option of wearing SCBA if they choose to continue working in the area. If it is impossible to restrict people from the area of aeration during regular work hours, consider aeration during another time of the day. When securing the duct outlet area, consider the direction of the wind. Face the duct outlet toward an open area, and away from people. Point the duct outlet upward to aid in dispersing the exhausted gas.

After the first 10 minutes of aeration, if an exhaust duct is not used, then a perimeter of 30 feet or more from the stack is usually regarded as a safe distance for personnel. However, for personal safety, gas levels should occasionally be monitored at greater distances, especially downwind. Experience provides the best guide.

Step 5—Arranging the Stack

Break Bulk Cargo

Have the cargo arranged in a square or rectangular shape, if possible, to make it easy to cover and to calculate the volume of the stack. An even shaped stack is easy to tarp. The height of the stack should be uniform so dosage can be calculated accurately. For loose cargo, the tarpaulin should be 2 feet above the load and one foot from the sides and ends. Unless specified in the treatment schedule, cargo should not exceed two-thirds of the volume of the area to be fumigated. The maximum size for an enclosure is 25,000 ft^3. Contact the Center for Plant Health Science & Technology (CPHST) in Raleigh, North Carolina, to get approval for any enclosures larger than 25,000 ft^3. For very large enclosures, it may be necessary to:

- install extra circulation fans
- add more samplig leads
- introduce the fumgant at several sites, using multiple volatilizers
- run the circulation fans longer than just the first 30 minutes, if the difference between the highest and lowest gas concentration readings exceeds 4 ounces

Once CPHST has approved the site and enclosure, it does not require additional approvals for subsequent fumigations. The commodity should be on pallets to permit air movement along the floor and between the cargo. Allow an inch or more of space between pallets. By arranging the stack evenly and with space between pallets or cartons, the fumigant will be effectively distributed and dosage calculation should be easier and more accurate. Dosages are easier to calculate when the dimensions are uniform.

When the fumigation involves multiple stacks, allow 10 feet of space between each uncovered stack. After the stack is tarped, there should be approximately 5 feet between enclosures.

Containerized Cargo

Place no more than eight containers that are 20 to 40 feet in length under a single tarpaulin. APHIS recommends that containers not be stacked. Stacking may create too great a safety risk to the person placing the tarp, fans, and gas monitoring leads. If fumigating multiple containers in a single row, have all the rear doors opening on the same side. If multiple containers are placed in two rows, then have all the doors opening on a center aisle toward each other (See **Figure 2-4-1**). The aisle must be at least 3 feet wide. The aisle must be at least 3 feet wide. All doors should be completely open, if possible.

However, APHIS will allow fumigation of containerized cargo with one door open on each container using a configuration such as the one shown in **Figure 2-4-2**, or in a single row of eight containers. Gas should be introduced at both ends of this long row configuration, either at the same time or half at one end and half at the other end. In any case, the single open door on each container must be kept from closing during the fumigation, either taped or blocked open.

CAUTION

APHIS recommends that perishable commodities be fumigated outside their containers. Because it is difficult to aerate the container, the commodity may be damaged by the fumigant if left in the container. Therefore, it is best to remove perishable commodities from their containers before fumigation. When a commodity is removed from the container, spray the emptied container with Malathion as a precaution against leaving the container contaminated with live pests. Pests such as hitchhikers may not remain with the commodity.

However, because of the cost of devanning the commodity most importers choose to have their commodity fumigated inside the container.

Due to safety considerations, containers to be fumigated should not be stacked. Also, to conserve methyl brombide use, CPHST recommends that containers be removed from their chassis prior to fumigation. (If this is not done, then the space beneath the container must be calculated as part of the total volume being fumigated.

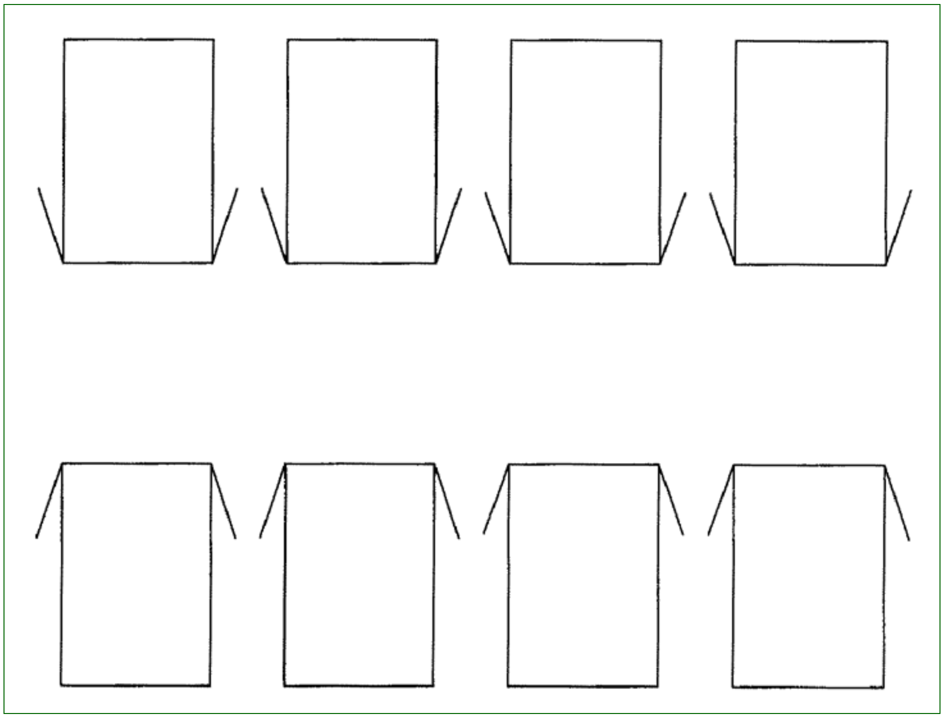

FIGURE 2-4-1: Container Arrangement in Two Rows

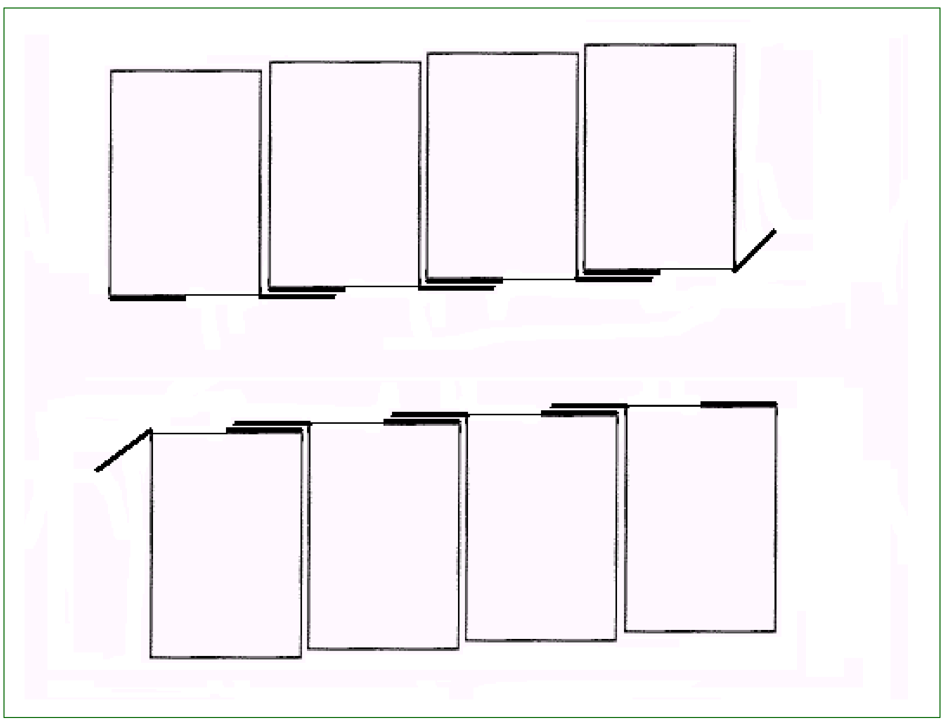

FIGURE 2-4-2: Container Arrangement in Two Rows

Containers should ordinarily not be loaded beyond 80 percent of their capacity. A space of 20 percent (18 inches) should be provided above the commodity. This allows a crawl space for placing the gas monitoring leads and fans, and to facilitate uniform gas distribution. (Some restacking of cargo may be necessary to meet this requirement.) Adequate space (2 inches) should be provided below the commodity. No additional head space is required between the roof of the container and the tarp, unless the pest is found on the outside of the container.

If fumigating multiple containers in a single row, the rear doors should all open on the same side of the stack. If containers are parked parallel to one another and close together, it is permissible to open only the door on the right side of each container, overlapping and taped to the closed left door of the container adjacent to it. In such circumstances, however, one must have a fan positioned high, blowing into the open door of each container, to assure uniform fumigant distribution. If containers are not parked closely together, all doors must be completely open.

Gas Penetration and Distribution

MB will penetrate most cargo easily. When fumigating finely milled products (such as flour, cottonseed meal, and baled commodities), provide space every 5 feet in any direction. Penetration is enhanced by the availability of free MB.

Some of the more common types of impermeable materials are cellophane, plastic, wax coated materials, laminated, and waterproofed papers. Tight wooden packing cases are also relatively gastight. Impermeable materials will allow some gas to penetrate, but make it difficult to aerate and evacuate the gas. Remove, perforate, or open all impermeable materials.

For impermeable wrappers or containers, open the entire top or side and place the package with the open portion on the side.

Step 6—Arranging and Operating Fans

Break Bulk Cargo

Use fans which have the capacity to move a volume in cubic feet per minute equivalent to the total volume of the enclosure. For a 5,000 ft^3 enclosure, use two axial-type (blade) fans of approximately 2,500 cfm. Place one fan on the floor at the rear of the stack facing the front and the other fan at the top front (where the gas is introduced) facing the rear. For enclosures from 5,000 to 7,500 ft^3, add a third fan near the upper middle facing the rear. For enclosures from 7,501 to 10,000 ft^3, add a fourth fan on the floor near the middle facing the front. Enclosures from 10,001 to 25,000 ft^3 may require up to seven fans to provide adequate gas circulation. Enclosures larger than 25,000 ft^3 require approval from the Center for Plant Health Science & Technology (CPHST) in Raleigh, North Carolina.

Turn on all fans to make sure they work. Operate fans during gas introduction and for 30 minutes after the gas is introduced. If after taking gas concentration readings the fumigant is not evenly distributed, run the fans until the gas is evenly distributed as indicated by concentration readings (within 4 oz. of each other). Operate fans when adding gas, but only long enough to get even gas distribution.

Containerized Cargo

Use an appropriate number of fans which have the capacity to move the equivalent cubic feet per minute of the total volume of the enclosure. In addition, place one additional fan of at least 2,500 cfm at the top of the load (near door) of each container facing the opposite end of the container.

Place air introduction ducts, for aeration, into the far ends of each container. Also, place exhaust ducts on the ground in front of the end doors of the containers. Place the end of the ducts near the edge of the tarpaulin so they can be pulled under the tarpaulin when aeration begins.

Step 7—Placing the Gas Introduction Lines

Break Bulk Cargo

Place the gas introduction line directly above the upper front fan. Attach the line to the top of the fan to prevent movement of the hose. An unsecured introduction line could tear the tarpaulin, move the line, or direct it out of the airflow. The fan should be firmly attached to the cargo or have a base that prevents it from toppling (not a pedestal type). Place a piece of impermeable sheeting (example—plastic or rubberized canvas) over the commodity below and to the front of each gas supply line. The sheet will prevent any liquid MB from coming in contact with the cargo.

Containerized Cargo

The number and placement of gas introduction lines will depend upon the number and arrangement of containers to be fumigated.

For single containers, place the introduction line directly above the fan near the rear door of the container.

For multiple containers, place the introduction line near the door end of the containers, but aimed across the open doors rather than directly into one container.

If you are fumigating four or more containers under one tarpaulin, then use two gas introduction lines.

Step 8—Placing the Gas Sampling Tubes

Break Bulk Cargo

Place a minimum of three gas sampling tubes for fumigations up to 10,000 ft^3. Position the gas sampling tubes in the following locations:

- Front low—front of the load, 3 inches above the floor
- Middle center—center of the load, midway from bottom to top of load
- Rear high—rear of the load, at the extreme top of the load

See **Figure 2-4-3**

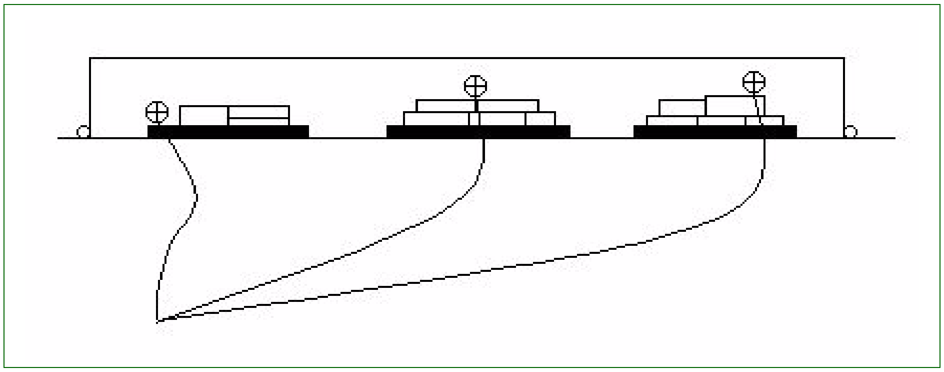

FIGURE 2-4-3: Gas Lead Position (Side View)

For fumigations from 10,001 to 25,000 ft^3, use six gas sampling tubes. Position the gas sampling tubes in the following locations:

- Front low—front of the load, 3 inches above the floor
- Upper front quarter section
- Middle center—center of the stack, midway from bottom to top
- Upper rear quarter section
- Lower rear quarter section
- Rear high—rear of the stack, at the extreme top

Contact the Center for Plant Health Science & Technology (CPHST) in Raleigh, North Carolina, for approval of fumigations larger than 25,000 ft^3, for instructions for number of gas sampling tubes, and for other technical information.

For khapra beetle cargo containing baled, packaged, finely milled, or closely packed commodities, place two additional gas sampling tubes in the center of the bags, packages, or bales. Before placing gas sampling tubes in commodities, place burlap over the end of the tube and secure the burlap to the tube with tape.

Containerized Cargo

For multiple containers (either 20 or 40 feet in length) under the same tarpaulin, use at least three tubes per container. Also, for single containers, use at least three tubes, and for khapra beetle infestations, use two additional tubes. Position the gas sampling tubes as follows:

- Front low—near the floor at the door end of the container
- Rear high—rear of the load at the high end opposite the fan
- Middle center—mid way from front to back, at mid depth

If treating commodities for khapra beetle, you will need the following additional gas sampling tubes:

- High (in the commodity)
- Low (in the commodity)

Cover the end of the gas sampling tube with burlap taped to the tube before insertion into the commodity.

Break Bulk and Containerized Cargo

Use gas sampling tubes of sufficient length to extend from the sampling position inside the enclosure to at least 30 feet beyond the tarpaulin. Have all the gas sampling tubes meet in one area for ease and safety in taking gas concentration readings. Do not splice gas sampling tubes. Before starting the fumigation, test all gas sampling tubes for tightness by connecting each gas sampling tube to the T/C unit and placing a finger over the far end of the gas sampling tube. The ball in the flow meter will fall to zero if the gas sampling tube connections are tight. Replace any defective gas sampling tubes. Before starting the fumigation, check for gas sampling tube blockage or pinching by connecting each tube for a short time. If the tube is blocked, the flow meter will drop sharply.

Fix all gas sampling tubes securely in place under the tarpaulin and label each one at the end where the gas concentration readings will be taken. By labeling each gas sampling tube, you will be able to record concentration readings easily.

Step 9—Padding Corners

Look for corners and sharp angles which could tear the tarpaulin. Never use commodity to support the tarpaulin. If the sharp angles or corners can not be eliminated, they must be covered with burlap or other suitable padding (example—old tires or cloth). (See **Figure 2-4-4** below.)

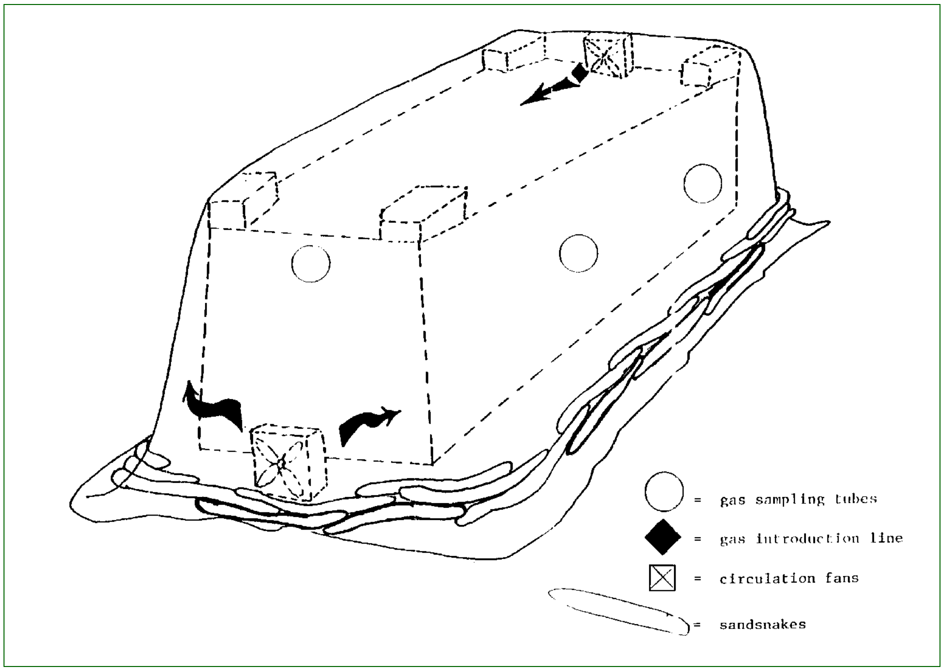

FIGURE 2-4-4: Typical Stack Arrangement with Fans, Leads, Introduction Line, Padding, and Sand Snakes

Step 10—Measuring the Temperatures

Important

Regardless of the commodity, never fumigate at temperatures below 40 °F.

Temperature recordings should be rounded to the nearest tenth of a degree (C ° or F °)

Determine the temperature to use in selecting the proper dosage rate:

- For fruits, pulpy vegetables, or logs use only the commodity temperature.
- For all other commodities use both the commodity and air temperature.

To take the temperature readings, use a bimetallic, mercury, or digital long-stem thermometer that has been calibrated. Use **Table 2-4-2** to determine which temperature to use when selecting the proper dosage rate for commodities other than fresh fruits, vegetables, or logs.

TABLE 2-4-2: Determine the Temperature for the Proper Dosage Rate

If the air temperature is:	And:	Then, for commodities other than fresh fruits or pulpy vegetables or logs and lumber:
Higher than the commodity temperature	→	Use the single lowest commodity temperature for determining the dosage rate (Do Not use the average commodity temperature).
Lower than the commodity temperature	By 9 degrees or less	
	By 10 degrees or more	Use the average of the single lowest air and commodity temperatures for determining the dosage rate (Never initiate a fumigation if any commodity temperature reads lower than 40°F.)

EXAMPLE: You are about to fumigate guar gum and the commodity temperature is 82 °F and the air temperature is 69 °F. Average the air and commodity temperatures to determine the dosage rate because the air is 13 degrees lower than the commodity temperature. The average of the two temperatures is 75.5 °F. Use 75 °F to determine the dosage rate.

If the commodity is fruits, pulpy vegetables, or logs, see the specific procedures that follow.

Fresh Fruits and Pulpy Vegetables

For fresh fruit and pulpy vegetables, insert the thermometer into the pulp. (for purposes of this paragraph, peppers are also included in the category of pulpy vegetables.) For commodities which have been refrigerated, probe the fruit that have the lowest pulp temperature. Again, fumigate only when the fruit pulp is at 40 °F or higher.

However, if the commodity has no pulp (for example, peas, beans, grains, herbs, spices, etc.), take the temperature of the air space immediately surrounding the commodity as well as the commodity temperature. With these temperatures, use **Table 2-4-2** to determine the correct temperature for use when selecting the proper dosage rate.

Logs and Lumber

Select several representative locations within the stack at the ends of the logs or pieces of lumber and drill holes in them to accommodate a thermometer. After drilling, wait at least 10 minutes to allow the wood around the holes to cool. Insert the thermometer into the holes drilled. Record the temperature from each hole, and average the readings. All readings (not just the average) must be above 40 °F.

Take temperature readings in each hold. Base the dosage calculation on the lowest reading obtained. (Do not average temperatures.) All readings must be above 40 °F to initiate the fumigation. If not, you must postpone it.

Record the temperatures in Block 22 of the PPQ Form 429.

Important

> When the commodity and air temperature drastically differ, moisture may condense inside the gas sampling tubes or inside the T/C unit and cause inaccurate gas concentration readings. Check the gas sampling tubes frequently for possible puddling of condensed water, and drain it off, as needed, before taking a reading. Also, check the Drierite frequently, and change it as soon as it becomes saturated with water [turns pink], to obtain true gas concentration readings. Never fumigate commodities that are frozen.

Step 11—Covering the Stack

After covering the stack, check the tarpaulin for rips, tears, and holes. Look at the spots that have been taped, and verify they are properly sealed. Have the fumigator repair all holes.

The tarpaulin should be made of a material such as vinyl, polyethylene plastic, or coated nylon. 4 mil vinyl or polyethylene plastic tarpaulins are only approved for one usage; 6 mil vinyl or polyethylene plastic tarpaulins may be used up to four times with the officer's approval for each usage; 10 to 12 mil rubber or plastic coated nylon tarpaulins may be approved for multiple use with the officer's approval for each usage.

The fumigator should cover all corners and sharp ends with burlap or other padding to prevent the tarpaulin from ripping. Have the fumigator pull the tarpaulin over the stack, being careful not to catch or tear the tarpaulin. Make sure there is sufficient structural support to raise the tarpaulin 2 feet above and 1 foot beyond the sides of the commodity.

The tarpaulin must be large enough to provide a floor overlap of at least 18 inches around all sides of the stack. Carefully lay the tarpaulin out to prevent excess folds or wrinkles along the floor, especially around corners.

Important

> Sealed containers and vans cannot be considered as "fumigation chambers," and therefore **must be covered by a tarpaulin**, unless they can pass the pressure-leakage test.
>
> However, refrigerated containers (reefers) may be fumigated without a tarpaulin if specific requirements are met. See "Special Procedures for Container Fumigations Without a Tarpaulin.

Step 12—Sealing the Tarpaulin

Sealing may be accomplished with loose, wet sand, sand snakes, water snakes, adhesives, or a combination. If there is danger of crushing or crimping the gas sampling or introduction tubes, use the loose, wet sand. If using snakes, use two rows of snakes along the sides and three rows on the corners. The snakes should overlap each other by approximately 1 foot. The goal in sealing the tarpaulin is to get the tarpaulin to lie flat against the floor to prevent gas from leaking out. When wind is not a factor, plastic tape may be used for sealing the tarp. The tarp must be at least 2 inches in width, and applied (only to a smooth surface) with the aid of high-tack spray adhesive.

Seal corners by laying two sand snakes around the corner and working the tarpaulin until it is flat. Place a third snake on top of the two other snakes to provide additional weight to force the tarpaulin against the floor. Loose, wet sand can be used in the area where the gas introduction line, electrical cords, and gas sampling tubes extend from under the tarpaulin.

Step 13—Measuring the Volume

Using a 100-foot tape measure, carefully measure the length, width, and height of the enclosure. *Never* estimate the measurements. An error in measurement of as little as 12 inches can result in miscalculation of the dosage by as much as 15 percent. When measuring, round off to the nearest quarter foot (example—3 inches = .25 feet). In the case of fumigations of edible commodities, an error can result in an unacceptable level of residue on the commodity. If the sides of the enclosure slope outward from top to bottom, measure both the top and bottom and average the two to determine the dimension. Enclosure height should always be uniform and not require adjustment.

Formula for determining volume:

Length × width × height = volume in cubic feet

EXAMPLE: A stack with measurements H=10′6″, L=42′3″, and W=10′9″ 10.50 × 42.25 × 10.75 = 4,768.9 ft^3 round to 4,769 ft^3

Record volume in Block 26 of the PPQ Form 429.

Step 14—Calculating the Dosage

Calculate dosage by doing the following:

1. Refer to the treatment schedule for the correct dosage rate (lbs./ 1,000 ft^3) based on temperature (°F) (Step 10).
2. Multiply by the dosage (lbs./1,000 ft^3) rate by the volume (ft^3) to get the dosage in pounds.
3. Rules for rounding. Round to nearest 1/4 pound.

Formula for calculating dosage:

$$\text{dosage (lbs.)} = \text{volume}(\text{ft}^3) \times \text{dosage rate (lbs./1,000 ft}^3) = \frac{\text{volume}(\text{ft}^3) \times \text{dosage rate (lbs.)}}{1{,}000 \text{ ft}^3}$$

EXAMPLE: You need to determine the dosage for a stack with a volume of 3,000 ft^3. For 72 °F (air and commodity temperatures), the treatment schedule lists the dosage rate at 2 pounds MB/1,000 ft^3. Determine dosage by doing the following:

$$
\begin{aligned}
\text{1. Volume} &= 3{,}000 \text{ ft}^3 \\
\text{2. Dosage rate} &= 2 \text{ lbs. MB}/1{,}000 \text{ ft}^3 \\
\text{3. Dosage (lbs.)} &= \text{volume (ft}^3) \times \text{dosage rate (lbs./}1{,}000 \text{ ft}^3) \\
&= 3{,}000 \text{ ft}^3 \times 2 \text{ lbs. MB}/1{,}000 \text{ ft}^3 \\
&= \frac{3{,}000 \text{ ft}^3 \times 2 \text{ lbs. MB}}{1{,}000 \text{ ft}^3} \\
&= 6 \text{ lbs. MB}
\end{aligned}
$$

Step 15—Making a Final Check

Just prior to introducing the gas, do the following:

- Turn on all fans and T/C unit to make sure they work.
- Warm up T/C unit at least 30 minutes before zeroing in.
- If contaminant, CO_2, is detected, test again with Ascarite®. If you get a zero reading, proceed. If you don’t get a zero reading, suspect a leak.
- Start volatilizer and heat water to 200 °F or above. A minimum temperature of 150 °F is required at all times during the introduction process.
- Place fumigant cylinder with gas introduction line on scale and take initial weight reading. Make sure the gas introduction line is attached to the cylinder. After obtaining the correct weight, subtract the dosage to be introduced into the enclosure. After you have introduced the proper amount of gas, the scale will be balanced.
- Check that tarpaulin is placarded and the area is secured. Only people working on the fumigation may be in the area.
- Check tarpaulin to make sure it is free from rips and tears.
- Check that all gas sampling tubes are labeled and are not crimped or crushed. Inspect tubes visually, or use an electric or Mityvac hand pump to check tubes. Either a fumiscope or vacuum pump may be used to test leads for unrestricted flow.

Important

When conducting fumigations with methyl bromide, sulfuryl fluoride or phosphine, erroneous readings may occur if the monitoring leads become blocked or crimped. It would be impossible to install a new monitoring lead during a fumigation treatment. Therefore, to avoid an unsuccessful fumigation, you should test monitoring leads before the treatment begins.

CPHST has developed the following procedure to detect blocked monitoring leads with the use of a Mityvac hand-held pump (for supplier, see **Vacuum Pump**, **Appendix H**):

1. Prior to fumigant introduction, connect the Mityvac hand-held vacuum pump to a monitoring lead.
2. Squeeze the handle on the Mityvac unit. If the lead is blocked, a vacuum will be indicated on the vacuum gauge of the Mityvac unit. (The handle should be squeezed two or three times for monitoring leads longer than 25 feet. The Mityvac hand-held pump has the capacity to attain and hold 25 inches of Hg vacuum and a minimum of 7 psig pressure.)
3. Disconnect the Mityvac hand-held pump from the monitoring lead, and repeat this procedure for each monitoring lead. (Connect monitoring leads to the gas analyzer prior to fumigant introduction.)

- Check that there is enough gas in the cylinder and if necessary, that other cylinders are available.
- Check the gas introduction line connections to make sure they are tight and free of leaks (wearing the SCBA).
- Check all safety equipment, especially SCBA, is available and in working order.
- Install Drierite® tube on gas sample line attached to the T/C unit and check to make sure granules are blue, if pink—replace Drierite®. If humidity is high, additional Drierite® tubes or frequent changes may be necessary.

Conducting the Fumigation

Step 1—Introducing the Gas

CAUTION

The acceptable air concentration level for methyl bromide (MB) is 5 ppm. A respirator (approved SCBA or MSHA/NIDSH) is required if the MB concentration level in the air is greater than 5 ppm at any time. You and the fumigator must use your SCBA while introducing the gas, checking for leaks, and when taking aeration readings.

Turn on all fans before introducing the gas. When using large cylinders of MB, have the fumigator open the cylinder valve slightly, then close the valve. With a halide detector, check all connections on the gas introduction line for leaks. If leaks are found, advise the fumigator to tighten the connections and repeat the test. If no leaks are found, then open the valve to the point where 3 to 4 pounds of MB are being introduced per minute. The water temperature in the volatilizer should never go below 150 °F at any time during gas introduction. The water in the volatilizer may include an antifreeze and should be handled with the appropriate safeguards.

CAUTION

Don't touch the introduction line with your bare hands—you could get burned! Close the cylinder valve once the proper dosage has been introduced.

The fumigation time begins once all the gas has been introduced. Record the time gas introduction was started and completed in Block 32 on the PPQ Form 429. Run the fans for 30 minutes to achieve even gas distribution. Take the initial concentration reading 30 minutes after all the gas has been introduced.

When evacuating large cylinders, getting the final amount of gas out may take a long time. Consider taking a T/C unit reading 30 minutes after the gas was first introduced. If the gas distribution is even (all readings within 4 ounces of each other) and at a significantly high concentration, then turn off the fans. Running the fans longer may contribute to gas leakage. Allow the remainder of the gas to discharge with intermediate running of the fans. Normally, all the gas should be introduced within 30 minutes.

Important

Do **not** begin counting fumigation time until all the gas has been introduced and valve on the MB tank is closed.

Step 2—Testing for Leaks

Wear the SCBA while checking for leaks. Use a halide detector to test for leaks before the 30 minute reading or anytime when the concentration level is unknown or above 5 ppm. Test around the perimeter of the tarpaulin on the floor, corners, and especially where electric cords, gas sampling tubes, or gas introduction lines are present. When you detect leaks, have them sealed using more sand or sand snakes for floor leaks and tape for sealing small holes in the tarpaulin.

If you detect excessive leakage (concentration readings of 50 percent or less of the minimum concentration) in a tarpaulin which cannot be corrected in a practical way, do not attempt to correct the problem by adding more gas. Quickly evacuate the remaining gas from the enclosure, eliminate the problem, and construct a new enclosure. Aerate as usual following procedures on **page-2-2-3**. Restart the fumigation in the new enclosure.

CAUTION

Commodities used for food or feed may not be re-treated. If commodities fall into this category, the only options are the following:

- Return to the country of origin
- Re-exported to another country if they will accept the shipment
- Destroy by incineration

Step 3—Taking Concentration Readings

Important

Before taking a reading, always purge sampling lines with a mechanical or hand pump. After connecting the T/C unit to the sampling lead, always adjust the gas flow rate to 1.0, and wait until the meter registering "ounces per thousand cubic feet" stabilizes before taking a reading. (This may take a minute or more, depending upon the length of the tubing and whether or not an auxiliary pump is used.). If you're using treatment schedule T101 or **T401-a** to fumigate fresh fruit or vegetables, see "Special Procedures for Fruits, Vegetables, or Perishable Commodities Using Schedule **T101-a-1** or Equivalent" on **page-2-4-28**.

Take concentration readings with a T/C unit to determine the gas concentration and distribution within the enclosure. Check desiccant tubes before each reading and change Drierite® if its color is pink. Depending upon the length of exposure period, take concentration readings at the following times:

- 30 minutes
- 2 hours
- 4 hours (optional)
- 6 hours (optional)
- 12 hours (optional)
- 24 hours[5]
- 36 hours (optional)
- 48 hours
- 72 hours

Any final concentration reading (see following example)

EXAMPLE: If the treatment schedule lists a 6 hour exposure period, then the 6 hour reading would be required and not optional as shown in step 3. If the treatment schedule lists a 16 hour exposure period, you must take a 16 hour reading.

5 If fumigating oak logs or lumber for export, see "Special Procedures for Adding Gas to Oak Logs and Lumber."

CAUTION

Avoid using hand-held two-way radios near the T/C unit. Using two-way radios near the T/C unit will interfere with an accurate concentration reading.

Thirty Minute Reading

The 30 minute reading shows the initial concentration and distribution of gas. The 30 minute reading can indicate leakage, sorption, incorrect dosage calculation, or error in fumigant introduction—all of which require immediate attention. Concentration readings should not differ more than 4 ounces among the leads.

Two Hour Reading

In comparison with the 30 minute reading, the 2 hour reading also will indicate if the tarpaulin is leaking or the commodity is sorbing gas. Readings more than 15 percent lower than the 30 minute reading will require close monitoring and possible corrective action.

EXAMPLE: Your dosage for the fumigation was 4 pounds (64 ounces). The 30 minute reading was 50 ounces (3.125 pounds). The 2 hour reading is 42 ounces (2.625 pounds). The 2 hour reading is more than 15 percent less than the 30 minute reading and would indicate that either a leak or sorption problem may exist. You would need to monitor the fumigation closely until the concentration level stabilizes.

Four, Six, Twelve, or Thirty-Six Hour Reading

Not required if previous readings are satisfactory and experience with similar fumigations indicate successful treatment can be expected. If either the 4, 6, 12, or 36 hour reading is the final reading, then you must take the reading. If you are unfamilar with the treatment schedule, optional concentration readings may be necessary to ensure a successful fumigation.

Final Reading

The final reading is required for all tarpaulin fumigations in order to determine if the fumigation has been successfully completed. You may start the final reading before the finishing time of the treatment so that aeration commences at the finishing time. Starting the final reading before finishing time is especially critical when fumigating perishables. Do not add gas after the final reading.

Additional Readings

Decide the need to take additional readings based on the following:

- Rate of gas concentration decrease
- Any condition which could change the gas concentration such as severe winds, or rain.

When concentration readings differ by more than 4 ounces, run the fans to equalize the gas and record readings on the APHIS 429. Generally, at the 1/2 hour reading, gas should be evenly distributed, and you should not have to restart the fans unless you added gas.

Severe winds (30 mph or higher including any amount severe enough to cause damage) are a good reason to take additional readings on an outdoor fumigation. Any sharp or unusual decreases of the readings in relation to previous readings is a clue to take corrective action and supplementary readings. Take additional readings every 30 minutes until problems are rectified. Adverse weather conditions may indicate the need for additional readings.

Sorptive commodities may also require additional concentration readings.

Step 4—Determining the Need to Add Gas and Adjust Exposure

Use the following table to determine when to add gas or extend the exposure period:

TABLE 2-4-3: Determine the Need to Add Gas and Adjust Exposure

If the average T/C unit readings are:	And the schedule is:	Then:
Below the required minimum concentration	T101-a-1* or equivalent	ADD gas and extend fumigation. SEE “Special Procedures for Fruits, Vegetables, or Perishable Commodities Using Schedule T101-a-1 or Equivalent” on **page-2-4-25**
	Other than T101-a-1 or equivalent	ADD gas using ““Special Procedures for Adding Gas to Oak Logs and Lumber Using T312 or Equivalent” on **page-2-4-28**
At or above required minimum concentration	T101-a-1* or equivalent	SEE pages **page-2-4-21** for corrections at 0.5 hour and 2 hour readings
	Other than T101-a-1	No action necessary

Important

* T101-a-1 or equivalent treatment schedules are those schedules that are not greater than 2 hours long (exposure time), and the dosage rate is not greater than 4lbs per 1000ft^3, anywhere on the schedule.

Special Procedures for Adding Gas and Extending Exposure Period

Adding Gas to Commodities that are Fumigated Using Treatment Schedules other than T101-a-1 or Equivalent (may include perishables)

Important

T101-a-1 or equivalent treatment schedules are those schedules that are **not** greater than 2 hours long (exposure time), and the dosage rate is **not** greater than 4lbs per 1000ft^3.

NOTICE

To avoid injuring the commodity, add fumigant using the following formula:

1.6 × number of oz. below minimum × volume in ft.3/1,000 ft.3 = oz. of gas to add or oz. of gas to add/16 oz/lbs. = pounds (lbs.) of gas to add.

When adding gas, these procedures must be followed:

1. Heat water in volatilizer.
2. Turn on fans.
3. Take weight of the cylinder.
4. With SCBA on, open valve on cylinder and introduce the gas.
5. Close valve when the weight of the cylinder indicates that the needed amount of gas has been added.
6. Record quantity of fumigant added in Block 34 and the additional fan time in Block 30 of the PPQ Form 429.

Note the time the fumigator started introducing additional gas and the time the fumigator finished introducing gas and record in Block 40 (Remarks) of the PPQ Form 429. Run the fans until there is even gas distribution throughout the stack. Turn off fans, then take a concentration reading 30 minutes after the gas has been introduced. If all readings are above minimum concentration levels, then proceed as usual with the remaining scheduled concentration readings.

Excessive leakage in any one tarpaulin enclosure, which cannot be eliminated in a practical way, must ***not*** be corrected by the addition of MB. (Excessive leakage has occured when concentration readings are less than or equal to 50 percent of minimum concentration reading). Quickly evacuate remaining gas from such an enclosure, eliminate the problem, and construct a new enclosure. Start a new treatment in the new enclosure.

CAUTION

Commodities used for food or feed may not be re-treated. If commodities fall into this category, the only options are the following:

- Re-export to another country if they will accept the shipment
- Destroy by incineration

Extending the Exposure Period for Food, Nonfood, Feed, or Nonfeed Commodities

Use the following table to determine how long to extend the exposure period.

TABLE 2-4-4: Determine the Extended Exposure Period

If the exposure time is:	And the reading is below minimum by:[1]	Then extend exposure:
Less than 12 hours	10 oz. or less	10 percent of the time lapse since the last acceptable reading
	11 oz. or more	30 minutes
12 hours or more	10 oz. or less	10 percent of the time lapse since the last acceptable reading
	11 oz. or more	2 hours or 10 percent of time lapse since last acceptable reading, whichever is greater

1 If a reading is 50 percent or more below the minimum concentration reading, then abort the treatment. For example, if the minimum reading is 38 ounces then the reading 50 percent below the minimum is 19 ounces [38 ounces – (38 ounces × .50) = 19 ounces]. (See the following special procedures for fruits and vegetables using T101 or equivalent.) For oak logs and oak lumber (T312-a and T312-b), the rule for adding exposure time does not apply. Refer to the schedules for specifics.

Special Procedures for Fruits, Vegetables, or Perishable Commodities Using Schedule T101-a-1 or Equivalent

Use these instructions only for fruits and vegetables being fumigated under treatment schedule T101-a-1 or equivalent.

CAUTION

Fresh fruits and vegetables are sensitive to MB so you should double check volume calculations and dosage measurements to avoid accidental overdoses. If any 30 minute readings are 50 percent or more above the minimum concentration, it indicates a miscalculation of the dosage. Include a brief report on the PPQ Form 429 stating possible reasons for the overdose. Exposure periods are decreased for fumigations where concentration readings are much higher than required. See table on the following pages to determine when to reduce exposure periods.

Use **Table 2-4-5** and **Table 2-4-3** on the following pages for fresh fruits and vegetables to determine if you need to add gas or extend or decrease the exposure time. Average your concentration readings before using the tables. Select the proper table based on the time of the T/C unit concentration reading (30 minutes or 2 hours).

Important

These tables apply **only** to those T101 schedules lasting 2 hours or less at a dosage rate of 4lbs/1000ft^3 or less. They do not apply to schedules of longer duration.

Adding Gas

NOTICE

To avoid injuring the commodity, add fumigant using the following formula:

1.6 × number of oz. below minimum × volume in ft.3/1,000 ft.3 = oz. of gas to add or oz. of gas to add/16 oz/lbs. = pounds (lbs.) of gas to add.

When adding gas, these procedures must be followed:

1. Heat water in volatilizer.
2. Turn on fans.
3. Take weight of the cylinder.
4. With SCBA on, open valve on cylinder and introduce the gas.
5. Close valve when the weight of the cylinder indicates that the needed amount of gas has been added.
6. Record quantity of fumigant added in Block 34 and additional fan time in Block 30 of the PPQ Form 429.

Note the time the fumigator started introducing additional gas and the time the fumigator finished introducing gas and record in Block 40 (Remarks) of the PPQ Form 429. Run the fans until there is even gas distribution throughout the stack. Turn off fans, then take a concentration reading 30 minutes after the gas has been introduced. If all readings are above minimum concentration levels, then proceed as usual with the remaining scheduled concentration readings.

TABLE 2-4-5: Determine Gas Concentration Values and Corrections for Fruits and Vegetables at the 30 Minute Reading of T101-a-1 or Equivalent Schedules.

If the schedule is:	Add the minimum concentration reading (oz.) in schedule is:	And the average concentration reading (oz.) is:	Then:
40-49 °F 4 lbs for 2 hrs	48	73 or higher*	EVACUATE excess gas immediatley
		65 or greater[1]	REDUCE exposure by 15 minutes
		64-48	TAKE 2 hour reading as scheduled
		47 or lower	1. ADD gas, and 2. EXTEND exposure 15 minutes
50-59 °F 3 lbs for 2 hrs	38	58 or higher*	EVACUATE excess gas immediatley
		52 or greater	REDUCE exposure by 15 minutes
		51-38	TAKE 2 hour reading as scheduled
		37 or lower	1. ADD gas, and 2. EXTEND exposure 15 minutes
60-69 °F 2.5 lbs for 2 hrs	32	49 or higher*	EVACUATE excess gas immediatley
		48 or greater	REDUCE exposure by 15 minutes
		47-32	TAKE 2 hour reading as scheduled
		31 or lower	1. ADD gas, and 2. EXTEND exposure 15 minutes
70-79 °F 2 lbs for 2 hrs	26	40 or higher*	EVACUATE excess gas immediatley
		37 or greate	REDUCE exposure by 15 minutes
		36-26	TAKE 2 hour reading as scheduled
		25 or lower	1. ADD gas, and 2. EXTEND exposure 15 minutes
80-89 °F 1.5 lbs for 2 hrs	19	30 or higher*	EVACUATE excess gas immediatley
		27 or greater	REDUCE exposure by 15 minutes
		26-19	TAKE 2 hour reading as scheduled
		18 or lower	1. ADD gas, and 2. EXTEND exposure 15 minutes

1 *If concentration reading is more than 50 percent above the minimum concentration reading, it indicates that something is radically wrong and an immediate check should be made to determine the cause and to correct it.

TABLE 2-4-6: Determine Gas Concentration Values and Corrections for Fruits and Vegetables at the 2 Hour Reading of T101-a-1 or Equivalent Schedules.

If the schedule is:	And the average concentration reading at 2 hours is:	Then do not add gas, but:
40-49 °F 4 lbs for 2 hours	38 and above	AERATE commodity (see **page-2-4-29**)
	37-28	EXTEND exposure by 15 minutes
	27-25	EXTEND exposure by 30 minutes
50-59 °F 3 lbs for 2 hrs	29 and above	AERATE commodity (see **page-2-4-32**)
	28-24	EXTEND exposure by 15 minutes
	23-21	EXTEND exposure by 30 minutes
60-69 °F 2.5 lbs for 2 hrs	24 and above	AERATE commodity (see **page-2-4-32**
	23-21	EXTEND exposure by 15 minutes
	20-18	EXTEND exposure by 30 minutes
70-79 °F 2 lbs for 2 hrs	19 and above	AERATE commodity (see **page-2-4-32**
	18-16	EXTEND exposure by 15 minutes
	15-13	EXTEND exposure by 30 minutes
80-89 °F 1.5 lbs for 2 hrs	14 and above	AERATE commodity (see **page-2-4-32**)
	13-12	EXTEND exposure by 15 minutes
	11-10	EXTEND exposure by 30 minutes

Special Procedures for Adding Gas to Oak Logs and Lumber Using T312 or Equivalent

After taking the 24 hour concentration reading, if necessary, add gas to bring the concentration level up to 240 ounces. Subtract the 24 hour concentration reading from 240 to determine how many ounces the concentration is below 240 ounces. Use the following formula in calculating how much gas to add:

1.6 × number of oz. below 240 × volume in $\text{ft}^3/1{,}000\ \text{ft}^3$ = oz. of gas to add or

$$\frac{\text{oz. of gas to add}}{16\frac{\text{oz.}}{\text{lbs.}}} = \text{pounds (lbs.) of gas to add}$$

EXAMPLE: You're fumigating a 10,000 ft^3 enclosure of oak logs for export. At the 24 hour reading, the T/C unit readings indicate a 160 oz. concentration level. To determine how much gas to add, do the following:

240 oz. – 160 oz. = 80 oz. below 240 oz.

1.6 × 80 oz. × 10,000 $\text{ft}^3/1{,}000\ \text{ft}^3$ = 1,280 oz. or

$$\frac{1{,}280\text{oz.}}{16\frac{\text{oz.}}{\text{lbs.}}} = 80 \ \text{ pounds (lbs.) of gas to add}$$

Take concentration readings 30 minutes after adding gas and record on the PPQ Form 429.

Step 5—Exhausting the Gas

Exhaust the gas at the completion of the exposure period. If the treatment schedule is a FIFRA Section 18 Exemption, then you must monitor the aeration of the commodity. Use the following table to determine the need to monitor the aeration of the fumigation.

TABLE 2-4-7: Determine the Need to Monitor Aeration

If the treatment schedule is:	Then:
A FIFRA Section 18 Exemption	MONITOR the aeration of the commodity. FOLLOW "Aerating the Enclosure" steps which follow.
A labelled treatment	RELEASE the commodity and RELEASE the fumigation to the fumigator for aeration.

Aerating the Enclosure

Aeration procedures are designed to provide safe working conditions during the aeration period and to assure that commodities are safe for handling, storage, and transportation. A fumigant must be aerated in accordance with Environmental Protection Agency (EPA) label requirements, the Occupational Safety and Health Administration (OSHA), and the PPQ Treatment Manual.

When treatments are conducted in a paticular location on a regular basis, a permanent site should be designated. At such sites, the fan used to remove the fumigant from the enclosure during aeration must be connected to a permanent stack extending above the roof level.

Aeration of fumigated structures and ships are covered within those particular sections.

Responsibility for Aerating the Commodity

The label requires that at least two people trained in the use of the fumigant must be present at all times during gas introduction, treatment, and aeration. The PPQ officer, however, is not required to be continuously present at the fumigation site throughout the aeration process unless specified by the label or by State or local regulations.

If the fumigation is performed under a Section 18 Exemption, then a PPQ officer must be present at the initiation of aeration and to verify the final aeration readings.

TABLE 2-4-8: Determine Responsibility for Aerating the Commodity

If the Treatment Schedule is:	Then:
A FIFRA Section 18 Exemption	1. MONITOR the aeration of the enclosure, and 2. USE the table 2-4-9 to determine which aeration procedure to follow
A labeled Treatment Schedule	1. RELEASE the fumigation to the fumigator to aerate according to label instructions and the conditions of the compliance agreement. 2. RELEASE the commodity.

Materials Needed

The following materials will be needed to aerate the enclosure:

- SCBA[6]
- Colorimetric tubes (Draeger or Kitagawa for example)
- Exhaust fan[7]
- Exhaust duct[8]
- Danger signs[9]
- Materials for limiting access to area (barricades, rope)[10]
- PPQ Form 429

The following procedures apply to the aeration of all tarpaulin fumigations.

Securing the Area

Assuming that you have already restricted access and secured the fumigation area, you now must restrict access to the area where the exhaust duct extends on the ground beyond the enclosure.

CAUTION

During the first 10 minutes of aeration, it is recommended that no people should be within 200 feet of the exhaust duct outlet.

If this buffer zone is regulated by the State or municipality where the fumigation takes place, local regulations must be followed.

6 Materials required for both PPQ and commercial fumigator.
7 Materials to be furnished by the commercial fumigator.
8 Materials to be furnished by the commercial fumigator.
9 Materials to be furnished by the commercial fumigator.
10 Materials to be furnished by the commercial fumigator.

If it is impossible to restrict people from the area of aeration during regular work hours, consider aeration during another time of the day. When securing the duct outlet area, consider the direction of the wind. Face the duct outlet toward an open area, and away from people. Point the duct outlet upward to aid in dispersing the exhausted gas.

Advise the fumigator to use a physical barrier such as ropes, barricades, or walls to secure the area.

Placard the secure area near the exhaust outlet with the appropriate DANGER/PELIGRO signs. Make sure the placards meet the appropriate fumigant label or labeling requirements. The skull and crossbones should be present as well as “AREA UNDER FUMIGATION, DO NOT ENTER/NO ENTRE”; date of the fumigation; name of the fumigant used; and the name, address, and telephone number of the fumigator.

Unless you authorize their use, do *not* allow motorized vehicles to operate within the secure area.

Wearing Respiratory Protection

The fumigator and the PPQ officer monitoring the aeration must wear approved respiratory protection (SCBA, air supplied respirator, or a combination unit) when:

- Installing the exhaust system
- Opening the tarpaulin for aeration
- Removing the tarpaulin if measured levels of fumigant are above 5 ppm
- Any time during the aeration process when a risk of exposure to concentrations above 5 ppm exists. This includes any time the concentration is unknown.

TABLE 2-4-9: Determine the Aeration Procedure

If:	And:	And:	Then:
Nonsorptive	Containerized	→	GO to **page-2-4-32**
	Noncontainerized	Fresh fruits and vegetables, and cut flowers	GO to **page-2-4-33**
		Other than fresh fruits and vegetables, and cut flowers	GO to **page-2-4-33**
Sorptive, including yams and chestnuts	Containerized	→	GO to **page-2-4-38**
	Noncontainerized	→	GO to **page-2-4-36**

Aerating Nonsorptive, Containerized Cargo—Indoors and Outdoors

Step 1—Installing Exhaust System

Advise the fumigator to:

1. Install an exhaust fan (minimum of 5,200 cfm capacity) to a 16 inch, or greater, diameter duct located at the floor near rear doors of the container.
2. Install an air introduction duct system consisting of a 3,750 cfm, or greater, fan attached to a 12 inch, or larger, duct which reaches two-thirds of the length of the container at the top of the load. Have the ducts installed prior to the start of the fumigation. For indoor fumigation, extend the exhaust duct at least 30 feet beyond the building or through a vertical stack extending through the roof. For outdoor fumigations, extend the exhaust duct at least 30 feet beyond the container.

Important

(1) Volume of enclosure (in cubic feet) divided by the sum of cubic feet per minute (cfm) of the exhaust fan(s) or exhaust blower equals the number of minutes required per complete gas volume exchange. (2) Sixty minutes divided by the number of minutes per gas volume exchange equals the number of complete gas exchanges per hour. The result should be in the range of 4 to 15. The faster the rate of aeration the better, particularly for perishable commodities. If the exhaust flow is•connected to a methyl bromide recovery system, this device must not impede the flow rate to less than 4 volumes per hour.

Step 2—Aerating the Commodity

Advise the fumigator to:

1. Connect the exhaust duct to the exhaust fan.
2. Start the exhaust fan(s) and lift the end of the tarpaulin opposite the end at which the exhaust fan and duct are located.
3. Aerate for 3 hours.
4. Stop the aeration fans.
5. Use a colorimetric tube to take a concentration reading in the exhaust duct.

After the fumigator takes the concentration reading, you must record the date, concentration reading, and time in Block 39 of PPQ Form 429. Then use the following table to determine when to release the commodity.

TABLE 2-4-10: Determine When to Release the Commodity

If the gas concentration level is:	Then:
5 ppm or less	RELEASE the commodity
6 ppm or more	1. CONTINUE aeration until the concentration is 5 ppm or less[1], then 2. RELEASE the commodity

1 Take concentration readings with colormetric tubes 4 feet from the base of the stack and 1 foot inside the stack at two locations between the cartons, but not inside the cartons.

Aerating Nonsorptive, Noncontainerized Cargo—Indoors and Outdoors

Step 1—Installing the Exhaust System

Important

This step is optional for outdoor fumigations, but must be done for indoor fumigations.

Advise the fumigator to:

1. Install an exhaust duct (minimally one 3,500 cfm capacity fan connected to an exhaust duct). An exhaust duct is optional for outdoor fumigations.
2. Extend the exhaust duct outlet to an outside area where there is adequate ventilation and at least 30 feet away from the building or through a vertical exhaust stack extending through the roof.

Important

(1) Volume of enclosure (in cubic feet) divided by the sum of cubic feet per minute (cfm) of the exhaust fan(s) or exhaust blower equals the number of minutes required per complete gas volume exchange. (2) Sixty minutes divided by the number of minutes per gas volume exchange equals the number of complete gas exchanges per hour. The result should be in the range of 4 to 15. The faster the rate of aeration the better, particularly for perishable commodities. If the exhaust flow is•connected to a methyl bromide recovery system, this device must not impede the flow rate to less than 4 volumes per hour.

Step 2—Aerating the Commodity

Advise the fumigator to:

1. Start the exhaust fan.

2. Lift the end of the tarpaulin opposite the end with the exhaust fan and duct (if used).
3. Aerate the enclosure for 2 hours.

Outdoor Fumigations

Advise the fumigator to:

1. Stop the fans.
2. Remove the tarpaulin.
3. Take concentration readings with colormetric tubes 4 feet form the base of the stack and 1 foot inside the stack at two locations between the cartons, but not inside the cartons.

After the fumigator takes the concentration reading, you must then record the date, concentration reading, and time in Block 39 of PPQ Form 429. If you are not at the fumigation site, have the fumigator call and give you the information. Then use the following table to determine when to release the commodity.

TABLE 2-4-11: Determine When to Release the Commodity for Outdoor Fumigations

If the gas concentration level is:	Then:
5 ppm or less	RELEASE the commodity
6 ppm or more	1. CONTINUE aeration and take concentration readings until the level is 5 ppm or less, then 2. RELEASE the commodity

Indoor Fumigations

Advise the fumigator to:

1. Stop the fans.
2. Take concentration readings with colorimetric tubes in the exhaust duct.

After the fumigator takes the concentration reading, you must record the date, concentration reading, and time in Block 39 of PPQ Form 429. Then use the following table to determine when to release the commodity.

TABLE 2-4-12: Determine When to Release the Commodity for Indoor Fumigations

If the gas concentration level is:	Then:
5 ppm or less	1. ADVISE fumigator to REMOVE the tarpaulin, and 2. RELEASE the commodity
6 ppm to 99 ppm	1. ADVISE fumigator to REMOVE the tarpaulin, and 2. CONTINUE aeration until the concentration is 5 ppm or less, then 3. RELEASE the commodity
100 ppm or above	1. CONTINUE aeration and take concentration readings until the concentration level is below 100 ppm, then remove the tarpaulin, and 2. CONTINUE aeration until concentration is 5 ppm or less, then 3. RELEASE the commodity

Aeration Procedures for Fresh Fruits, Vegetables, and Cut Flowers—Indoors or Outdoors

Important

Do **not** use these procedures for fresh chestnuts or yams. (See procedures for sorptive commodities on page-2-4-38)

Step 1—Installing Exhaust System

Use the following table to determine which size fan to use.

TABLE 2-4-13: Determine Number of Fans

If the enclosure is:	Then:
Evenly stacked up to 25,000 ft^3	USE two 5,000 cfm fans connected to 3 foot diameter exhaust ducts
Irregularly stacked of any size	USE three 5,000 cfm fans connected to 3 foot diameter exhaust ducts
More than 25,000 ft^3	CONTACT the Center for Plant Health Science & Technology (CPHST) in Raleigh, North Carolina.
Up to 1000 cu ft	USE one fan, 67-350 cfm
1001-15,000 cu ft	USE one or 2 fans. The volume of the enclosure divided by the sum of the cfm of the fans should equal a figure of 15 or less. Connect fan(s) to 3-ft diameter exhaust duct(s) 3 ft in diameter.
15,001-25,000 cu ft	USE two fans, each 1,000 to 5,000 cfm. The volume of the enclosure divided by the sum of the cfm of the fans should equal a figure of 15 or less. Connect fan(s) to exhaust duct(s) 3 ft in diameter.
More than 25,000 cu ft	CONTACT the Center for Plant Health Science and Technology (CPHST) in Raleigh, North Carolina, for advice prior to conducting the first fumigation.

An alternate procedure to using exhaust fans and ducts is to aerate through a vertical stack.

Important

(1) Volume of enclosure (in cubic feet) divided by the sum of cubic feet per minute (cfm) of the exhaust fan(s) or exhaust blower equals the number of minutes required per complete gas volume exchange. (2) Sixty minutes divided by the number of minutes per gas volume exchange equals the number of complete gas exchanges per hour. The result should be in the range of 4 to 15. The faster the rate of aeration the better, particularly for perishable commodities. If the exhaust flow is•connected to a methyl bromide recovery system, this device must not impede the flow rate to less than 4 volumes per hour.

Step 2—Aerating the Commodity

Advise the fumigator to:

1. Connect the exhaust duct to the exhaust fan.
2. Start the exhaust fan(s) and lift the end of the tarpaulin opposite the end at which the exhaust fan and duct are located.
3. Aerate for 2 hours.
4. Remove the tarpaulin and allow 2 hours for passive aeration.
5. Take a final reading.

After the fumigator takes the concentration reading, you must record the date, concentration reading, and time in Block 39 of PPQ Form 429. Then use the following table to determine when to release the commodity.

TABLE 2-4-14: Determine When to Release the Commodity

If the gas concentration level is:	Then:
5 ppm or less	RELEASE the commodity
6 ppm or more	1. CONTINUE aeration and take concentration readings until the level is 5ppm or less, then 2. RELEASE the commodity

Important

Give the original and one copy to your supervisor for review. The supervisor should keep the original for port files and send one copy to:

USDA, APHIS, PPQ, CPHST
Treatment Support & Certification
1017 Main Campus Drive, Suite 2500
Raleigh, NC 27606

Aerating Sorptive, Noncontainerized Cargo—Indoors and Outdoors

Step 1—Installing the Exhaust System

Important

This step is optional for outdoor fumigations, but must be done for indoor fumigations.

Advise the fumigator to:

1. Install an exhaust duct (minimally one 3,500 cfm capacity fan connected to an exhaust duct).
2. Extend the exhaust duct outlet to an outside area where there is adequate ventilation and at least 30 feet away from the building or through a vertical exhaust stack extending through the roof.

Step 2—Aerating the Commodity

Outdoor Fumigations

Advise the fumigator to:

1. Lift both ends of the tarpaulin.
2. Start the circulation fans and exhaust fans (if available).
3. Run the fans for 4 hours.
4. Remove the tarpaulin.
5. Take concentration readings with colormetric tubes 4 feet from the base of the stack and 1 foot inside the stack at two locations between the cartons, but not inside the cartons.

After the fumigator takes the concentration reading, you must record the date, concentration reading, and time in Block 39 of PPQ Form 429. Then use the following table to determine when to release the commodity.

TABLE 2-4-15: Determine when to Realease the Commodity

If the gas concentration level is:	Then:
5 ppm or less	RELEASE the commodity
6 ppm or more	1. CONTINUE aeration and take concentration readings until the level is 5ppm or less, then 2. RELEASE the commodity

Indoor Fumigations

Advise the fumigator to:

1. Complete the installation of the exhaust duct.
2. Start the circulation fans and exhaust fans.
3. Lift the end of the tarpaulin opposite the exhaust fan.
4. Run the fans for 4 hours.
5. Stop the fans and take concentration readings with colorimetric tubes in the exhaust duct within 2 feet of the enclosure.
6. Remove the tarpaulin.

After the fumigator takes the concentration reading, you must then record the date, concentration reading, and time in Block 39 of PPQ Form 429. Then use the following table to determine when to release the commodity. Take successive readings at intervals of not less than 2 hours. Take concentration readings with colormetric tubes 4 feet from the base of the stack and 1 foot inside the stack at two locations between the cartons, but not inside the cartons. You, as well as the fumigator, may take concentration readings.

TABLE 2-4-16: Determine When to Release the Commodity for Indoor Fumigations

If the gas concentration level is:	Then:
5 ppm or less	1. REMOVE the tarpaulin, and 2. RELEASE the commodity
6 ppm to 99 ppm	1. REMOVE the tarpaulin, and 2. CONTINUE aeration until the concentration is 5 ppm or less[1], then 3. RELEASE the commodity
100 ppm or above	1. CONTINUE aeration and take concentration readings until the concentration level is below 100 ppm, then remove the tarpaulin, and 2. CONTINUE aeration until concentration is 5 ppm or less, then 3. RELEASE the commodity

1 Take concentration readings with colormetric tubes 4 feet from the base of the stack and 1 foot inside the stack at two locations between the cartons, but not inside the cartons.

Aerating Sorptive Commodities in Containers—Indoors and Outdoors

Step 1—Installing the Exhaust System

Important

This step is not required for outdoor fumigations.

Advise the fumigator to:

1. Install an exhaust fan (minimum of 5,200 cfm capacity) to a 16 inch or greater diameter duct located at the floor near rear doors or the container.
2. Install an air introduction duct system consisting of a 3,750 cfm or greater fan attached to a 12 inch or greater duct which reaches two-thirds of the length of the container at the top of the load. Have the ducts installed prior to the start of the fumigation. For indoor fumigations, extend the exhaust duct at least 30 feet beyond the building or through a vertical stack extending through the roof. For outdoor fumigations, extend the exhaust duct 30 feet beyond the container.

Step 2—Aerating the Commodity

Indoors

Advise the fumigator to:

1. Complete installation of exhaust duct and begin exhaust fan operation.
2. Lift both ends of the tarpaulin and begin exhaust fan operation. Do not remove the tarpaulin until the gas concentration level is below 100 ppm (see **Table 2-4-17**).
3. Start the circulation and air introduction fans. Sorptive commodities generally require 12 hours or longer to aerate. Since sorptive commodities vary in their rates of desorption, aeration may be completed in less than 12 hours. Require a minimum of 4 hours aeration for all sorptive commodities.
4. Take concentration readings with colorimetric tubes in the exhaust duct 2 feet within the enclosure. Record your readings on PPQ Form 429. Take successive readings within the enclosure 4 feet from the floor, at two representative locations. Take the readings between the cartons, but not inside the cartons.

After the fumigator takes the concentration reading, you must record the date, concentration reading, and time in Block 39 of PPQ Form 429. Then use **Table 2-4-17** to determine when to release the commodity.

TABLE 2-4-17: Determine when to Realease the Commodity

If the gas concentration level is:	Then:
5 ppm or less	1. ADVISE fumigator to REMOVE the tarpaulin, and 2. RELEASE the commodity
6 ppm to 99 ppm	1. HAVE fumigator REMOVE the tarpaulin, and 2. CONTINUE aeration until the concentration is 5 ppm or less, then 3. RELEASE the commodity
100 ppm or above	1. CONTINUE aeration and take concentration readings until the concentration level is below 100 ppm, then remove the tarpaulin, and 2. CONTINUE aeration until concentration is 5 ppm or less, then 3. RELEASE the commodity

Outdoors

Advise the fumigator to:

1. Complete installation of exhaust duct and begin exhaust fan.
2. Lift both ends of the tarpaulin that are furthest from exhaust fan.
3. Start the circulation and air introduction fans. Sorptive commodities generally require 12 hours or longer to aerate. Since sorptive commodities vary in their rates of desorption, aeration may be completed in less than 12 hours. Require a minimum of 4 hours aeration for all sorptive commodities.
4. Remove the tarpaulin after 4 hours aeration.

5. Stop the circulation fans and take concentration readings with colorimetric tubes 4 feet from the ground and 1 foot inside the outer edge of the stack between the cartons but not inside the cartons. One location is sufficient.

After the fumigator takes the concentration reading, you must record the date, concentration reading, and time in Block 39 of PPQ Form 429. If you are not at the fumigation site, have the fumigator call and give you the information. Then use **Table 2-4-18** to determine when to release the commodity.

TABLE 2-4-18: Determine when to Realease the Commodity

If the gas concentration level is:	Then:
5 ppm or less	RELEASE the commodity
6 ppm or more	1. CONTINUE aeration and take concentration readings until the level is 5ppm or less, then 2. RELEASE the commodity

2

Treatment Manual

Chemical Treatments

Fumigants • Methyl Bromide • Chamber Fumigation

Contents

Methods and Procedures

Materials Needed

The procedures covered in this section provide commercial fumigators with the methods, responsibilities, and precautions for chamber fumigation.

- Colorimetric tubes (Draeger, Kitagawa, or equivalent)[1]
- Halide leak detector[1]
- Methyl bromide
- Scale or graduated cylinder for volume (liquid measurements)
- SCBA or supplied air respirator[1]
- Thermal conductivity (T/C) unit
- Thermometer[1]
- Volatilizer
- Warning signs

The chamber operator is responsible for supplying the above materials as well as ensuring that the chamber is certified for conducting PPQ quarantine treatments.

Conducting the Fumigation

Step 1—Selecting a Treatment Schedule

Select an appropriate treatment schedule to effectively eliminate the plant pest without damaging the commodity to be fumigated.

Turn to the treatment schedule Index and look up by commodity or by pest the treatment schedule(s) available. Treatment schedules which are approved for chambers will be listed as either "NAP" (normal atmospheric pressure) or as "vacuum."

Step 2—Determining Section 18 Exemptions and Sampling Requirements

After selecting the treatment schedule, you will be able to determine which treatment schedules are FIFRA Section 18 Exemptions by the presence of broad, bold lines on the border of the treatment schedule table. Some treatment schedules are Section 18 Exemptions only at specific temperature ranges. Check the treatment schedule and temperature to determine if the fumigation will be a Section 18

1 You will need to bring these items unless the chamber is operated by PPQ, in which case all materials are provided by PPQ.

Exemption. Once you've determined that a treatment schedule is a Section 18 Exemption, look in the far right column of the table to determine if a sample is required. If a sample is required, you must take a sample prior to the start and another after the aeration. See instructions in the section tabbed "Monitoring."

Step 3—Measuring the Temperature

Determine the temperature to use in selecting the proper dosage rate:

- For fruits, pulpy vegetables, or logs use only the commodity temperature.
- For all other commodities use both the commodity and air temperature.

To take the temperature readings, use a bimetallic, mercury, or digital long-stem thermometer that has been calibrated. Use **Table 2-5-1** to determine which temperature to use when selecting the proper dosage rate for commodities other than fresh fruits, vegetables, or logs. Record the temperatures in Block 22 of the PPQ Form 429.

Important

Commodity and space temperatures must be 40 °F or above.

TABLE 2-5-1: Determine Whether to Use Commodity or Air Temperature for Determining Dosage Rate

If the air temperature is:	And:	Then, for commodities other than fresh fruits or vegetables or logs and lumber[1]:
Higher than the commodity temperature	→	Use the commodity temperature for determining the dosage rate
Lower than the commodity temperature	By 9 degrees or less	
	By 10 degrees or more	Use the average of the air and commodity temperature for determining the dosage rate

1 Use commodity temperature for fresh fruits or vegetables or logs and lumber.

Step 4—Calculating the Dosage

In order to calculate dosage, you must have the following information:

- Treatment schedule
- Volume of the fumigation chamber (ft^3)
- Temperatures of commodity and air (°F)

Refer to the specific treatment schedule to determine the dosage rate (pounds/ft^3).

The formula for calculating dosage is:

$$\text{dosage(lbs.)} = \text{volume(ft}^3) \times \text{dosage rate(lbs./1,000 ft}^3)$$
$$= \frac{\text{volume(ft}^3) \times \text{dosage rate(lbs.)}}{1{,}000\ \text{ft}^3}$$

EXAMPLE: Using a fumigation chamber which has a volume of 500 ft^3, you determine the temperature of the commodity and space is 72 °F. The treatment schedule requires 2 lbs. MB/1,000 ft^3 at 70 °F or above. To calculate dosage multiply the volume (500 ft^3) by the dosage rate (2 lbs. MB/1,000 ft^3). This equals 1.0 lbs. of MB needed for the dosage.

Step 5—Conducting the Fumigation

Since fumigation chambers vary by manufacturer and model, refer to the manufacturer's operating manual to determine how to use the chamber. However, in any case, circulation fans in a chamber should be kept running for 15 minutes following introduction of the gas.

Aerating the Chamber

Responsibility for aerating the chamber and releasing the commodity depends on whether the treatment schedule used was a labelled use or FIFRA Section 18 Exemption. Use the following table to determine responsibility for monitoring the aeration of the fumigation.

TABLE 2-5-2: Determine the Responsibility for Monitoring the Aeration

If the fumigation chamber is:	And the treatment schedule is:	Then:
Privately or State owned	A labelled treatment	RELEASE the fumigation to the fumigator to aerate and release the commodity
	A FIFRA Section 18 Exemption (noted in the treatment schedules)	1. MONITOR the aeration, and 2. USE the following table to determine which aeration procedures to follow
PPQ owned	→	

Use the following table to determine which procedures to follow for aerating normal atmospheric pressure (NAP) and vacuum chambers.

TABLE 2-5-3: Determine the Aeration Procedure

If the chamber is:	And the cargo is:	Then:
NAP	Noncontainerized	Use the procedures on **page-2-5-5**
	Containerized	Use the procedures on **page-2-5-6**
Vacuum	→	Use the procedures on **page-2-5-6**

Each chamber must be equipped with at least one permanent, metal gas sampling tube to allow you to take colorimetric tube readings during the aeration. Any extensions of the gas sampling tube or flexible connectors must be made of Teflon™ tubing or metal. The gas sampling tube must be located in the vicinity of the exhaust duct inside the chamber. The gas sampling tube must extend outside the chamber to allow for colorimetric tube readings.

Normal Atmospheric Pressure Chamber—Aerating Noncontainerized Cargo

Step 1—Securing the Area

Assuming that you've already secured the fumigation area, allow only the chamber operator and the PPQ officer monitoring the fumigation into the secure area.

WARNING

Do ***not*** allow motorized vehicles to operate within the secure area.

Step 2—Aerating the Chamber

Run the exhaust long enough to obtain at least four complete changes of air (about 4 to 15 minutes per change of air or 1 hour).

Step 3—Taking Concentration Readings

Draw an air sample from the chamber into a colorimetric tube. Air samples must be taken near the floor of the chamber in the vicinity of the exhaust duct. This can be accomplished by installing a metal tube in the chamber to transport the sample from the floor to a convenient opening in the chamber walls.

Use **Table 2-5-4** to determine when to release the commodity.

TABLE 2-5-4: Deterimine When to Release the Commodity

If the gas concentration is:	Then:
5 ppm or less	RELEASE commodity
6 ppm or above	1. TAKE concentration readings, and 2. RELEASE commodity when the concentration level is 5 ppm or less

Normal Atmospheric Pressure Chamber—Aerating Containerized Cargo

Step 1—Securing the Area

Assuming that you've already secured the fumigation area, allow only the chamber operator and the PPQ officer monitoring the fumigation into the secure area.

WARNING

Do ***not*** allow motorized vehicles to operate within the secure area.

Step 2—Aerating the Chamber

Run the exhaust long enough to obtain at least four complete changes of air (about 4 to 15 minutes per change of air or 1 hour). If the containers have internal fans, run them unless they are operated by internal combustion engines. Remove container from the chamber at the conclusion of four complete changes of air to an outdoor secure area for passive aeration. Wear the SCBA while the container is being moved outdoors.

Step 3—Taking Concentration Readings

Wearing your SCBA, draw an air sample 3 feet inside the container and 3 feet above the floor.

Use the following table to determine when to release the commodity.

TABLE 2-5-5: Determine When to Release the Commodity

If the gas concentration is:	Then:
5 ppm or less	RELEASE commodity
6 ppm or above	1. CONTINUE passive aeration 2. TAKE concentration readings, and 3. RELEASE commodity when the concentration level is 5 ppm or less

Vacuum Fumigation Chambers—Aerating Containerized and Noncontainerized Cargo

Step 1—Securing the Area

Assuming that you've already secured the fumigation area, allow only the chamber operator and the PPQ officer monitoring the fumigation into the secure area.

WARNING

Do ***not*** allow motorized vehicles to operate within the secure area.

Step 2—Aerating the Chamber

Adjust any vacuum remaining at the end of the fumigation to zero by temporarily opening the air intake valve, then closing it. Draw a 15 inch vacuum and adjust it to zero. Repeat this process of drawing a 15 inch vacuum and releasing it four times or as many times as experience indicates is necessary.

Step 3—Taking Concentration Readings

Draw an air sample from the chamber through the gas sampling tube into a colorimetric tube. Use **Table 2-5-6** to determine when to release the commodity.

TABLE 2-5-6: Determine When to Release the Commodity

If the gas concentration is:	Then:
5 ppm or less	RELEASE commodity
6 ppm or above	1. Do two more vacuum washes 2. TAKE concentration readings, and 3. RELEASE commodity when the concentration level is 5 ppm or less

Important

Some vacuum chambers do not have sampling tubes. After four air washes, while wearing the SCBA, open chamber door and take colorimetric reading.

2

Treatment Manual

Chemical Treatments

Fumigants • Methyl Bromide • Ship Fumigation

Contents

Methods and Procedures

The procedures covered in this section provide commercial fumigators with the methods, responsibilities, and precautions for ship fumigation.

CAUTION

These procedures are used primarily for fumigation of ships that are infested with khapra beetle.

Generally, fumigation of commodities within the structure of a ship, such as cargo holds, cannot meet APHIS standards for fumigation, and these fumigations are not recommended by APHIS. However, on a case by case basis, commodities may be fumigated within the structure of a ship if Methods Development first approves the fumigation. For approval, call the Center for Plant Health Science & Technology (CPHST) (tel: 919-513-2496)

In general, ship fumigations present problems not encountered in other types of fumigations. The large amount of gas required and the varying space configurations from ship to ship make it essential that experienced pest control operators and PPQ officers with extensive fumigation experience perform ship fumigations.

Materials Needed

PPQ Officer Provides

- PPQ Form 429
- Calculator (optional)
- Colorimetric tubes (Draeger/Kitagawa)
- Desiccant (Drierite®)
- Halide leak detector
- SCBA or supplied air respirator
- Tape measure
- Thermal conductivity unit[1]
- Thermometer

Fumigator Provides

- Adhesive sealer, tape, and putty or other pliable material for sealing off holes around pipes
- Auxiliary pump for purging long gas sample tubes
- Carbon dioxide filter (Ascarite®)
- Colorimetric tubes (Draeger/Kitagawa)
- Electrical wiring (ground, permanent type), three prong extension cords
- Exhaust blower and ducts

1 T/C unit must be calibrated annually by the Center for Plant Health Science and Technology (CPHST) in Raleigh, North Carolina. If requested, CPHST will calibrate a commercial fumigator's T/C unit.

- Fans (circulation, exhaust, and introduction)
- Framework and supports
- Gas sampling tubes (leads)
- Gas supply line
- Heat supply
- Insecticides and spray equipment
- Methyl bromide
- Padding
- Portable generator as backup unit to operate T/C unit, auxiliary pump, and lights
- Sand or water snakes
- Scales or dispensers
- SCBA or supplied air respirator
- Tape
- Tarpaulin and supports
- Thermal conductivity unit
- Volatilizer
- Warning signs

PPQ officer and fumigator should be prepared to use auxiliary power if shore power is not available as most ships' power is 220 volts.

Taking Safety Measures When Fumigating Ships

The most important consideration when fumigating ships is the protection of human life. The commercial fumigator has the following safety responsibilities when fumigating ships:

- Observe all safety precautions while fumigating
- Prevent access of unauthorized personnel, including the ship's crew, to the fumigated area
- Conduct fumigation properly to result in an effective treatment
- Evacuate gas from ship and aerate when fumigation is completed
- Test, with a gas detector, all areas aboard ship to ensure freedom from MB before allowing crew members access to the ship

The commercial fumigator must abide by the following guidelines when fumigating ships:

- Have a representative present throughout the entire fumigation. The representative must be familiar with directions for using the fumigant, warnings, antidotes, etc., shown on the label, on the gas cylinder, and contained in the manufacturer's application manual.
- Have adequate first-aid equipment, SCBA, and other safety equipment available
- Have all areas of the ship tested with a gas detector prior to crew re-entry. Pay particular attention to all fumigated areas, crew quarters, and the engine rooms
- Provide for immediate contact with the responsible ship's officer to provide information and access to areas of the ship which may be needed to assure a safe fumigation

Preparing to Fumigate

Step 1—Meeting With Ship's Captain and Agent

When planning a ship fumigation, meet with the ship's captain, agent, and the fumigation company representative to discuss the conditions of the fumigation. If cargo is present in an area about to be fumigated, determine if any materials might be adversely affected by the fumigant (see Methyl Bromide—Properties for a list of commodities adversely affected by MB). Notify the ship's agent of possible effects and if conditions permit, allow removal of the material from the hold for an alternate treatment.

Discuss plans for removing all crew from the ship. It is the responsibility of the commercial fumigator to comply with all label requirements, and with State, local, and U.S. Coast Guard regulations (see **Coast Guard Regulations** in **Appendix B**) concerning shipboard fumigation.

Step 2—Selecting a Treatment Schedule

Refer to treatment schedule T402 (SHIPS) for the correct treatment. Select a treatment schedule based on the plant pest and commodity to be fumigated. Consider all the commodities present in the area to be fumigated when determining the best treatment available. In the case of khapra beetle fumigation, determine if finely milled products (example—flour) will be fumigated. If finely milled products are to be fumigated, give the captain the option to use the 12 hour schedule. Have the finely milled products destroyed either by incineration or by sterilization after the fumigation has been completed. If the captain elects not to remove and destroy the finely milled products, then use the 24 hour treatment schedule.

Treating Deck Areas

Areas which may be pest contaminated or suspected of being contaminated, such as the deck, hatch covers, drain channels, crevices around hatches, hallways, and similar areas that cannot be fumigated, should be treated with a 3 percent malathion emulsion spray (0.5 pint, 57 percent premium grade to a gallon of water). Spray at the rate of 2 gallons/1,000 sq. ft., or to the point of runoff.

> **CAUTION** Malathion emulsion sprays may break down asphalt surfaces. For asphalt surfaces, prepare a spray from a 25 percent wettable powder (1 pound to a gallon of water), rather than the emulsion.

Step 3—Determining Section 18 Exemptions and Sampling Requirements

After selecting the treatment schedule, you will be able to determine if the schedule is a FIFRA Section 18 Exemption by the presence of broad, bold, vertical lines on the borders of the treatment schedule table listed in the reference. Some treatment schedules are FIFRA Section 18 Exemptions only at specific temperature ranges. Check the treatment schedule and temperature to determine if the fumigation will be a FIFRA Section 18 Exemption.

If food is fumigated, alert the captain that there may be higher than permitted residues.

Step 4—Preparing Areas to Be Fumigated

Storerooms

Open all bins, drawers, and cupboards. Stack all bagged commodities so gas can penetrate all sides of the commodity. Stacking bagged commodities on pallets will facilitate gas distribution and penetration.

Cargo Holds

Prepare to fumigate the entire hold regardless of the location of the infestation within the hold. If you want to fumigate a single deck (lower hold, lower ’tween deck, upper ’tween deck, etc.), you must get approval from your Regional Director. The decision to approve single deck fumigations should only be made after all sections of the hold have been inspected and there is no possibility of gas escaping to other parts of the hold.

In most cases, it is unnecessary to open or rearrange cargo containers within the hold. Occasionally, some rearrangement may be required to ensure uniform gas distribution. Have the hatch coverings between decks opened in such a manner as to permit adequate distribution and circulation of the gas.

Step 5—Arranging and Operating Fans

Storerooms

Storerooms normally require a minimum of two, 1,800 cfm fans. Place one fan at a low level and the other at a high level. Fans with capacity above 1,800 cfm create strong air currents which could result in gas leakage around the seals. If you’re fumigating an area which includes the galley and adjoining storerooms, be sure to place the fans to evenly distribute gas. Make certain that fans can be turned on and off from an area outside the fumigation site.

Cargo Holds

Use the volume of the hold (ft^3) in determining how many fans you will need. The total cfm's of all the fans should approximate the volume of the hold. Use fans capable of 2,500 cfm or greater during gas introduction and for 30 minutes following the introduction. Placement of fans within holds depends on the presence or absence of cargo. Normally, place two fans in the lower hold at opposite ends facing across the hold. The number of fans can be reduced by using fans greater than 2,500 cfm. Fans should be labeled as to location and have the capability of being turned on and off individually in case of low readings in certain locations or pockets of gas.

Test all fans to ensure that they are in good operating condition. Operate fans during the gas introduction and for 30 minutes after introduction is completed.

Step 6—Placing Gas Sampling Tubes

Place gas sampling tubes in areas and commodities which will give representative samples within the fumigated area. Have all leads brought to one central point at least 30 feet up- wind from the area being fumigated. Label all gas sampling tubes so they can be easily identified when you take concentration readings. Label each tube by identifying the level of the hold and whether the gas sampling tube is in a commodity or space.

Storerooms

Place a minimum of two gas sampling tubes in open space and at least one gas sampling tube within the commodity considered to be the most difficult for the fumigant to penetrate.

Cargo Holds

Within cargo holds, the exact location will depend primarily on the location of cargo within the hold. Place a minimum of two leads for each level of empty hold space. The average size hold of three levels is approximately 125,000 ft^3. Use one additional lead for every 50,000 ft^3 over 125,000 ft^3.

When cargo is present in the hold, place two additional gas sampling tubes in the commodity at each hold level. For mixed cargo, place additional gas sampling tubes in the cargo considered to be the most difficult for the fumigant to penetrate.

Step 7—Placing the Gas Introduction Lines

Storerooms, Galley, Quarters

Numerous gas introduction lines may be necessary in order to obtain even gas distribution throughout the fumigation area. Place the gas introduction line directly through an opening from the outside (example—a door or window) directly above a fan. Attach the introduction line securely to the top of the fan to prevent movement of the hose. An unsecured introduction line could move the line out of the airflow. Place a piece of nonpermeable sheeting (example—plastic or rubberized canvas) over the commodity in front of and below each gas supply line. The nonpermeable sheet will prevent any liquid MB from coming in contact with commodities and will prevent damage.

Cargo Holds

Numerous gas introduction lines may be necessary in order to obtain even gas distribution throughout the fumigation area. Place the gas introduction line directly into the air stream in front of one of the fans on the upper 'tween deck. Attach the introduction line securely to the top of the fan because gas passing through the line will cause the line to vibrate. An unsecured introduction line could be moved out of the airflow. Additional introduction lines can be used to hasten introduction and distribution of the gas. Place a piece of nonpermeable sheeting (example—plastic or rubberized canvas) over the commodity in front of and below each gas introduction line. The sheet will prevent any liquid MB from coming in contact with the cargo and prevent damage.

Step 8—Measuring the Temperature

Take temperature readings of the air (space) and of the commodity. Use a calibrated thermometer. Record the temperatures in Block 22 on the PPQ Form 429. If the temperature is below the minimum listed for the treatment schedule, then you will need to heat the hold or other space to be fumigated.

TABLE 2-6-1: Determine Pre-fumigation Procedures

If the temperature is:	Then:
At or above the minimum temperature listed for the treatment schedule	GO to Step 10 (Sealing Stores)
Below the minimum temperature listed for the treatment schedule	GO to Step 9 (Heating the Cargo Hold)

Step 9—Heating the Cargo Hold

If heating a hold is necessary, negotiate the method with the fumigator and get the concurrence of the Center for Plant Health Science & Technology (CPHST), in Raleigh, North Carolina.

Step 10—Sealing Stores

One of the most important steps in preparing for a ship fumigation is sealing all openings and areas which have the potential to leak gas. Consider the entire area to be fumigated as a natural atmospheric chamber and make the area as gastight as possible. The most important task is to locate all openings (example—drain pipes, bilge drain holes, or air ducts) and seal them.

Do ***not*** seal out or make gastight recessed areas, ducts, or similar apertures which may harbor an infestation. In some cases it is better to seal sources of leaks on the outside of the area to be fumigated. Use caulking compound or tape for sealing small spaces. For sealing larger areas, use polyethylene or similar material secured with tape or adhesive spray. Seal doors and other openings with either polyethylene or spray with vinylite plastic. When practical, seal air ventilation ducts on the outside of the space being fumigated so sealing tape can be removed when you get ready to evacuate the gas and begin aeration. Large openings such as hatch cover openings should be covered with polyethylene and securely taped. When necessary, lace rope across the tarpaulin to prevent billowing in high winds. Look for and seal off the following ship areas when preparing a ship for fumigation:

- Wall plates
- Air vents
- Drains
- Pipes and other utility conduits through decks and bulkheads
- Dumb-waiter openings
- Heating, air conditioning, and ventilation systems common with or to cargo holds, engine room, crew quarters, storerooms, or other spaces that use intake from the vent systems common with cargo holds
- Engine room—recirculation air systems controlled from and common with the engine room areas—especially on newer ships; check for drilled holes or other openings in fore and aft bulkheads of engine room spaces, all engine room vent systems, and housing or casing leading into spaces to be fumigated
- All passageways, engine room, and other crew areas for electric pipeline or other duct work common with cargo holds
- Speaking tubes and fire and smoke detector systems from fumigated areas
- Emergency escape hatches from shaft alley and escape hatches from all holds
- CO_2 piping to all cargo holds; degassing systems (older ships) which usually run from hold to hold
- Vents in shaft alley and gear lockers to holds; breaks in bulkhead
- Bilge and drainwell vents and drains to all cargo holds sometimes common with more than one hold or engine room bilges
- Steam-smothering systems for connection between holds

- Inner bottom and deep tank covers to ensure that they are closed prior to fumigating
- Galley intake and exhaust systems (may be common with the dry stores)

Step 11—Measuring Volume

Obtain the volume of the cargo holds from the chief mate, captain, or the ship's plan, which is usually posted outside the captain's office. If actual hold measurements are available, then figure the volume by multiplying the length, width, and height of the hold. If actual measurements are not available, then look on the ship's plan for the grain cube. Use the grain cube as the volume in lieu of actual hold dimensions. Consider all hold areas such as deep tanks, security lockers, and refrigerated spaces when calculating the volume of the area to be fumigated.

For dry stores, galleys, and crew quarters, measure the actual dimensions to calculate volume.

Step 12—Calculating Dosage

The formula for calculating dosage is:

$$\text{dosage(lbs.)} = \text{volume}(\text{ft}^3) \times \text{dosage rate(lbs./1,000 ft}^3) = \frac{\text{volume}(\text{ft}^3) \times \text{dosage rate(lbs.)}}{1{,}000\ \text{ft}^3}$$

EXAMPLE: Number 3 Hold is infested with khapra beetle. The volume is 80,000 ft^3, and the temperature is 65 °F. The treatment schedule lists the dosage rate as 6 lbs. MB/1,000 ft^3. To calculate the dosage multiply the volume (80,000 ft^3) by the dosage rate (6 lbs./1,000 ft^3). This equals 480 lbs. of MB needed for the dosage.

Step 13—Making a Final Check

Just before introducing the gas, you and the fumigator must do the following:

- Prior to fumigation, use a halide detector to check all storeroom and reefer areas which have any refrigerating systems prior to fumigation. A halide detector will indicate any freon leaks. Freon, a halide gas like MB, will result in higher concentration readings. Also, after aeration is completed, freon leaks may falsely indicate that MB is still present within the fumigated area.
- Take T/C unit readings to determine if any contaminant gases are present
- Turn on all fans and T/C unit to make sure they work
- Start volatilizer and heat water to 200 °F or above

- Place fumigant cylinder with gas introduction line on scale and take initial weight reading. Make sure the gas introduction line is attached to the cylinder. After obtaining the correct weight, subtract the dosage to be introduced into the enclosure. When the entire dosage has been introduced, the scale will be balanced.
- Check to make sure the ship's gangway and areas to be fumigated are properly placarded and the area is secured. A guard should be present at the entrance to the gangway to restrict access to the ship. If the crew has been removed, walk through the quarters and other areas to make sure no one is aboard.
- Check all sealed areas to make sure they are securely taped and free from holes
- Check the gas introduction line connections to make sure they are tight
- Check to make sure all safety equipment is available and in working order

Conducting the Fumigation

Step 1—Introducing the Gas

CAUTION

PPQ Officers must wear the SCBA anytime they are within 30 feet of area being fumigated. You and the fumigator both must use SCBA while introducing the gas, checking for leaks, and when taking aeration readings.

Turn on all fans while introducing the gas. When using large cylinders of MB, have the fumigator slightly open the valve then close the valve. Using a halide detector, check all connections on the gas introduction line for leaks. If leaks are found, have the fumigator tighten the connections and repeat the test. If no leaks are found, have the fumigator open the valve to the point where 3 to 4 pounds of MB are being introduced per minute. The gas introduction line should always feel hot and the volatilizer must read at least 150 °F.

CAUTION

Do not touch the introduction line with your bare hands—you may get burned! Have the fumigator close the cylinder valve once the proper dosage has been introduced.

The fumigation time begins when all the gas has been introduced. Record the time gas introduction was started and completed in Block 32 on the PPQ Form 429. Run the fans for 30 minutes after all the gas has been introduced. You will take the initial concentration reading 30 minutes after all the gas has been introduced.

When using cylinders, getting the final amounts of gas out of the cylinder may take a long time. Consider taking T/C unit readings 30 minutes after the gas is first introduced. If the gas distribution is even (all readings within 4 ounces of each other) and at an adequately high concentration, then you can turn off the fans. Running the fans longer may contribute to gas leakage. Allow the remainder of the gas to discharge at its slow rate with intermittent running of the fans for dispersal.

Step 2—Taking Concentration Readings

Take concentration readings with a T/C unit to determine the gas concentration and distribution within the area being fumigated (galley, storeroom, or cargo holds). Check Drierite® tubes before each reading and change Drierite® if its color is pink. Depending upon the length of exposure period, take concentration readings at the following times after the introduction of the fumigant:

- 30 minutes
- 2 hours
- 4 hours
- 6 hours
- 12 hours
- 24 hours
- 48 hours
- 72 hours (for *Cochlicella*, *Helicella*, and *Monacha* spp.)

Consult the treatment schedule being used for the actual concentration readings. You may start the final concentration reading 30 minutes prior to the end of the exposure period.

Take additional readings when there is indication that the gas is not properly distributed or the minimum gas concentration is not being maintained. Record readings on PPQ Form 429.

Step 3—Testing for Leaks

Wearing the SCBA, use a halide detector to test for leaks after all the gas has been introduced. Test around the perimeter of the area being fumigated, especially where doors, windows, pipes, electric cords, gas sampling tubes, and gas introduction lines are present. If you detect leaks, be sure they are sealed with additional tape, adhesive, or by placing more polyethylene and adhesive over the leaking areas.

Step 4—Adding Gas and Extending Exposure

You may add gas at the following rate when concentration readings fall below the minimum:

1.6 × number of oz. below minimum × volume/1,000 = oz. of gas to add

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EXAMPLE: You are fumigating a ship's storeroom for khapra beetle and the minimum concentration for the 2 hour reading is listed at 50 oz. but your readings average 45 oz. The volume of the storeroom is 1,500 ft^3. Using the above formula, you would figure the following:

1.6 × 5 (oz. below min.) × 1,500/1,000

8 × 1.50 = 12 oz. gas to be added

Extending Exposure Period

Use **Table 2-6-2** to determine how long to extend the exposure period:

TABLE 2-6-2: Determine Time for Extended Exposure

If the exposure time is:	And the reading is below minimum by:	Then extend exposure:
Less than 12 hours	10 oz. or less	10 percent of the time lapse since the last reading
	11 oz. or more	30 minutes
12 hours or more	10 oz. or less	10 percent of the time lapse since the last reading
	11 oz. or more	2 hours or 10 percent of time lapse since last reading, whichever is greater

Step 5—Exhausting the Gas

Exhaust the gas at the completion of the exposure period. If the treatment schedule is a FIFRA Section 18 Exemption, then you must monitor the aeration of the fumigated area. Use **Table 2-6-3** to determine if you need to monitor the aeration of the fumigated area:

TABLE 2-6-3: Determine the Responsibility for Monitoring the Aeration

If the treatment schedule is:	Then:
A FIFRA Section 18 Exemption	MONITOR the aeration of the commodity. FOLLOW “Aerating the Hold or Storeroom” steps which follow.
A labelled treatment	RELEASE the fumigation to the fumigator and RELEASE the ship.

Removal of the fumigant from cargo holds is facilitated by using an outside blower to force fresh air through portable canvas, plastic, or similar ducts. Another method is to use compressed air hoses to force fresh air into the bottom of the hold. Use fans or blowers within the fumigated space to help aerate the hold. Use suction type fans with portable ducts to evacuate gas from storerooms to outside, downwind areas away from crew areas, preferably on the offshore side of the ship. Do not point the ducts upward, since dissipation onto the deck may occur. Use the ship's aeration/ventilation equipment if possible. Make sure that use of ship's equipment will not distribute the exhausted gas to other areas within the ship.

Aerating the Hold or Storeroom

Step 1—Securing the Area

Assuming that you've already restricted access and secured the fumigation area, you now must restrict access to the area where the exhaust duct extends beyond the enclosure. During the first 10 minutes of aeration, there should be no people within 200 feet of the exhaust duct outlet. When securing the duct outlet area, consider the direction of the wind. Face the duct outlet toward an open area, and away from people. Point the duct outlet upward to aid in dispersing the exhausted gas.

Have the fumigator use a physical barrier such as ropes, barricades, or walls to secure the area.

Placard the secure area near the exhaust outlet with the appropriate DANGER/PELIGRO signs. Make sure the placards meet the appropriate fumigant label or labeling requirements. The skull and crossbones should be present as well as "AREA UNDER FUMIGATION, DO NOT ENTER/NO ENTRE"; date of the fumigation; name of the fumigant used; and the name, address, and telephone number of the fumigator.

Unless you authorize their use, do *not* allow motorized vehicles to operate within the secure area.

Step 2—Aerating the Area

Wearing the SCBA, advise the fumigator to make an opening (if possible) at the end furthest from the exhaust duct to allow entry of fresh air. The fumigator may open doors, hatches, tarpaulins, and areas to facilitate aeration. Start the exhaust system (minimum 3,500 cfm exhaust fan connected to an exhaust duct) and aerate the hold or storeroom.

Step 3—Taking Concentration Readings to Determine When to Release the Ship

Stop the aeration fans. Take a concentration reading with a colorimetric tube in the exhaust duct within 2 feet of the storeroom or within the first 2 feet of the exhaust duct where it exits the hold. If the concentration is above 5 ppm, but less than 100 ppm, advise the fumigator to remove the tarpaulin while wearing a SCBA.

Release the ship when the following conditions are met:

For Storerooms

When the concentration is 5 ppm or less after taking readings 4 feet from the floor and 1 foot inside the fumigation perimeter at several representative locations (a minimum of two are required).

For Holds

When the concentration is 5 ppm or less after taking readings by:

1. Drawing a sample for a minimum of 1 minute through a sampling tube with the auxiliary pump. The sampling tube should be teflon or metal to obtain accurate readings. If a polyethylene sampling tube is used, it should be replaced at frequent intervals due to adsorption of gas by the polyethylene.
2. Taking a concentration reading with a colorimetric tube in the sampling tube.
3. Taking a minimum of two readings for each level of the hold.

Record the date, concentration reading, and time on PPQ Form 429.

2

Treatment Manual

Chemical Treatments

Fumigants • Methyl Bromide • Structure Fumigation

Contents

Methods and Procedures

The procedures in this section provide guidelines for the methods, responsibilities, and precautions for structure fumigation. These procedures relate to structure fumigation primarily for khapra beetle.

In general, structure fumigations present problems not encountered in other types of fumigations. The large amount of gas required and the fact that the structure configurations vary from structure to structure make it essential that experienced fumigators and PPQ officers with extensive fumigation experience perform structure fumigations.

Materials Needed

PPQ Officer Provides

- Calculator (optional)
- Colorimetric tubes (Draeger/Kitagawa)
- Desiccant (Drierite®)
- Forms (PPQ Form 429 and APHIS Form 2061 if necessary)
- Halide leak detector
- SCBA or supplied air respirator
- Tape measure
- Thermal conductivity unit[1]
- Thermometer

Fumigator Provides

- Adhesive sealer, tape, and putty or other pliable material for sealing off holes around pipes
- Auxiliary pump for purging long gas sample tubes
- Carbon dioxide filter (Ascarite®)
- Colorimetric tubes (Draeger/Kitagawa)
- Device for adding nitrogen into MB cylinders
- Electrical wiring (ground, permanent type), three prong extension cords
- Exhaust blower and ducts
- Fans (circulation, exhaust, and introduction)
- Framework and supports
- Gas sampling tubes (leads)
- Gas supply line
- Heat supply
- Insecticides and spray equipment
- Methyl bromide
- Padding
- Portable generator as backup unit to operate T/C unit, auxiliary pump, and lights

1 T/C unit must be calibrated annually by the Center for Plant Health Science and Technology (CPHST) in Raleigh, North Carolina. If requested, CPHST will calibrate a commercial fumigator's T/C unit.

- Sand or water snakes
- Scales or dispensers
- SCBA or supplied air respirator
- Tape
- Tarpaulin and supports
- Thermal conductivity unit
- Volatilizer
- Warning signs

Taking Safety Measures When Fumigating Structures

The most important consideration when fumigating structures is the protection of human life. The commercial fumigator has the following safety responsibilities when fumigating structures:

- Observe all safety precautions while fumigating
- Prevent access of unauthorized personnel to the fumigated area
- Conduct fumigation properly to result in an effective treatment
- Evacuate gas from the structure and aerate when fumigation is completed
- Test, with a gas detector, the fumigated areas within the structure to ensure freedom from MB before allowing access to the fumigated areas

The commercial fumigator must abide by the following guidelines when fumigating structures:

- Have a representative present throughout the entire fumigation. The representative should be familiar with the directions for using the fumigant, warnings, antidotes, etc., shown on the label, on the gas cylinder, and contained in the manufacturer’s application manual.
- Have adequate first-aid equipment, SCBA, and other safety equipment available
- Have all fumigated areas and any adjoining areas that were not fumigated tested with a gas detector prior to worker re-entry
- Contact all necessary local and State authorities (fire, police, etc.)

Preparing to Fumigate

Step 1—Determining Type of Treatment Required

Consider the following factors in selecting a treatment for the structure:

- Type of commodities involved (example—grain, spices, or flour)
- Degree of infestation (light, moderate, heavy)
- Potential risk of spread from infestation
- Nature of the business—business shipping materials that could spread pest (example—a spice wholesaler or specialty foods distributor)
- Availability of food supply—is food available or is the find incidental
- Type of structure(s) infested
- Environmental conditions—warm, humid areas favor reproduction

In locations where reproduction occurs, or the potential for reproduction exists (warm temperature, humidity, and available food supply), seriously consider fumigation. Fumigation is not mandated every time an infestation is found.

In locations where reproduction is not occurring or the potential for reproduction does not exist (unfavorable temperature, low humidity, and no available food supply), consider using alternative treatments.

Make the final determination of which type of treatment to use with the concurrence of the following:

- PPQ line (Officer in Charge and Regional Director)
- PPQ staff (Riverdale/Raleigh (CPHST))
- Responsible State regulatory official

Options consist of the following:

- Complete Property Fumigation and Treatment (Category 1)
- Selective Property Fumigation and Treatment (Category 2)
- Interior Fumigation (Category 3)
- Alternate Treatment (Category 4)
- Selective Property Fumigation plus Alternative Treatments (Category 5)

The following is a detailed description of each of the above options:

Category 1—Complete Property Fumigation and Treatment

Fumigate all structures of similar usage on a single property. Place all structures under a gastight tarpaulin(s) and fumigate with MB.

Spray the area surrounding the structure(s) within the confines of the property at least twice with a registered malathion formulation. Make the last application after covering the structure(s) with the tarpaulin.

Free the surface area of all debris by raking or sweeping all debris toward the structure, include the debris under the cover.

Depending upon local conditions as determined by the PPQ Officer in Charge and the responsible State regulatory official, you may unconditionally release the structure after fumigation or hold the release until a series of inspections are conducted as outlined in Category 2.

Category 2—Selective Property Fumigation and Treatment

This treatment is similar to Category 1 except not all structures of related usage are fumigated and the fumigation is followed by at least three inspections of the entire property.

Notify the owner of the establishment in writing on the PPQ Form 523 (Emergency Action Notification) of the inspection requirement prior to fumigating any structures (see Appendix A). To verify success of this treatment, conduct at least three inspections of the entire property within 1 year. In the Northeast and other cooler regions, inspections must extend through two summer seasons when khapra beetles are active. Allow at least 90 days to elapse between inspections. Make the last inspection within 30 days of the time the structure is to be released.

Category 3—Interior Fumigation

Treat all structures on the premises or only those structures known to be infested. Use interior fumigation when conditions make the use of complete fumigation impractical. Conduct three inspections of the property after the fumigation has been completed.

This method of fumigation is less desirable because khapra beetles may crawl into cracks, crevices, and other openings on both the interior and exterior of an infested structure. Seal all openings in the structure with masking tape, putty, polyethylene, or other materials from the outside of the structure. Make the structure as airtight as possible without sealing out any areas that may harbor khapra beetle.

Spray the area surrounding the structures or the structures within the confines of the property at least twice with a registered malathion formulation. Make the last application after sealing the structure prior to fumigation. Free the surface area of all debris by raking or sweeping all debris toward the building. Include the debris in the fumigated structure.

Notify the owner of the establishment in writing on the PPQ Form 523 (Emergency Action Notification) of the inspection requirement prior to fumigating any structures (see "Appendix A" on **page-1-A-1**). To verify success of this treatment, conduct at least three inspections of the entire property within 1 year. In the Northeast and other cooler regions, inspections must extend through two summer seasons when khapra beetles are active. Allow at least 90 days to elapse between inspections. Make the last inspection within 30 days of the time the structure is to be released.

Category 4—Alternative Treatment

Use alternative treatments in infested properties where little or no regulatory hazard exists (little or no chance for the pest to escape and spread). Typically, such properties may include unused structures or buildings, facilities that do not handle commodities or materials of regulatory significance, or facilities that by the nature or type of operation or for other reasons do not pose a regulatory hazard as a result of the commerce conducted there.

Alternative treatments include either a crack and crevice or broadcast application of a registered or exempt pesticide (including approved cleaning and sanitation prior to treatment) and may include one or more of the following procedures:

- A specified program of sanitation
- An extensive trapping program utilizing adult and larval traps treated with both an attractant and an insecticide
- The use of bait treated with an insecticide
- An intensive, repeated inspection program augmented by intensive larval and adult trapping

Apply one or more of the above treatments when the Port Director, Plant Health Programs in Riverdale, and the responsible State regulatory official believe treatment will result in eradication and no regulatory hazard.

Category 5—Selective Property Fumigation Plus Alternative Treatments

Fumigate selected structures with related usage on a single, infested property. Apply one or more alternative treatments to all structures which are on the property and are not fumigated.

Step 2—Issuing a PPQ Form 523 (Emergency Action Notification)

Once an infestation of khapra beetle is identified and confirmed by a PPQ area identifier, issue a PPQ Form 523 (Emergency Action Notification) to the owner of the premises, except when treatment is ordered under State or county regulations. Follow instructions in Appendix 1 for completing and distributing PPQ Form 523 (Emergency Action Notification).

Be sure to document the treatment selected plus any alternative treatments, inspections, and safeguards to be applied.

Step 3—Conducting Prefumigation Conference

Fumigating a structure presents problems not usually encountered in other types of fumigations. The quantity of fumigant, supplies, equipment needed, and the variations in building configurations make it essential that experienced commercial fumigators and PPQ officers conduct structure fumigations.

Arrange a meeting with the fumigator to discuss the conditions of the treatment. Discuss the following items:

- An accurate measurement of the cubic capacity (volume) of the enclosure.
- Fumigation schedule to be used.
- Adequate tarpaulin material—polyethylene or equivalent tarpaulin of 6 mil or greater thickness.
- Electrical power source sufficient to operate circulation fans and T/C unit.
- Gas sampling tubes—types and number.
- Auxiliary air pump—to quickly draw samples through gas sampling tubes.
- Pedestal type fans for fumigant distribution and aeration.
- Sufficient quantity of fumigant for initial dosage plus an additional amount of fumigant in case gas must be added.
- Commodities involved and identification of materials that may be adversely affected by the fumigant (see Methyl Bromide—Properties for a list of commodities). Advise the property owner of any possible adverse effects. Articles or materials that may be damaged should be subjected to an alternate treatment if possible. Office furniture and equipment with foam rubber can be affected and should be removed. Computer equipment may have to be completely sealed with polyethylene and a positive pressure maintained within the sealed enclosure during the exposure period.

- Provide a sheltered area for taking gas concentration readings. The area should be located a safe distance (30 feet or more) from the enclosure. All gas sampling tubes and the electrical source should be located within the sheltered area.
- Aeration of structure and commodities.
- Final release—This is the responsibility of the fumigator unless the structure contains commodities requiring a Section 18 Exemption.

In addition to the above, explain to the fumigator that it is the fumigator's responsibility to perform the fumigation in a manner which meets required treatment schedule, treatment procedures, and pest safeguards prescribed by the PPQ officer. The fumigator is also responsible for meeting all Federal, State, and local regulations. The fumigator must notify local fire, police, and health officials as required. The fumigator is also responsible for making arrangements for utility services such as electricity, telephone, and water.

Your responsibility is to determine that the prescribed procedures are followed, actually checking volume and dosage calculations, dosage applications, and that the required gas concentrations are maintained. When food commodities are involved, you must notify the local Food and Drug Administration (FDA) office so they can collect residue samples if they deem it necessary.

Step 4—Preparing Areas to Be Fumigated

In order to ensure uniform gas distribution and penetration, you may require commodities within the structure to be restacked. Place dense commodities such as flour and similar bagged commodities on pallets or other supports to improve gas circulation.

In the outside surrounding area, rake the surface area of all debris by raking the debris toward the structure.

Step 5—Arranging and Operating Fans

Use fans capable of 2,500 cfm or greater during gas introduction and for 30 minutes following gas introduction. Extend fan operation only if gas distribution is inadequate (concentration readings vary more than 4 oz.), or you need to add gas. If you must operate fans after the 30 minute reading, do so for the least amount of time required to get equal gas distribution.

Placing fans is largely determined by the configuration of the structure and the absence or presence of cargo, its nature, and quantity. Pedestal fans are preferred for large structures. Direct fan air movement upward to complement other fans and assure even gas distribution in every area of the enclosure. There is no definitive rule for determining the proper number of fans, but both you and the commercial fumigator must be satisfied that circulation will be adequate for both gas introduction and recirculation. Extremely tall buildings may require fans at several levels to ensure gas distribution to the top of the structure. Arrange the electrical source and extension cords of the fan system so the fans can be turned on and off individually from the outside of the enclosure.

Step 6—Placing Gas Sampling Tubes

Place gas sampling tubes in areas and commodities which will give representative samples of the gas concentration within the fumigated area. All gas sampling tubes must be 0.25 inch interior diameter polyethylene tubing.

The recommended number of sampling tubes is as follows:

TABLE 2-7-1: Deterimne the Number of Sampling Tubes

If the size of the enclosure is:	Then use:
500,000 ft^3 or less	Six sampling tubes for the first 100,000 ft^3, and Add one tube for each additional 50,000 ft^3
Greater than 500,000 ft^3	Fourteen sampling tubes for the first 500,000 ft^3, and Add one tube for each additional 200,000 ft^3

In addition to the number of sampling tubes described above, you must place sampling tubes within commodities stored in the structure. Place the sampling tube as near as practical to the center of the packaging (example—boxes, bags, or bins). Before placing the sampling tube in the commodity, wrap a piece of burlap over the end of the sampling tube and secure the burlap to the tube with tape.

Use a minimum of three tubes for the first 10,000 ft^3 of commodity. Use additional tubes to assure sampling of all types of tightly packed and difficult to penetrate commodities. Take care in placing sampling tubes to avoid clogging or pinching. Label each sampling tube with the location. Indicate if tube is in a commodity prior to fumigation and at the point where the concentration readings will be taken. For safety purposes, the gas sampling tubes should extend a minimum of 30 feet up-wind from the enclosure. You should have extra tubing on hand to extend beyond 30 feet if necessary.

Step 7—Measuring the Temperature

Take temperature readings of the air (space) and of the commodity. Use a calibrated thermometer. Record the temperatures in Block 22 on the PPQ Form 429. If the temperature is below the minimum listed for the treatment schedule, then you will have to heat the space to be fumigated or wait until the temperature rises to the level required by the schedule treatment.

Step 8—Sealing the Structure

Depending upon the method of fumigation, interior fumigation or tarpaulin fumigation, the effort required in this step will vary greatly.

Tarpaulin Fumigation

Locate and seal all openings which have the potential to leak gas. Since the entire structure will be tarped, do not cover openings to the exterior of the structure such as doors, windows, and air vents. Look for and seal all openings which may lead outside the structure such as manhole covers, drain pipes, and vent pipes. Seal these types of openings with polyethylene, tape, putty, or a combination of these materials. Do ***not*** seal out recessed areas, ducts, or similar areas which may harbor an infestation.

The structure or portion to be fumigated must be transformed into a gastight fumigation enclosure. This is accomplished by covering the entire structure with a 6 mil or greater, polyethylene tarpaulin. Tarpaulins may be joined together with mastic and tape or rolled and clamped together.

Have padding, such as burlap, placed on all corners of the structure and in any area where the tarpaulin may rub against rough or sharp edges of the structure.

Interior Fumigation

One of the most important steps in preparing for a structure interior fumigation is sealing all openings and areas which have the potential to leak gas. Consider the entire area to be fumigated as a natural atmospheric chamber and make the area as gastight as possible. The most important task is to locate all openings (example—drain pipes, or air ducts) and seal them.

Do ***not*** seal out or make gastight recessed areas, ducts, or similar apertures which may harbor infestations. In some cases, it is better to seal sources of leaks from the outside of the area to be fumigated. Use caulk compound or tape for sealing small spaces. For sealing larger areas, use polyethylene or similar material secured with tape or adhesive spray. Seal doors and other openings with either polyethylene or spray with vinylite plastic. When practical, seal air ventilation ducts on the outside of the space being fumigated so sealing tape can be removed when you get ready to evacuate the gas and begin aeration. Large openings should be covered with polyethylene and securely taped.

Step 9—Measuring Volume

For rectangular and square shaped buildings, multiply the length, width, and height. If the buildings are irregular, the volume of each unit can best be calculated separately and then added together.

Step 10—Calculating Dosage

The formula for calculating dosage is:

$$\text{dosage(lbs.)} = \text{volume(ft}^3) \times \text{dosage rate(lbs./1,000 ft}^3)$$
$$= \frac{\text{volume(ft}^3) \times \text{dosage rate(lbs.)}}{1{,}000 \text{ ft}^3}$$

EXAMPLE: A structure infested with khapra beetle has a volume of 100,000 ft^3. The space and commodity temperature is 65 °F. The treatment schedule requires 6 lbs. MB/1,000 ft^3 at 65 °F. To calculate the dosage multiply the volume (100,000 ft) by the dosage rate (6 lbs. MB/1,000 ft). This equals 600 lbs. of MB needed for the dosage.

Step 11—Placing the Gas Introduction Line(s)

Introduce MB from the outside of the building with the introduction line going under the tarpaulin and directly into the airstream in front of a fan. Use the "hot gas" method of gas introduction by passing the fumigant through volatilizers after it leaves the cylinders. Depending upon the size of the structure being fumigated, you may want to have several gas introduction lines going into the structure to shorten the time required for gas introduction. Attach introduction lines to the top of the fans to prevent movement of the hose. Place a piece of nonpermeable sheeting (example—plastic or rubberized canvas) over the commodity in front of and below each gas introduction line. The sheet will prevent any liquid MB from coming in contact with the cargo and will prevent damage.

The other option of gas introduction is to release MB from inside the building. If this option is selected, 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 fumigators can walk away from the released gas as they open each subsequent cylinder.

Because MB is heavier than air, it is advisable to increase slightly the amount of gas released on the top floor. Cylinders should be placed within a room for best distribution into all areas. Cylinders should be placed in an upright position and the shipping caps removed.

Because MB is heavier than air, it is advisable to attach standpipes (or curved pipes directed slightly upward) to the cylinder valves in order to reduce stratification at lower levels in the structure. If standpipes are used, they should be equipped with "T" fittings to direct the gas laterally and to prevent direct contact with the ceiling.

If the "inside release" option is used, provision must be made to have equipment in place to use the gas method of hot gas introduction to add fumigants as necessary to all areas of the structure.

You must be present during the introduction of the fumigant to ensure that the correct dosage is introduced into the enclosure.

Step 12—Making a Final Check

Just before introducing the gas, you and the fumigator must do the following:

- Make sure building is clear of all personnel and animals
- Make sure all areas requiring sealing are sealed
- Check the placement and identification of gas introduction lines and gas sampling tubes
- Turn on all fans and T/C unit to make sure they work
- Check that the tarpaulin is placarded with warning signs on all sides of the building
- Take T/C unit readings to determine if any contaminant gases are present (contaminant gases may affect concentration readings)
- Check that all gas sampling tubes are labelled and not crimped or crushed by attaching to T/C unit and watch the air flow meter to ensure that air is getting through
- Check that there is enough gas for dosage and additional gas in case you need to add gas
- Start volatilizer and heat water to at least 200 °F or above
- Place fumigant cylinders with gas introduction line on scale and take initial weight reading. Make sure the gas introduction line is attached to the cylinder. After obtaining the correct weight, subtract the dosage to be introduced into the enclosure. When you have introduced the proper amount of gas, the scale will be balanced
- Check gas introduction line connections to make sure they are tight
- Install Drierite® tube on gas sampling lines of T/C unit making sure the Drierite® granules are blue in color and have not turned pink
- Make sure all safety equipment is present and in working order

Conducting the Fumigation

Step 1—Introducing the Gas

CAUTION

You and the fumigator must wear the SCBA whenever:

- Concentration exceeds 5 ppm
- The concentration level is unknown, as with spills, leaks, and other emergencies
- Introducting gas
- Checking for leaks
- Taking aeration readings

In addition, the PPQ Officer must wear SCBA when they are within 30 feet of the enclosure.

Turn on all fans before introducing the gas. When using large cylinders of MB, have the fumigator slightly open the cylinder valve then close the valve. Using a halide detector, check all connections on the gas introduction line for leaks. If leaks are found, have the fumigator tighten the connections and repeat the test. Also, check all areas which are sealed. If you find a leak and it cannot be readily corrected, evacuate this partial dosage and reseal the area. If no leaks are found, then open the valve to the point where 3 to 4 pounds of MB are being introduced per minute. The gas introduction line should always be hot and the volatilizer should read at least 150 °F.

CAUTION

Do not touch the introduction line with your bare hands—you may get burned! Close the cylinder valve once the proper dosage has been introduced.

The fumigation time begins once all the gas has been introduced. Record the time gas introduction was started and completed in Block 32 on the PPQ Form 429. Run the fans for 30 minutes after all gas has been introduced. You will take the initial concentration reading 30 minutes after all the gas has been introduced.

When using large cylinders, getting the final amount of gas out of the cylinder may take a long time. Using a pressurized cylinder will shorten the time. Consider taking a T/C unit reading 30 minutes after the gas was first introduced. If the gas distribution is even (all readings within 4 ounces of each other) and at a sufficiently high concentration, then turn off the fans. Running the fans longer may contribute to gas leakage. Allow the remainder of the gas to discharge at its slow rate with intermittent running of the fans for dispersal.

Step 2—Testing for Leaks

Wear the SCBA while checking for leaks. Use a halide detector to test for leaks before the 30 minute reading. Test around the perimeter of the tarpaulin on the ground, corners, and especially where electric cords, gas sampling tubes, or gas introduction lines are present. If you detect leaks, be sure they are sealed by using more sand or water snakes for floor leaks and tape for small holes in the tarpaulin.

Step 3—Taking Concentration Readings

Take concentration readings with a T/C unit to determine the gas concentration and distribution within the enclosure. Check Drierite® tubes before each reading and change Drierite® if its color is pink. Depending upon the length of exposure period, take concentration readings at the following times after the introduction of the fumigant:

- 30 minutes
- 2 hours
- 4 hours
- 6 hours
- 12 hours
- 24 hours
- 36 hours
- 48 hours
- 72 hours

All times are after gas introduction is completed.

Use an auxiliary air pump when there are many gas sampling tubes or the gas sampling tubes are very long. The auxiliary air pump will lessen the time required to draw gas to the T/C unit.

You may start the final reading 30 minutes to 1 hour prior to completion of the exposure period. If final gas concentration levels meet minimum levels, start aeration immediately at the end of the exposure period.

Additional Readings

Adverse weather conditions may indicate the need for additional readings. Sorptive commodities and indications of a steady decline in gas concentration also indicate the need to take additional concentration readings.

Step 4—Adding Gas

For concentration readings below minimum levels, add gas at the following rate:

1.6 × number of oz. below × volume/1,000 = oz. of fumigant to add

Once you've determined that you need to add gas, follow the same procedures as introducing the gas (Step 1). That is—

1. Heat water in the volatilizer to at least 200 °F.
2. Turn on the fans.
3. Weigh the cylinder.
4. Use your SCBA.
5. Open valve on cylinder and introduce the gas.
6. Close valve when the weight of the cylinder indicates that the needed amount of gas has been added.
7. Record quantity of fumigant added in Block 34 on the PPQ Form 429.

Note the time you started introducing additional gas and the time you finished introducing gas and record in Block 40 (Remarks) on the PPQ Form 429. Run the fans until you get even gas distribution throughout the enclosure. Turn off the fans, then take a concentration reading 30 minutes after you complete introducing the gas. If all readings are above minimum concentration levels, then proceed as usual with the remainder of the concentration readings. If gas is not evenly distributed (readings not within 4 oz. of each other), then run fans until you get gas evenly distributed.

Step 5—Exhausting the Gas

Exhaust the gas at the completion of the exposure period. The aeration of the structure and the final release to the owner is the responsibility of the commercial fumigator unless under a Section 18 Exemption. Exhausting the fumigant is facilitated by partially removing the tarpaulin and the use of suction fans which are supplied with ducts leading from the enclosure to the outside. The fumigant should be evacuated to the outside, downwind areas of the enclosure. The fumigator must be certain that the removal of the covers and ventilation is done in a manner that minimizes the hazard from the released gas.

Aerating the Enclosure

TABLE 2-7-2: Determine the Responsibility for Monitoring the Aeration

If the treatment schedule is:	Then:
A FIFRA Section 18 Exemption	MONITOR the aeration of the commodity. FOLLOW "Aerating the Enclosure" steps which follow.
A labelled treatment	RELEASE the commodity and RELEASE the fumigation to the fumigator.

Step 1—Securing the Area

Assuming that you've already restricted access and secured the fumigation area, you now must restrict access to the area where the exhaust duct extends beyond the enclosure. During the first 10 minutes of aeration, there should be no people within 200 feet of the exhaust duct outlet. When securing the duct outlet area, consider the direction of the wind. Face the duct outlet toward an open area and away from people. Point the duct outlet upward to aid in dispersing the exhaust gas.

Have the fumigator use a physical barrier such as ropes, barricades, or walls to secure the area.

Placard the secure area near the exhaust outlet with the appropriate DANGER/PELIGRO signs. Make sure the placards meet the appropriate fumigant label or labeling requirements. The skull and crossbones should be present as well as "AREA UNDER FUMIGATION, DO NOT ENTER/NO ENTRE"; date of the fumigation; name of the fumigant used; and the name, address, and telephone number of the fumigator.

Unless you authorize their use, do ***not*** allow motorized vehicles to operate within the secure area.

Step 2—Aerating the Structure

Wearing the SCBA, have the fumigator open slightly the opposite end of the enclosure to allow entry of fresh air. The fumigator may open doors, tarpaulins, and areas to facilitate aeration. Start the exhaust system (minimum 2,500 cfm exhaust fan connected to an exhaust duct) and aerate the structure.

Important

The PPQ officer is not required to be continuously onsite during the entire aeration unless specified by the label, Section 18 Exemption, or State or local regulations. The officer must verify the gas concentration levels before removal of the tarpaulin and final release of the structure.

Step 3—Taking Concentration Readings

Stop the aeration fans. Take a concentration reading with a colorimetric tube in the exhaust duct within 2 feet of the enclosure. If the concentration is above 5 ppm but less than 100 ppm (for MB), the fumigator may remove the tarpaulin while wearing the SCBA. Release the structure when the concentration is 5 ppm or less after taking readings 4 feet from the floor and 1 foot inside the fumigation perimeter at several representative locations (a minimum of two are required). Record the date, concentration reading, and time on PPQ Form 429.

2

Treatment Manual

Chemical Treatments

Fumigants • Methyl Bromide • Special Procedures for Container Fumigations Without a Tarpaulin

Contents

Methods and Procedures

The procedures covered in this section provide PPQ Officers and commercial fumigators with the methods, responsibilities, and precautions for container fumigation without a tarpaulin.

A refrigerated container may be used for fumigations without a tarpaulin provided the following requirements are met:

- The container must be a refrigerated (reefer) container
- The container must have the two drainage holes removed at the doors. If damage will occur to the container by removal of these drains, the fumigator should obtain permission from the container manufacturer
- before proceeding.
- The container must have three gas monitoring leads to be located in the front-high, middle-middle and rear-low of the container. (The "rear" is considered to be at the doors.)
- The container must be packed (in some cases re-packed) so that one circulation fan can be placed in the front and one in the back. This will ensure at least 2’ of air space above the commodity. Use fans which have the capacity to move a volume of air in cubic feet per minute equivalent to the total volume of the container. The rear fan (at the doors) has the gas introduction hose attached to it and is referred to as the gas introduction fan.
- The PPQ officer must visually inspect the container prior to fumigation to identify any possible areas of leakage for the fumigator to repair.
- Air exchange vents must be closed and taped if any openings are visible.

Materials Needed

PPQ Officer Provides

- Calculator (optional)
- Colorimetric tubes (Draeger/Kitagawa)
- Desiccant (Drierite®)
- Forms (PPQ Form 429 and APHIS Form 2061 if necessary)
- Halide leak detector
- Self-contained breathing apparatus (SCBA) or supplied air respirator to be used by PPQ officer

- Tape measure
- Thermal conductivity unit[1], [2]
- Thermometer

Fumigator Provides

- Auxiliary pump for purging long gas sample tubes
- Carbon dioxide filter (Ascarite®)
- Colorimetric tubes (Draeger/Kitagawa)
- Desiccant (Drierite®, anhydrous calcium sulfate)
- Electrical wiring (grounded, permanent type), three prong extension cords
- Fans (circulation, exhaust, and introduction)
- Gas introduction line
- Gas sampling tubes (leads)
- Methyl bromide
- Scales or dispensers
- Self-contained breathing apparatus (SCBA) or supplied air respirator
- Tape
- Thermal conductivity unit[3], [4]
- Volatilizer
- Warning signs

Preparing to Fumigate

Step 1—Selecting a Treatment Schedule

Select a treatment schedule to effectively eliminate the plant pest without damaging the commodity being fumigated.

Turn to the Treatment Schedule Index and look up the available treatment schedule(s) by commodity (example—apples, pears, or citrus) or by pest (example—Mediterranean fruit fly). Some

1 If fumigating oak logs or lumber for export, the unit must be capable of reading 400 oz.
2 T/C unit must be calibrated annually by the Center for Plant Health Science and Technology (CPHST). If requested, CPHST will calibrate a commercial fumigator's T/C unit.
3 If fumigating oak logs or lumber for export, the unit must be capable of reading 400 oz.
4 T/C unit must be calibrated by CPHST. If requested, CPHST will calibrate a commercial fumigator's T/C unit.

commodities may have several treatment schedules. The "Fumigants—Methyl Bromide" section on Residual Effects lists those commodities which may be damaged by MB. Each treatment schedule lists the target pest or pest group (e.g., *Ceratitis capitata*, surface feeders, wood borers...), commodity, or both pest and commodity. If there is no schedule, contact the Center for Plant Health Science and Technology (CPHST) in Raleigh, North Carolina, to see if a schedule is available under a FIFRA Section 18 Exemption. If a treatment is required, go to **Table 2.2.1**.

TABLE 2-8-1: Determine Reporting Requirements

If a treatment is required:	Then:
As a result of a pest interception	GO to Step 2
As a condition of entry	GO to Step 3

Step 2—Issuing a PPQ Form 523 (Emergency Action Notification)

When an intercepted pest is identified and confirmed by a PPQ Area Identifier as requiring action, issue a PPQ Form 523 (Emergency Action Notification) to the owner, broker, or representative. Be sure to list all treatment options when completing the PPQ Form 523 (Emergency Action Notification). Follow instructions in Appendix 1 for completing and distributing the PPQ Form 523 (Emergency Action Notification).

Step 3—Determining Section 18 Exemptions and Sampling Requirements

After selecting the treatment schedule, you will be able to determine which treatment schedules are FIFRA Section 18 Exemptions by the presence of broad, bold, vertical lines on the borders of the treatment schedule table listed in the reference. Some treatment schedules are only FIFRA Section 18 Exemptions at specific temperature ranges. Check the treatment schedule and temperature to determine if the fumigation will be a FIFRA Section 18 Exemption.

Food or Feed Fumigations

Residue monitoring by taking samples of the commodity prior to the start of the fumigation and after aeration is no longer required.

Step 4—Selecting a Fumigation Site

Consider the following factors in selecting a fumigation site:

- A well-ventilated, sheltered area
- Ability to heat area (in colder areas)
- A nonwork area which can be effectively marked and safeguarded or isolated
- Electrical power supply
- Water supply

- A well-lighted area
- Aeration requirements

A Well-Ventilated Area

Select sites which are well-ventilated. A well-ventilated site is required for exhausting gas.

Important

> Only open-air fumigations are allowed for non-tarped containers. Non-tarped containerized fumigations may not be conducted in a warehouse.

Some gas will escape from the container even in the best conditions. Ensure that the exhausted gas does not endanger people working outdoors. When treatments are conducted in a particular location on a regular basis, a permanent site should be designated. Select a site that is semi-sheltered such as the leeward side of a warehouse or pier.

A Nonwork Area

Select a secure area where traffic and people are restricted from entering and which is isolated from people working. You want a non-work area to help prevent accidents such as a forklift piercing a container and for other safety reasons. Consider either the entire structure area or an area which extends 30 feet from the container and is separated by a physical barrier such as ropes, barricades, or walls as the fumigation area. Some states, for example California, require a 100-foot perimeter around fumigation sites. If a wall of gas-impervious material is less than 30 feet from the container, the wall may serve as the edge of the secured area. Place placards clearly in sight of all who come near. Placards must meet label requirements regarding specific warnings, information, and language. Placards generally include the name of the fumigant, the fumigation date, time, and the name of the company conducting the fumigation. Restrict access to the fumigation area to the fumigator's employees and PPQ employees monitoring the treatment. Use rope or marker tape to limit access within 30 feet of the enclosure. Do not allow motor vehicles (includes forklifts) to operate within 30 feet of the enclosure during the fumigation and aeration periods.

The area outside the 30-foot perimeter is generally regarded as a safe distance from the container. Gas concentrations exceeding 5.0 ppm (TLV for MB) are seldom recorded by gas monitoring, except during aeration. PPQ Officers that work within the 30-foot primeter must wear (and use) respiratory protection (SCBA), unless the gas levels are safe to breath and validated as safe by gas monitioring. The 30-foot perimeter is not specifically mentioned on the MB label, but is required for PPQ Officers.

When space is tight, it is permissible to overlap two or more adjoining 30-foot perimeters. However, there must be sufficient space for a person wearing SCBA to walk between the containers.

Electrical Power Supply

An adequate electrical source must be available to run the circulation fans and the T/C unit. A separate line should be available for the T/C unit. Electrical outlets must be ground and conveniently located in relation to the fumigation area. Do not use generators as a power source, except under emergency conditions.

Water Supply

A water supply is necessary for safety purposes. Water is necessary for washing off MB if the liquid form is spilled on someone. Water is also used to fill the volatilizer. If no permanent water is present on site, the fumigator must provide a portable, 5-gallon supply of clean water.

Well-Lighted Areas

The area should have adequate lighting for safety purposes and for ease in reading T/C units, thermometers, and for determining whether a container has holes or places where the MB may leak.

Aeration Requirements

Assuming that you've already restricted access and secured the fumigation area, you now must restrict access to the area where the exhaust duct extends beyond the enclosure. Before you start a fumigation, make sure the exhaust duct is located in a safe place. During the first 10 minutes of aeration, there should be no people within 200 feet down wind of the exhaust duct outlet. If it is impossible to restrict people from the area of aeration during regular work hours, consider aeration during another time of the day. When securing the duct outlet area, consider the direction of the wind. Face the duct outlet toward an open area, and away from people. Point the duct outlet upward to aid in dispersing the exhausted gas.

If an exhaust duct is not used, then a perimeter of 30 feet or more from the containers is usually regarded as a safe distance for personnel. However, for personal safety, gas levels should occasionally be monitored at greater distances, especially downwind. Experience provides the best guide.

Step 5—Arranging the Stack

Containerized Cargo

Containers should ordinarily not be loaded beyond 80 percent of their capacity. A space of 20 percent (18 inches) should be provided above the commodity. This allows a crawl space for placing the gas monitoring leads and fans, and to facilitate uniform gas distribution.

(Some restacking of cargo may be necessary to meet this requirement.) The commodity should be on a pallet to allow adequate space (at least 2 inches) below the commodity.

"Due to safety considerations, APHIS recommends that containers to be fumigated should not be stacked

Gas Penetration and Distribution

MB will penetrate most cargo easily; however, cargo may be packaged in an impermeable material.

Some of the more common types of impermeable materials are cellophane, plastic, wax coated materials, laminated, and waterproofed papers. Tight wooden packing cases are also relatively gastight. Impermeable materials will allow some gas to penetrate, but make it difficult to aerate and evacuate the gas. Remove, perforate, or open all impermeable materials.

For impermeable wrappers or containers, open the entire top or side and place the package with the open portion on the side.

Step 6—Arranging and Operating Fans

Containerized Cargo

There must be two circulation fans in the container, both placed on top of the stack. Place one fan at the doors (rear) and one fan in the front. The rear fan is the gas introduction fan and should be pointed into the container. The front fan is pointing in the opposite direction.

The electrical cords for the fans should be inserted through the drainage holes located at the doors. The fumigator must obtain approval from the owner of the container before removing the drains. The drains may be removed by any practical means available. Re-seal the holes using plumber’s putty or similar water-proof caulking material to ensure minimal gas loss.

Turn on fans to make sure they work. Operate fans during gas introduction and for 30 minutes after the gas is introduced. If after taking gas concentration readings the fumigant is not evenly distributed, run the fans until the gas is evenly distributed as indicated by concentration readings (within 4 oz. of each other). Operate fans when adding gas, but only long enough to get even gas distribution.

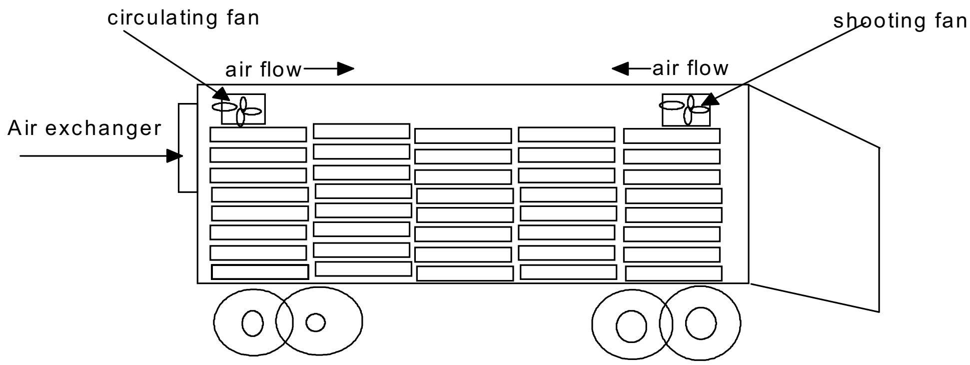


FIGURE 2-8-1 Fan Placement

The refrigeration unit may be run throughout the entire fumigation to enhance gas circulation and maintain pre-selected temperatures.

Important

However, the ½ hour readings are at the minimum required concentration, or if gas has been added twice to the reefer, turn the refrigeration unit off for the remainder of the fumigation.

Step 7—Placing the Gas Introduction Lines

Containerized Cargo

Place the gas introduction line directly above the rear (door) fan. Attach the line to the top of the fan to prevent movement of the hose. The fan should be firmly attached to the cargo or have a base that prevents it from toppling (not a pedestal type). Place a piece of impermeable sheeting (example—plastic or rubberized canvas) over the commodity below and to the front of the gas supply line. The sheet will prevent any liquid MB from coming in contact with the cargo.

Step 8—Placing the Gas Sampling Tubes

Containerized Cargo

Place a minimum of three gas sampling lines in the container. Position the gas sampling tubes in the following locations:

- Rear low - at the doors, 3 inches above the floor
- Middle center—center of the load, midway from bottom to top of load
- Front high - at the extreme top of the load

The gas introduction and sampling lines should be inserted through the drainage holes located at the doors. The fumigator must obtain approval from the owner of the container before removing the drains. The drains may be removed by any practical means available. Re-seal the holes using plumber’s putty or similar water-proof caulking material to ensure minimal gas loss.

Use gas sampling tubes of sufficient length to extend from the sampling position inside the container to at least 30 feet up-wind from the container. Have all the gas sampling tubes meet in one area for ease and safety in taking gas concentration readings. Do not splice gas sampling tubes. Before starting the fumigation, test all gas sampling tubes for tightness by connecting each gas sampling tube to the T/C unit and placing a finger over the far end of the gas sampling tube. The ball in the flow meter will fall to zero if the gas sampling tube connections are tight. Replace any defective gas sampling tubes. Before starting the fumigation, check for gas sampling tube blockage or pinching by connecting each tube for a short time. If the tube is blocked, the flow meter will drop sharply. Fix all gas sampling tubes securely in place in the container and label each one at the end where the gas concentration readings will be taken. By labeling each gas sampling tube, you will be able to record concentration readings easily.

Step 9—Measuring the Temperatures

Important

Regardless of the commodity, never fumigate at temperatures below 40 °F.

If the commodity temperature drops below 40 °F after the fumigant has been added, do not include the time below 40 °F as part of the required exposure. Begin counting exposure time only after the temperature increases to at least 40 °F. However, in the case of parishable commodities, you must abort the fumigation immediately, unless it is feasible to add supplemtal heat to bring the commodity temperature back to 40 °F or above. (Do not use an open flame or electric heating elements to increase the temperature.)

Determine the temperature to use in selecting the proper dosage rate:

- For fruits, pulpy vegetables, or logs use only the commodity temperature.
- For all other commodities use both the commodity and air temperature.

To take the temperature readings, use a bimetallic, mercury, or digital long-stem thermometer that has been calibrated. Use TABLE 2-8-2: Determine the Temperature for the Proper Dosage Rate **page-2-8-10** to determine which temperature to use when selecting the proper dosage rate for commodities other than fresh fruits, vegetables, or logs.

TABLE 2-8-2: Determine the Temperature for the Proper Dosage Rate

<table>
<tr><th>If the air temperature is:</th><th>And:</th><th>Then, for commodities other than fresh fruits or pulpy vegetables or logs and lumber:</th></tr>
<tr><td>Higher than the commodity temperature</td><td>→</td><td rowspan="2">Use the single lowest commodity temperature for determining the dosage rate (Do Not use the average commodity temperature).</td></tr>
<tr><td rowspan="2">Lower than the commodity temperature</td><td>By 9 degrees or less</td></tr>
<tr><td>By 10 degrees or more</td><td>Use the average of the single lowest air and commodity temperatures for determining the dosage rate
(Never initiate a fumigation if any commodity temperature reads lower than 40°F.)</td></tr>
</table>

EXAMPLE: You are about to fumigate guar gum and the commodity temperature is 82 °F and the air temperature is 69 °F. Average the air and commodity temperatures to determine the dosage rate because the air is 13 degrees lower than the commodity temperature. The average of the two temperatures is 75.5 °F. Use 75 °F to determine the dosage rate.

If the commodity is fruits, pulpy vegetables, or logs, see the specific procedures that follow.

Fresh Fruits and Pulpy Vegetables

For fresh fruit and pulpy vegetables, insert the thermometer into the pulp. (for purposes of this paragraph, peppers are also included in the category of pulpy vegetables.) For commodities which have been refrigerated, probe the fruit that have the lowest pulp temperature. Again, fumigate only when the fruit pulp is at 40 °F or higher. However, if the commodity has no pulp (for example, peas, beans, grains, herbs, spices, etc.), take the temperature of the air space immediately surrounding the commodity as well as the commodity temperature. With these temperatures, use TABLE 2-8-2: Determine the Temperature for the Proper Dosage Rate **page-2-8-10** to determine the correct temperature for use when selecting the proper dosage rate

Step 10—Measuring the Volume

Using a 100-foot tape measure, carefully measure the length, width, and height of the enclosure. *Never* estimate the measurements. An error in measurement of as little as 12 inches can result in miscalculation of the dosage by as much as 15 percent. When measuring, round off to the nearest quarter foot (example—3 inches = .25 feet). In the case of fumigations of edible commodities, an error can result in an unacceptable level of residue on the commodity.

Formula for determining volume:

Length × width × height = volume in cubic feet

Record volume in Block 26 of the PPQ Form 429.

Step 11—Calculating the Dosage

Calculate dosage by doing the following:

1. Refer to the treatment schedule for the correct dosage rate (lbs./ 1,000 ft^3) based on temperature (°F) (Step 10).
2. Multiply by the dosage (lbs./1,000 ft^3) rate by the volume (ft^3) to get the dosage in pounds.
3. Rules for rounding. Round to nearest ¼ pound.

Formula for calculating dosage:

$$\text{dosage (lbs.)} = \text{volume}(\text{ft}^3) \times \text{dosage rate (lbs./1,000 ft}^3)$$
$$= \frac{\text{volume}(\text{ft}^3) \times \text{dosage rate (lbs.)}}{1{,}000\ \text{ft}^3}$$

Step 12—Making a Final Check

Just prior to introducing the gas, do the following:

- Turn on all fans and T/C unit to make sure they work.
- Warm up T/C unit at least 30 minutes before zeroing in.
- If contaminant, CO_2, is detected, test again with Ascarite®. If you get a zero reading, proceed. If you don't get a zero reading, suspect a leak.
- Start volatilizer and heat water to 200 °F or above. A minimum temperature of 150 °F is required at all times during the introduction process.
- Place fumigant cylinder with gas introduction line on scale and take initial weight reading. Make sure the gas introduction line is attached to the cylinder. After obtaining the correct weight, subtract the dosage to be introduced into the enclosure. After you have introduced the proper amount of gas, the scale will be balanced.
- Check that container is placarded and the area is secured. Only people working on the fumigation may be in the area.
- Check container to make sure it is free from holes where MB might leak.
- Check that all gas sampling tubes are labeled and are not crimped or crushed. Inspect tubes visually, or use an electric or Mityvac hand pump to check tubes. Either a fumiscope or vacuum pump may be used to test leads for unrestricted flow.

Important

When conducting fumigations with methyl bromide, sulfuryl fluoride or phosphine, erroneous readings may occur if the monitoring leads become blocked or crimped. It would be impossible to install a new monitoring lead during a fumigation treatment. Therefore, to avoid an unsuccessful fumigation, you should test monitoring leads before the treatment begins.

The Center for Plant Health Science and Technology (CPHST) has developed the following procedure to detect blocked monitoring leads with the use of a Mityvac hand-held pump (for supplier, see ***Vacuum Pump***, Appendix 8):

1. Prior to fumigant introduction, connect the Mityvac hand-held vacuum pump to a monitoring lead.
2. Squeeze the handle on the Mityvac unit. If the lead is blocked, a vacuum will be indicated on the vacuum gauge of the Mityvac unit. (The handle should be squeezed two or three times for monitoring leads longer than 25 feet. The Mityvac hand-held pump has the capacity to attain and hold 25 inches of Hg vacuum and a minimum of 7 psig pressure.)
3. Disconnect the Mityvac hand-held pump from the monitoring lead, and repeat this procedure for each monitoring lead. (Connect monitoring leads to the gas analyzer prior to fumigant introduction.)

- Check that there is enough gas in the cylinder and if necessary, that other cylinders are available.
- Check the gas introduction line connections to make sure they are tight and free of leaks (wearing the SCBA).
- Check all safety equipment, especially SCBA, is available and in working order.
- Install Drierite® tube on gas sample line attached to the T/C unit and check to make sure granules are blue, if pink—replace Drierite®. If humidity is high, additional Drierite® tubes or frequent changes may be necessary.

Conducting the Fumigation

Step 1—Introducing the Gas

CAUTION

The acceptable air concentration level for methyl bromide (MB) is 5 ppm. A respirator (approved SCBA or MSHA/NIDSH) is required if the MB concentration level in the air is greater than 5 ppm at any time. You and the fumigator must use your SCBA while introducing the gas, checking for leaks, and when taking aeration readings.

Turn on all fans before introducing the gas. When using large cylinders of MB, have the fumigator open the cylinder valve slightly, then close the valve. With a halide detector, check all connections on the gas introduction line for leaks. If leaks are found, advise the fumigator tighten the connections and repeat the test. If no leaks are found, then open the valve to the point where 3 to 4 pounds of MB are being introduced per minute. The water temperature in the volatilizer should never go below 150 °F at any time during gas introduction. The water in the volatilizer may include an antifreeze and should be handled with the appropriate safeguards.

CAUTION

Don’t touch the introduction line with your bare hands—you could get burned! Close the cylinder valve once the proper dosage has been introduced.

The fumigation time begins once all the gas has been introduced. Record the time gas introduction was started and completed in Block 32 on the PPQ Form 429. Run the fans for 30 minutes to achieve even gas distribution. Take the initial concentration reading 30 minutes after all the gas has been introduced.

When evacuating large cylinders, getting the final amount of gas out may take a long time. Consider taking a T/C unit reading 30 minutes after the gas was first introduced. If the gas distribution is even (all readings within 4 ounces of each other) and at a significantly high concentration, then turn off the fans. Running the fans longer may contribute to gas leakage. Allow the remainder of the gas to discharge with intermediate running of the fans. Normally, all the gas should be introduced within 30 minutes.

CAUTION

Do not begin counting fumigation time until all the gas has been introduced and valve on the MB tank is closed.

Step 2—Testing for Leaks

Wear the SCBA while checking for leaks. Use a halide detector to test for leaks before the 30 minute reading or anytime when the concentration level is unknown or above 5 ppm. Test around the perimeter of the container, and especially at the plugged drainage holes. When you detect leaks, have them sealed using tape.

If you detect excessive leakage (concentration readings of 50 percent or less of the minimum concentration) in a container which cannot be corrected in a practical way, do not attempt to correct the problem by adding more gas. Quickly evacuate the remaining gas from the enclosure, eliminate the problem, and construct a new enclosure. Aerate as usual following procedures on **page-2-8-14**. Restart the fumigation in the new enclosure.

CAUTION

Commodities used for food or feed may not be re-treated. If commodities fall into this category, the only options are the following:

- Re-exported to another country if they will accept the shipment
- Destroy by incineration

Step 3—Taking Concentration Readings

Important

Before obtaining readings, always purge sampling lines with a mechanical or hand pump. If you're using treatment schedule T101 or T104-a-1 to fumigate fresh fruit or vegetables, see "Special Procedures for Fruits and Vegetables" on **page-2-4-25**.

Take concentration readings with a T/C unit to determine the gas concentration and distribution within the enclosure. Check desiccant tubes before each reading and change Drierite® if its color is pink. Depending upon the length of exposure period, take concentration readings at the following times:

- 30 minutes
- 2 hours
- 4 hours (optional)
- 6 hours (optional)
- 12 hours (optional)
- 24 hours[5]
- 36 hours (optional)
- 48 hours
- 72 hours

Any final concentration reading (see following example)

EXAMPLE: If the treatment schedule lists a 6 hour exposure period, then the 6 hour reading would be required and not optional as shown in Step 3. If the treatment schedule lists a 16 hour exposure period, you must take a 16 hour reading.

CAUTION

Avoid using hand-held two-way radios near the T/C unit. Using two-way radios near the T/C unit will interfere with an accurate concentration reading.

5 If fumigating oak logs or lumber for export, see "Special Procedures for Adding Gas to Oak Logs and Lumber."

Thirty Minute Reading

The 30 minute reading shows the initial concentration and distribution of gas. The 30 minute reading can indicate leakage, sorption, incorrect dosage calculation, or error in fumigant introduction—all of which require immediate attention. Concentration readings should not differ more than 4 ounces among the leads.

Two Hour Reading

In comparison with the 30 minute reading, the 2 hour reading also will indicate if the container is leaking or the commodity is sorbing gas. Readings more than 15 percent lower than the 30 minute reading will require close monitoring and possible corrective action.

EXAMPLE: Your dosage for the fumigation was 4 pounds (64 ounces). The 30 minute reading was 50 ounces (3.125 pounds). The 2 hour reading is 42 ounces (2.625 pounds). The 2 hour reading is more than 15 percent less than the 30 minute reading and would indicate that either a leak or sorption problem may exist. You would need to monitor the fumigation closely until the concentration level stabilizes.

Four, Six, Twelve, or Thirty-Six Hour Reading

Not required if previous readings are satisfactory and experience with similar fumigations indicate successful treatment can be expected. If either the 4, 6, 12, or 36 hour reading is the final reading, then you must take the reading. If you are unfamilar with the treatment schedule, optional concentration readings may be necessary to ensure a successful fumigation.

Final Reading

The final reading is required for all container fumigations in order to determine if the fumigation has been successfully completed. You may start the final reading before the finishing time of the treatment so that aeration commences at the finishing time. Starting the final reading before finishing time is especially critical when fumigating perishables. Do not add gas after the final reading.

Additional Readings

Decide the need to take additional readings based on the following:

- Rate of gas concentration decrease
- Any condition which could change the gas concentration such as severe winds, or rain.

When concentration readings differ by more than 4 ounces, run the fans to equalize the gas and record readings on the APHIS 429. Generally, at the ½ hour reading, gas should be evenly distributed, and you should not have to restart the fans unless you added gas.

Severe winds (30 mph or higher including any amount severe enough to cause damage) are a good reason to take additional readings on an outdoor fumigation. Any sharp or unusual decreases of the readings in relation to previous readings is a clue to take corrective action and supplementary readings. Take additional readings every 30 minutes until problems are rectified. Adverse weather conditions may indicate the need for additional readings.

Sorptive commodities may also require additional concentration readings.

Step 4—Determining the Need to Add Gas and Adjust Exposure

Use the following table to determine when to add gas or extend the exposure period:

TABLE 2-8-3Determine the Need to Add Gas and Adjust Exposure

If the average T/C unit readings are:	And the schedule is:	Then:
Below the required minimum concentration	T101-a--1* or equivalent	ADD gas and extend fumigation. SEE “Special Procedures for Fruits and Vegetables” on page-2-4-25
	Other than T101a--1 or equivalent	ADD gas using “Special Procedures for Adding Gas and Extending Exposure” on page page-2-4-25
At or above required minimum concentration	T101-a--1* or equivalent	SEE page-2-4-19 for corrections at 0.5 hour and 2 hour readings
	Other than T101-a-1	No action necessary

Important

* T101-a-1 or equivalent treatment schedules are those schedules that are not greater than 2 hours long (exposure time), and the dosage rate is not greater than 4lbs per 1000ft^3 anywhere on the schedule

Special Procedures for Adding Gas and Extending Exposure Period

Adding Gas to Commodities that are Fumigated Using Treatment Schedules Other Than T101-a-1 or Equivalent (may include perishables)

Important

T101-a-1 or equivalent treatment schedules are those schedules that are ***not*** greater than 2 hours long (exposure time), and the dosage rate is ***not*** greater than 4lbs per 1000ft^3.

NOTICE

To avoid injuring the commodity, add fumigant using the following formula: 1.6 × number of oz. below minimum × vol/1,000 = oz. of gas to add

When adding gas, these procedures must be followed:

1. Heat water in volatilizer.
2. Turn on fans.
3. Take weight of the cylinder.
4. With your SCBA on, open valve on cylinder and introduce the gas.
5. Close valve when the weight of the cylinder indicates that the needed amount of gas has been added.
6. Record quantity of fumigant added in Block 34 and the additional fan time in Block 30 of the PPQ Form 429.

Note the time the fumigator started introducing additional gas and the time the fumigator finished introducing gas and record in Block 40 (Remarks) of the PPQ Form 429. Run the fans until there is even gas distribution throughout the stack. Turn off fans, then take a concentration reading 30 minutes after the gas has been introduced. If all readings are above minimum concentration levels, then proceed as usual with the remaining scheduled concentration readings.

Excessive leakage (concentration readings are less than 50 percent of minimum) in any one container which cannot be eliminated in a practical way must *not* be corrected by the addition of MB. "Quickly evacuate remaining gas from the container, eliminate the problem,and start a new treatment

CAUTION

Commodities used for food or feed may not be re-treated. If commodities fall into this category, the only options are the following:

- Return to the country of origin
- Re-export to another country if they will accept the shipment
- Destroy by incineration

Extending the Exposure Period for Food, Nonfood, Feed, or Nonfeed Commodities

Use the following table to determine how long to extend the exposure period.

TABLE 2-8-4: Determine the Extended Exposure Period

If the exposure time is:	And the reading is below minimum by:*	Then extend exposure:
Less than 12 hours	10 oz. or less	10 percent of the time lapse since the last acceptable reading
	11 oz. or more	30 minutes
12 hours or more	10 oz. or less	10 percent of the time lapse since the last acceptable reading
	11 oz. or more	2 hours or 10 percent of time lapse since last acceptable reading, whichever is greater

*If reading is 50 percent below minimum or less, then abort the treatment. For example, if the minimum reading is 38 ounces then the reading 50 percent below the minimum is 19 ounces [38 ounces – (38 ounces × .50) = 19 ounces]. (See the following special procedures for fruits and vegetables using T101 or equivalent.)

Special Procedures for Fruits, Vegetables, or Perishable Commodities Using Schedule T101-a-1 or Equivalent

Use these instructions only for fruits and vegetables being fumigated under treatment schedule T101-a-1 or equivalent.

CAUTION

Fresh fruits and vegetables are sensitive to MB so you should double check volume calculations and dosage measurements to avoid accidental overdoses. If any 30 minute readings are 50 percent or more above the minimum concentration, it indicates a miscalculation of the dosage. Include a brief report on the PPQ Form 429 stating possible reasons for the overdose. Exposure periods are decreased for fumigations where concentration readings are much higher than required. See table on the following pages to determine when to reduce exposure periods.

Use Table 2-2-6 and **Table** 2-2-7 on the following pages for fresh fruits and vegetables to determine if you need to add gas or extend or decrease the exposure time. Average your concentration readings before using the tables. Select the proper table based on the time of the T/C unit concentration reading (30 minutes or 2 hours).

Important

These tables apply ***only*** to those T101 schedules lasting 2 hours or less at a dosage rate of 4lbs/1000ft^3 or less. They do not apply to schedules of longer duration.

Adding Gas

NOTICE

To avoid injuring the commodity, add fumigant using the following formula:
1.6 X number of oz. below minimum X vol/1,000 = oz. of gas to add

When adding gas, these procedures must be followed:

1. Heat water in volatilizer.
2. Turn on fans.
3. Take weight of the cylinder.
4. With your SCBA on, open valve on cylinder and introduce the gas.
5. Close valve when the weight of the cylinder indicates that the needed amount of gas has been added.
6. Record quantity of fumigant added in Block 34 and additional fan time in Block 30 of the PPQ Form 429.

Note the time the fumigator started introducing additional gas and the time the fumigator finished introducing gas and record in Block 40 (Remarks) of the PPQ Form 429. Run the fans until there is even gas distribution throughout the stack. Turn off fans, then take a concentration reading 30 minutes after the gas has been introduced. If all readings are above minimum concentration levels, then proceed as usual with the remaining scheduled concentration readings.

TABLE 2-8-5: Determine Gas Concentration Values and Corrections for Fruits and Vegetables at the 30 Minute Reading of T101-a-1 or Equivalent Schedules

If the schedule is:	And the minimum concentration reading (oz.) in the schedule is:	And the average concentration reading (oz.) is:	Then:
40-49 °F 4 lbs for 2 hrs	48	73 or higher[1]	EVACUATE excess gas immediately
		65 or greater*	REDUCE exposure by 15 minutes
		64-48	TAKE 2 hour reading as scheduled
		47 or lower	1. ADD gas, and 2. EXTEND exposure 15 minutes
50-59 °F 3 lbs for 2 hrs	38	58 or higher*	EVACUATE excess gas immediately
		52 or greater	REDUCE exposure by 15 minutes
		51-38	TAKE 2 hour reading as scheduled
		37 or lower	1. ADD gas, and 2. EXTEND exposure 15 minutes
60-69 °F 2.5 lbs for 2 hrs	32	49 or higher*	EVACUATE excess gas immediately
		48 or greater	REDUCE exposure by 15 minutes
		47-32	TAKE 2 hour reading as scheduled
		31 or lower	1. ADD gas, and 2. EXTEND exposure 15 minutes
70-79 °F 2 lbs for 2 hrs	26	40 or higher*	EVACUATE excess gas immediately
		37 or greater	REDUCE exposure by 15 minutes
		36-26	TAKE 2 hour reading as scheduled
		25 or lower	1. ADD gas, and 2. EXTEND exposure 15 minutes

TABLE 2-8-5: Determine Gas Concentration Values and Corrections for Fruits and Vegetables at the 30 Minute Reading of T101-a-1 or Equivalent Schedules (continued)

If the schedule is:	And the minimum concentration reading (oz.) in the schedule is:	And the average concentration reading (oz.) is:	Then:
80-89 °F 1.5 lbs for 2 hrs	19	30 or higher*	EVACUATE excess gas immediately
		27 or greater	REDUCE exposure by 15 minutes
		26-19	TAKE 2 hour reading as scheduled
		18 or lower	1. ADD gas, and 2. EXTEND exposure 15 minutes

1 If concentration reading is more than 50 percent above the minimum concentration reading, it indicates that something is radically wrong and an immediate check should be made to determine the cause and to correct it.

TABLE 2-8-6: Determine Gas Concentration Values and Corrections for Fruits and Vegetables at the 2 Hour Reading of T101-a-1 or Equivalent Schedules

If the schedule is:	And the average concentration reading at 2 hours is:	Then do not add gas, but:
40-49 °F 4 lbs for 2 hours	38 and above	AERATE commodity (see page-2-4-29)
	37-28	EXTEND exposure by 15 minutes
	27-25	EXTEND exposure by 30 minutes
50-59 °F 3 lbs for 2 hrs	29 and above	AERATE commodity (see page-2-4-29)
	28-24	EXTEND exposure by 15 minutes
	23-21	EXTEND exposure by 30 minutes
60-69 °F 2.5 lbs for 2 hrs	24 and above	AERATE commodity (see page-2-4-29)
	23-21	EXTEND exposure by 15 minutes
	20-18	EXTEND exposure by 30 minutes
70-79 °F 2 lbs for 2 hrs	19 and above	AERATE commodity (see page-2-4-29)
	18-16	EXTEND exposure by 15 minutes
	15-13	EXTEND exposure by 30 minutes
80-89 °F 1.5 lbs for 2 hrs	14 and above	AERATE commodity (see page-2-4-29)
	13-12	EXTEND exposure by 15 minutes
	11-10	EXTEND exposure by 30 minutes

Special Procedures for Adding Gas to Oak Logs and Lumber Using T312 or Equivalent

After taking the 24 hour concentration reading, if necessary, add gas to bring the concentration level up to 240 ounces. Subtract the 24 hour concentration reading from 240 to determine how many ounces the concentration is below 240 ounces. Use the following formula in calculating how much gas to add:

1.6 × number of oz. below 240 × volume in $ft^3/1{,}000\ ft^3$ = oz. of gas to add or

$$\frac{\text{oz. of gas to add}}{16\frac{\text{oz.}}{\text{lbs.}}} = \text{pounds (lbs.) of gas to add}$$

EXAMPLE: You're fumigating a 10,000 ft^3 enclosure of oak logs for export. At the 24 hour reading, the T/C unit readings indicate a 160 oz. concentration level. To determine how much gas to add, do the following:

240 oz. – 160 oz. = 80 oz. below 240 oz.

1.6×80 oz. $\times$ 10,000 $ft^3/1{,}000\ ft^3$ = 1,280 oz. or

$$\frac{1{,}280\,\text{oz.}}{16\frac{\text{oz.}}{\text{lbs.}}} = 80 \text{ pounds (lbs.) of gas to add}$$

Take concentration readings 30 minutes after adding gas and record on the PPQ Form 429.

Exhausting the Gas

Exhaust the gas at the completion of the exposure period. If the treatment schedule is a FIFRA Section 18 Exemption, then you must monitor the aeration of the commodity. Use the following table to determine the need to monitor the aeration of the fumigation.

TABLE 2-8-7Determine the Need to Monitor Aeration

If the treatment schedule is:	Then:
A FIFRA Section 18 Exemption	MONITOR the aeration of the commodity. FOLLOW "Aerating the Enclosure" steps which follow.
A labelled treatment	RELEASE the commodity and RELEASE the fumigation to the fumigator for aeration.

Aerating the Enclosure

Aeration procedures are designed to provide safe working conditions during the aeration period and to assure that commodities are safe for handling, storage, and transportation. A fumigant must be aerated in accordance with Environmental Protection Agency (EPA) label requirements, the Occupational Safety and Health Administration (OSHA), and the PPQ Treatment Manual.

Aeration of fumigated structures and ships are covered within those particular sections.

Responsibility for Aerating the Commodity

The label requires that at least two people trained in the use of the fumigant must be present at all times during gas introduction, treatment, and aeration. The PPQ officer, however, is not required to be continuously present at the fumigation site throughout the aeration process unless specified by the label or by State or local regulations.

If the fumigation is performed under a Section 18 Exemption, then a PPQ officer must be present at the initiation of aeration and to verify the final aeration readings.

TABLE 2-8-8: Determine Responsibility for Aerating the Commodity

If the Treatment Schedule is:	Then:
A FIFRA Section 18 Exemption	1. MONITOR the aeration of the enclosure, and 2. USE the table on **page-2-4-31** to determine which aeration procedure to follow
A labeled Treatment Schedule	1. RELEASE the fumigation to the fumigator to aerate according to label instructions and the conditions of the compliance agreement. 2. RELEASE the commodity.

Materials Needed

The following materials will be needed to aerate the enclosure:

- SCBA[6]
- Colorimetric tubes* (Draeger or Kitagawa for example)
- Exhaust fan[7]
- Exhaust duct**
- Danger signs**
- Materials for limiting access to area (barricades, rope)**
- PPQ Form 429

The following procedures apply to the aeration of all container fumigations.

Securing the Area

Assuming that you have already restricted access and secured the fumigation area, you now must restrict access to the area where the exhaust duct extends on the ground beyond the enclosure.

6 Materials required for both PPQ and commercial fumigator.
7 Materials to be furnished by the commercial fumigator.

CAUTION

During the first 10 minutes of aeration, it is recommended that no people should be within 200 feet of the exhaust duct outlet.[1]

1 If this buffer zone is regulated by the State or municipality where the fumigation takes place, local regulations must be followed.

If it is impossible to restrict people from the area of aeration during regular work hours, consider aeration during another time of the day. When securing the duct outlet area, consider the direction of the wind. Face the duct outlet toward an open area, and away from people. Point the duct outlet upward to aid in dispersing the exhausted gas.

Advise the fumigator use a physical barrier such as ropes, barricades, or walls to secure the area.

Placard the secure area near the exhaust outlet with the appropriate DANGER/PELIGRO signs. Make sure the placards meet the appropriate fumigant label or labeling requirements. The skull and crossbones should be present as well as “AREA UNDER FUMIGATION, DO NOT ENTER/NO ENTRE”; date of the fumigation; name of the fumigant used; and the name, address, and telephone number of the fumigator.

Unless you authorize their use, do *not* allow motorized vehicles to operate within the secure area.

Wearing Respiratory Protection

The fumigator and the PPQ officer monitoring the aeration must wear approved respiratory protection (SCBA, air supplied respirator, or a combination unit) when:

- Installing the exhaust system
- Opening the container for aeration
- Any time during the aeration process when a risk of exposure to concentrations above 5 ppm exists. This includes any time the concentration is unknown.

TABLE 2-8-9 Determine the Aeration Procedure

If:	And:	And:	Then:
Nonsorptive	Containerized	→	GO to page-2-4-32
Sorptive, including yams and chestnuts	Containerized	→	GO to page-2-4-33

Aerating Nonsorptive, Containerized Cargo

Step 1—Installing Exhaust System

Advise the fumigator:

- Install an exhaust fan (minimum of 5,200 cfm capacity) to a 16 inch, or greater, diameter duct located at the floor near rear doors of the container.
- Or, as another option, install an air introduction duct system consisting of a 3,750 cfm, or greater, fan attached to a 12 inch, or larger, duct which reaches two-thirds of the length of the container at the top of the load. Have the ducts installed prior to the start of the fumigation. Extend the exhaust duct at least 30 feet beyond the container.

Important

(1) Volume of enclosure (in cubic feet) divided by the sum of cubic feet per minute (cfm) of the exhaust fan(s) or exhaust blower equals the number of minutes required per complete gas volume exchange. (2) Sixty minutes divided by the number of minutes per gas volume exchange equals the number of complete gas exchanges per hour. The result should be in the range of 4 to 15. The faster the rate of aeration the better, particularly for perishable commodities. If the exhaust flow is connected to a methyl bromide recovery system, this device must not impede the flow rate to less than 4 volumes per hour.

Step 2—Aerating the Commodity

Advise the fumigator:

1. Connect the exhaust duct to the exhaust fan.
2. Start the exhaust fan(s)
3. Aerate for 3 hours.
4. Stop the aeration fans.
5. Use a colorimetric tube to take a concentration reading in the exhaust duct.

After the fumigator takes the concentration reading, you must record the date, concentration reading, and time in Block 39 of PPQ Form 429. Then use the following table to determine when to release the commodity.

TABLE 2-8-10

If the gas concentration level is:	Then:
5 ppm or less	RELEASE the commodity
6 ppm or more	1. CONTINUE aeration until the concentration is 5 ppm or less[1], then 2. RELEASE the commodity

1 Concentration reading must be taken 4 feet from floor and 1 foot inside stack at two locations between the cartons but not inside the cartons.

Aerating Sorptive Commodities in Containers

Step 1—Installing the Exhaust System

Advise the fumigator:

- Install an exhaust fan (minimum of 5,200 cfm capacity) to a 16 inch or greater diameter duct located at the floor near rear doors or the container.
- Or, as another option, install an air introduction duct system consisting of a 3,750 cfm or greater fan attached to a 12 inch or greater duct which reaches two-thirds of the length of the container at the top of the load. Have the ducts installed prior to the start of the fumigation. For outdoor fumigations, extend the exhaust duct 30 feet beyond the container.

Step 2—Aerating the Commodity

Outdoors

Advise the fumigator:

1. Complete installation of exhaust duct and begin exhaust fan.
2. Start the circulation and air introduction fans. Sorptive commodities generally require 12 hours or longer to aerate. Since sorptive commodities vary in their rates of desorption, aeration may be completed in less than 12 hours. Require a minimum of 4 hours aeration for all sorptive commodities.
3. Stop the circulation fans and take concentration readings with colorimetric tubes 4 feet from the ground and 1 foot inside the outer edge of the stack between the cartons but not inside the cartons. One location is sufficient.

After the fumigator takes the concentration reading, you must record the date, concentration reading, and time in Block 39 of PPQ Form 429. If you are not at the fumigation site, have the fumigator call and give you the information. Then use the following table to determine when to release the commodity.

TABLE 2-8-11Determine When to Release the Commodity

If the gas concentration level is:	Then:
5 ppm or less	RELEASE the commodity
6 ppm or more	1. CONTINUE aeration and take concentration readings until the level is 5ppm or less, then 2. RELEASE the commodity

2 Chemical Treatments

Treatment Manual

Fumigants • Sulfuryl Fluoride

Contents

Consult the Vikane[1] Gas Fumigant label and Structural Fumigation Manual for more detailed instructions and additional supportive information.

Properties and Use

Sulfuryl fluoride (SF) is a compressed-gas fumigant which is used primarily against insects that attack wood. The following characteristics make this fumigant especially desirable:

- High vapor pressure — 13,442 mm Hg @ 770 °F.
- Penetrates wood better than any other commercial fumigants, including methyl bromide.
- Low solubility in water and low sorption by soil or commodity.
- Odorless, colorless, and nonflammable.
- Very low loss through plastic tarpaulins.
- Relatively non-reactive.

1 Trademark of Dow Agro Sciences

- 2.88 times heavier than air.

SF boils at minus 67 °F. SF is not registered for use on foodstuffs or on living plant material.

SF is effective at very low dosages on Drywood termites where control of the adult stage is the only concern (typically 0.5 – 1.0 lbs/$1{,}000^2$). Higher dosages are required for control of the egg stage of other insects (typically 3 – 5 lbs/$1{,}000^2$). Consult treatment schedules in this manual for specific dosages.

Leak Detection

Interscan (Model GF 1900) or Miran gas analyzers (these units are portable) may be used to detect SF in the range of 0 to 150 ppm respectively. Consult the Vikane Structural Fumigation Manual for further instructions. Colorimetric (“detector”) tubes are not available for detecting SF gas leaks around tarpaulins, chambers, and application equipment.

Important

A halide leak detector, which depends upon the color of a flame to indicate the presence and relative concentration of methyl bromide in the atmosphere, cannot be used to detect SF.

Tarpaulin Fumigation

Important

Refer to the section for tarpaulin fumigation with methyl bromide for additional information on the following:

- selecting fumigation sites

- placing gas sampling lines

- sealing tarpaulins

- taking concentration readings

- securing fumigation areas

Important

Refer to the PPQ Treatment Manual section on **Fumigants • Methyl Bromide • Tarpaulin Fumigation** (and aeration), the Vikane label, and Vikane Structural Fumigation Manual for a detailed discussion of proper procedures.

Sealing

The commodity to be fumigated should be placed onto a relatively even and non-porous surface, such as concrete, asphalt, or macadam. Special attention should be given to the seal along the ground or floor. The inspector should have tape, sand, or water snakes properly positioned.

Circulation

Fans are necessary to distribute SF and to help prevent condensation. The number of fans depends upon the cubic volume of the enclosure being treated, and the arrangement of cargo. Axial fans of approximately 5,000 cfm have proven effective. Usually two fans are used, one on either end facing the lower center and upper center of the load. If the enclosure is over 35 feet long, additional fans should be used. It is usually not necessary to run fans longer than 15 minutes after the gas has been introduced.

Prevention of Condensation

In cool weather, moisture may condense under tarpaulins if the sun is shining directly on the load. Continuous air circulation can prevent this from occurring. Do not tarp or seal any item while it is wet.

Gas Sampling Lines

A thermal conductivity unit calibrated for Vikane must be available for readings. Sampling lines should be arranged so that gas samples are drawn from representative parts of the fumigation area and lead to a common point.

A minimum of three sampling lines should be placed in enclosures of up to 10,000 ft^3 at the following locations:

- Front of the load, 3 inches from the floor
- Center of the load, midway from the bottom to the top of the load
- Rear of the load, at the top.

When 10,000 to 15,000 ft^3 are being treated, two additional lines should be appropriately deployed.

Gas Introduction

Unlike methyl bromide, SF does not require the use of a volatilizer to speed up its conversion from a liquid to a gas. The gas introduction tube should be placed directly in the air flow of a fan away from the cargo. Also, place a drip cloth under the tube. The introduction rate is controlled by the introduction line length and diameter. A 1/8 inch inside diameter by 100 ft long hose will allow a flow rate of approximately 2 lbs per minute while a 25 ft long hose will allow approximately 4 lbs per minute.

TABLE 2-0-30: Effect of Hose Inside Diameter on Rate of Gas Introduction through a 25 Foot Hose

Inside Diameter (in inches)	Pounds Vikane Per Minute
1/8	4
1/4	20
1/2	45

Approximate; dependent on pressure in cylinder.

TABLE 2-9-1: Effect of Hose Length on Rate of Gas Introduction through a 1/8 inch Inside Diameter Hose

Hose Length (in feet)	Pounds Vikane Per Minute
25 ft	4.0
50 ft	2.8
100 ft	2.0[1]

1 Where fumigant introduction rates lower than 2 lbs/min are needed, a longer hose can be used, e.g., 200 ft.

It is important not to overshoot the ability of the fan to rapidly disperse the cool air near the fumigant introduction site. Fan capacity should be at least 1,000 cfm for each lb of Vikane introduced per minute. In addition, a volatilizer (heat exchanger) may be used in fumigating containers or small chambers to prevent a “fog-out” (condensation) which could cause corrosion or damage to the contents. The last few pounds of fumigant will turn to gas within the cylinder before moving out, and the flow rate will be reduced. The cylinder and tubing will often become frosted. Be certain that no open flame or glowing hot surfaces above 400 °C are present since corrosive substances (mainly hydrofluoric acid) are formed when SF is exposed to such conditions. To avoid possible damage, do not apply the fumigant directly to any surface.

Dosage Rate

To control a particular pest, locate the proper fumigation schedule to be followed in the Treatment Manual. The three variables in these schedules are temperature, dosage, and exposure duration. Treatment is not recommended below 50 °F. Dosages are in pounds per 1,000 $feet^3$ of space. To determine the total amount of fumigant required by weight in pounds, divide the total volume of space by 1,000. Then multiply the resulting figure by the dosage rate schedule expressed in pounds (per 1,000 $feet^3$). The cylinder should be placed on a scale, and the flow of gas is controlled by the valve and introduction line until the desired cylinder end-weight is obtained. The valve should be turned fully open to fill the fumigant introduction hose with liquid SF. Initially, the valve should be opened slightly until flow has begun and then opened about one full turn which should give full flow through the 1/8″ fumigant introduction hose.

Measure Gas Concentrations

During the course of fumigation, minimum concentrations must be maintained according to the schedules used. Readings on the T/C unit (Fumiscope or Gow-Mac) if not calibrated for Vikane must be multiplied by a factor to obtain the actual ounces per 1,000 $feet^3$ present. The Center for Plant Health Science & Technology (CPHST) in Raleigh, North Carolina, will calibrate these instruments to determine the exact multiplication factor to use. Be certain that the reading without the multiplied factor is also registered on PPQ Form 429, however. Do not use filters containing soda asbestos (Ascarite) with SF. Fresh desiccant (Drierite) should be used with the T/C unit. Desiccant should be changed at appropriate intervals to insure accurate readings.

Replacing Lost Gas

When it appears that additional SF will be needed, the inspector should use his best judgment to determine the amount of gas to add, according to the prevailing conditions of tarpaulin tightness or wind conditions. Usually, 1.6 oz of gas should be added for every ounce of deficiency in the minimum concentration required.

Aeration

For detailed guidelines, consult the “Aeration” discussion elsewhere in this manual, under “Fumigants—Methyl Bromide—Tarpaulin Fumigation—Methods and Procedures,” the Vikane Gas Fumigant label, and Structural Fumigation Manual. The threshold limit value for SF is 5 ppm (20 mg/cubic meter), the same as for MB. Since no colorimetric (“detector”) tubes are available for SF, a suitable instrument must be used, such as the Interscan GF 1900 or Miran (calibrated for SF).

Structural Fumigation

Refer to the section on MB structural fumigation (or aeration) in this manual, the Vikane label, and Vikane Structural Fumigation Manual for a detailed discussion of proper procedures.

When preparing a structure for fumigation with SF, the surrounding soil should be watered thoroughly at the base of trees, shrubs, and other ornamental plants around the perimeter of the structure to prevent loss of fumigant into the soil. Watering around the plants will protect the roots; however, plants and grass closer than 1 ft may die even if this precaution is taken.

Before placing the tarpaulin over the structure, be sure to remove items for which the use of SF is not registered. These include food, feed, drugs, and medicines. Extinguish all flames (including pilot lights), unplug all heating elements, and turn off all lights. Open all internal doors.

Chamber Fumigation

Refer to the section on MB chamber fumigation (and aeration) in this manual, the Vikane label, and Vikane Structural Fumigation Manual for a detailed discussion of proper procedures.

CAUTION

> Trying to measure out a small quantity of SF in a graduated glass tube (sight gauge)—which is common practice with MB chamber fumigations—should never be attempted with SF because the cylinder pressure is much greater, and the glass gauge may explode and shatter.

The gas will generally be introduced through a volatilizer or heat exchanger in order to prevent a “fog-out” which could damage the contents. Introducing a very small amount of gas into a small chamber, however, is difficult to do with precise accuracy because the amount introduced must be calculated by weight loss from the cylinder. The scale used beneath the cylinder must be readable in ounces or grams, not just in pounds or kilograms.

Shipboard Fumigation

Refer to the section on MB ship fumigation (and aeration) in this manual, the Vikane label, and Vikane Structural Fumigation Manual for a detailed discussion of proper procedures. Surface ships (only those in port) must be fumigated at dock side, and not when the vessels are underway. Shipboard fumigation is also regulated by the U.S. Coast Guard (Department of Transportation). That regulation appears as 46CFR 147A.

Safety and First Aid

Read and understand all directions and safety precautions on Vikane label before applying. Additional information is presented in Vikane Structural Fumigation Manual. There is no known antidote for SF. Vikane is odorless. However, the chance of lethal exposure is not probable unless an individual actually enters the fumigation space. An SCBA must be worn by anyone in the fumigated areas when the level exceeds 5 ppm.

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 SF until thoroughly aerated and cleaned.

If SF Is Inhaled

An individual who has inhaled high concentrations of SF may exhibit the following symptoms:

- Slowed or garbled speech
- Slowed body movements
- Dulled awareness
- Nausea
- Difficulty in breathing
- Numbness of the extremities

If any of the above symptoms appear, then immediately do the following:

- Remove the victim to fresh air.
- Put victim at complete rest.
- Keep the victim warm and see that breathing is normal and unhampered. If breathing has stopped, give artificial respiration.
- Do not give anything by mouth to an unconscious person.
- Obtain medical assistance.

If Liquid SF Is Spilled on the Skin

Immediately apply water to the contaminated area of clothing before removing. Wash contaminated skin thoroughly or shower.

If Liquid SF Is in the Eyes

Flush with plenty of water for at least 20 minutes, and get medical attention. Damage to the eye may result from cold or freezing temperatures.

2

Treatment Manual

Chemical Treatments

Fumigants • Phosphine • Tarpaulin (NAP Chamber or Container)

Contents

Properties and Use

Phosphine (generally abbreviated as PH) may be generated from either aluminum phosphide (AP) or magnesium phosphide (MP).

Aluminum phosphide and magnesium phosphide are available under various trade names (see **page-5-4-28**) as tablets, pellets, prepacs, bags, or plates. For example, each pellet of Phostoxin weighs 0.6 grams and yields approximately 0.2 grams of PH and each tablet weighs 3 g and yields approximately 1 g of PH. Each 34 g bag or sachet of Detia yields 11.4 g of PH. Each plate of Fumi-Cel weighs 117 g, contains 32.3 percent MP and liberates 33 g of PH. A high humidity (40 percent or more) is needed to generate the gas, and temperatures above 40 °F are needed to produce satisfactory results.

In the presence of moisture, phosphine (hydrogen phosphide, PH_3), a colorless gas, is emitted. PH boils at -87.8 °C (-126 °F), is slightly soluble in water, has excellent penetrative power, and has approximately the same density as air. The lower level of flammability is 1.79 percent in air.

Flashpoint is 212 °F. Direct contact with a liquid could cause spontaneous combustion. In case of fire, a CO_2 dry chemical fire extinguisher should be used. *Never use water.* PH has an odor somewhat like garlic, which enables the gas to serve as its own warning agent. However, under some conditions, the odor may be lost, even at high toxic concentrations. Ammonia and carbon dioxide are also produced, which act as fire retardants.

Copper, brass, gold, and silver are severely damaged by PH. Other metals react to some extent, especially in high humidity. Normally, only electrical or electronic equipment (especially the contact points) and some household effects would be affected.

PH is used to control insects found with both plant and animal commodities, especially stored products, throughout the world. The program use of PH for commodities other than cotton, tobacco, and wood products may be limited because of the long exposure periods required compared to other fumigants. For some insects, long exposure to low concentrations is more effective than short exposure to high concentrations. The germination of most seeds does not seem to be affected, even with schedules higher than normally recommended for insecticidal use. Phosphine should not be used for fumigating growing plants, cut flowers and greenery, fresh fruits, or vegetables due to poor tolerance of these commodities. Phosphine is effective against most wood, cotton, tobacco, and grain insects in all stages of development. Phosphine leaves little or no residue. Baking and brewing qualities of treated commodities are unaffected.

Leak Detection—Gas Analysis

Phosphine levels can be detected using either detector tubes or any electronic instrument such as the “Porta-Sens” detector. (See Equipment Section for instructions on how to use the Porta-Sens.) This equipment is used for determining both the high (fumigation concentration) and low (personnel safety) levels of PH. Halide or any flame detectors *are not* to be used for PH. T/C units (e.g., Gow-Mac or fumiscope) cannot be used for this fumigant.

PH is poisonous to man and animals. The threshold limit value for an 8-hour per day exposure is 0.3 ppm. The maximum concentration for a single exposure for animals should not exceed 50 ppm.

Dosage

The dosage rate is usually measured in grams (g) per 1,000 cubic feet or grams per cubic meter and varies with the commodity, treatment temperature, and type of enclosure. However, some schedules may be based on the weight of grain. Schedules for use against specific pests by commodity are listed in the Domestic Program Manuals or in this manual.

Always follow manufacturer's instructions on the number of pellets, tablets, bags, prepacs, or plates to be placed at one spot. (See **Table 2-10-1**: Amount of Phosphine Liberated by Various Products.)

TABLE 2-10-1: Amount of Phosphine Liberated by Various Products

Calculate amount of product needed by using the amount of phosphine released as shown in the right column.

Product	Type	Unit and weight in grams	Grams of phosphine*
Degesch Fumi-Cel[1]	MP	1 plate; 117.0	33.0
Degesch Fumi-Strip[1]	MP	16 plates; 1872.0	528.0
Degesch Phostoxin[1]	AP	1 tablet; 3.0	1.0
Degesch Phostoxin[1] Tablet Prepac Rope	AP	1 prepac; 99.0 (strip or rope of 33 tablets)	33.0
Detia	AP	1 tablet; 3.0	1.0
Detia Rotox AP	AP	1 pellet; 0.6	0.2
Detia Gas EX-B	AP	1 bag or sachet; 34.0	11.4
Fumiphos tablets	AP	1 tablet; 3.0	1.0
Fumiphos pellets	AP	1 pellet; 0.6	0.2
Fumiphos bags	AP	1 bag; 34.0	11.0
Fumitoxin	AP	1 tablet; 3.0	1.0
Fumitoxin	AP	1 pellet; 0.6	0.2
Fumitoxin	AP	1 bag; 34.0	11.0
Gastoxin	AP	1 tablet; 3.0	1.0
Gastoxin	AP	1 pellet; 0.6	0.2
"L" Fume	AP AP	1 pellet; 0.5 1 pellet; 0.6	0.18 0.22
Phos-Kill	AP	1 tablet; 3.0	1.1
Phos-Kill	AP	1 pellet; 0.6	0.22
Phos-Kill	AP	1 bag; 34.0	12.0

Safety Precautions

Storage and Handling

Although PH is flammable and may ignite when exposed to excessive moisture, the commercial precautions of AP and MP are considered fire-safe and explosion-safe when used in accordance with the manufacturer's instruction. No more than ten pellets of Phostoxin should be placed in a single envelope which is supplied by the manufacturer. A Fumi-Cel plate should not contact another or the commodity.

Protective Clothing

No protective clothing is necessary when handling prepacs or strips. Use dry cloth gloves when handling tablets, pellets, or dust. Be sure to aerate gloves and contaminated clothing in well-ventilated area prior to laundering. Particularly useful are surgical or disposable thin rubber or polyethylene gloves. Wash hands thoroughly after each use.

Containers of AP and MP should be stored in a cool, dry, locked, ventilated protected area not subject to extremes of temperature. Water must never be allowed to come in contact with AP or MP. Shelf life of unopened containers is virtually unlimited. When a tube or container is first opened, the odor of PH (garlic) and ammonia will be noticeable and a blue flame sometimes occurs. However, the quantity of free PH present within that container should not be considered dangerous.

Respiratory Protection

Use of SCBA (Self-Contained Breathing Apparatus)

The slow evolution of PH from the AP or MP enables the operator to dispense the tablets, pellets, packets, or plates, or pre-pack ropes safely, usually without the need for wearing an SCBA. However, an SCBA unit must be available at all times. The individual opening the chamber or container doors, or initially raising the tarpaulin following fumigation should wear an SCBA. Do not eat or smoke while dispensing AP, MP, or any pesticide, and not until after washing. Wash thoroughly after handling any pesticide. SCBA must be immediately available and must be used by persons who may be exposed to phosphine concentration above the threshold limit value (TLV). Respiratory protection will be worn by the PPQ Officer when within 30 feet of the enclosure under treatment

Threshold limit values for phosphine are as follows:

- Single exposure for continuous daily 8-hour exposure = 0.3 ppm.
- Short term exposure limit (STEL) = 1 ppm or 1 mg/m^3.
- The threshold level of odor to the human nose is considered to range from 0.005 to 0.5 ppm.

Safety

In addition to instructions and precautions found on the label, be certain to:

- Study and follow the recommended application procedure.
- Comply with all regulations.
- Allow only personnel properly trained in the use of phosphine products to conduct fumigations under the monitoring of a certified pesticide applicator.
- Ensure that first aid equipment and information are readily available.
- Check that approved respiratory protection (SCBA) is readily available for each applicator.
- Placard the area to be fumigated and an area extending 30 feet from the fumigation enclosure (or the entire building if less than 30 feet to the walls). Placards must include the name of the chemical, date of the fumigation, and name, address, and telephone number of applicator. See fumigant label for proper wording.
- Always work in pairs, never alone. At least two people trained in the use of the fumigant must be present during the introduction of the fumigant, and the testing and aeration periods.
- Never smoke, eat, or drink while handling phosphine producing materials.
- Always wash hands after handling phosphine materials.
- Never save excess or partially used packets, plates, etc. It cannot and must not be done. Phosphine gas will evolve and constitute a serious safety hazard. Dispose of all opened material following label instructions.
- Remove placards when aeration is complete and concentrations are below the TLV. Only certified pesticide applicators should be used to remove placards.
- Mechanically unload grain treated with phosphine. Dust from the residue may release a small amount of phosphine when particles land on the moist mucous membrane of the nose or mouth.
- Never use phosphine in vacuum fumigation, and never pull a vacuum during chamber aeration. This compound is unstable at reduced pressure that can occur during aeration.

Disposal of Residue

Following treatment with AP, a powdery residue, essentially aluminum hydroxide, will remain in the envelope. This material should be collected and mixed in a container of water to which liquid detergent has been added (2 tablespoons of detergent per gallon of water). The liquid should then be buried or deposited in an approved pesticide disposal landfill.

Following treatment with MP, the plates may be disposed of by burial in an approved landfill or by burning where approved by local ordinances.

First Aid Treatment

Immediate warning signs resulting from exposure to high concentration of PH include nausea, vomiting, and diarrhea. Progressive signs include vertigo, chest pains, dry cough, choking, intense thirst, enlarged pupils, and possible coma. Get the victim to fresh air, treat for shock, and ***call a physician.***

Bulk Fumigations

Important

Refer to the section for tarpaulin fumigation with methyl bromide for additional information on the following:

- selecting fumigation sites
- placing gas sampling tubes
- sealing tarpaulins
- taking concentration readings
- securing fumigation areas

Sealing

Make the fumigation enclosure as gas tight as possible. Phosphine can penetrate polyethylene tarpaulins at a very low rate; 4-mil tarpaulins can be used only once; 6-mil tarpaulins should be used whenever possible.

Probing

When large quantities of grain or other commodity in bulk are to be treated, it will be necessary to “probe” tablets or pellets into the mass of the commodity for adequate distribution. Specially constructed probes made of steel tubing 1 1/4 inch in diameter are generally available as described below:

- **Head Piece—**Dosing device and numerical counter to indicate number of tablets used.
- **Tubing—**Usually in 3-foot sections, which can be added to one another to provide the desired length.
- **End Piece—**Cut obliquely and provided with a hinged flap, closing the entrance to the tube. When the tube is inserted into the commodity, the flap is closed and prevents the commodity from entering. When the probe is withdrawn, the flap opens due to the slightly larger diameter on the flap. The tablets or pellets are then released one at a time as the probe is withdrawn.

Grain or other bulk or loose commodities up to 30 feet deep can be probed. Best results are obtained by probing twice every square foot and as regularly as possible. Penetration of phosphine is up to 10 feet below the area in which the tablets are placed. When large bulk grain stores are treated, many probes may be placed prior to treatment. One head piece can be moved from probe to probe, or pellets or tablets can be placed in the tubes by hand (use surgical or disposable thin rubber or polyethylene gloves).

Gas generation starts within 4 hours of placement of the pellets or tablets (depending on relative humidity). Therefore, the whole procedure of pellet or tablet placement or tarpaulin covering must be accomplished within this time frame. It is possible to work in a probed area if the area is covered with a gas-proof tarpaulin. Special care should be taken to monitor gas concentrations to determine if toxic levels are approached and corrective action taken to prevent exposure.

If it is known ahead of time that grain or cottonseed will require treatment prior to placement in a means of conveyance or storage, the space should be sealed properly before loading. Tarpaulins of at least 6-mil thickness should be used if walls are permeable since lighter tarpaulins may tear. As the material is loaded, tablets or pellets can be metered into the bulk stream for even distribution of fumigant.

If a bulk shipment is in a large storage facility which has a high roof, it may be better to tarp on top of the grain rather than seal the roof. When side walls of the facility are not gas-impervious, tarpaulins can be placed around the outside of the facility to the height of the commodity. Again, 6-mil tarpaulins are preferred, since windy conditions can easily tear lighter gauge tarpaulins off the building.

Aeration

Phosphine treated commodities must be aerated using either electric exhaust fans or by passive aeration in the open air following completion of treatment. Personnel must not be allowed to reenter fumigated areas until gas concentrations are determined to be below the Threshold Limit Value's (TLV's) measured with a sensitive gas detection device.

Boxcars require little or no aeration after a 5-day treatment, but phosphine concentration must be measured and personnel not allowed entry until readings are below the TLV.

Container Fumigation

In all container fumigations, it is recommended that the container be covered with a gas impervious tarpaulin following the usual tarpaulin fumigation procedures.

For new containers (5 years old or less), the use of a tarpaulin is not an absolute requirement if all vents can be sealed off. The age of the container is usually shown in a metal decal on one of the rear doors. Any container with obvious dents, punctures, nail holes, or parallel floor boards will require a tarpaulin. Any untarped containers, at the very least, must have their rear doors thoroughly taped at all four edges.

Important

A relative humidity of at least 40% and an air temperature above 40 °F will produce satisfactory results for a phosphine fumigation.

If a gas tight enclosure can be assured for the fumigation, the following procedures may be used:

- Close and secure one of the doors. Seal all openings and joints. If possible, caulk all joints and drape entire doorway with polyethylene sheeting, securing the edges to the inner walls, floor, and ceiling with masking tape.
- Inspect the roof, floor, and walls for holes and/or cracks. Seal all openings with either masking tape or caulking compound. Containers require close inspection and a great deal of sealing to insure against leakage.
- Place half of the required packets or plates on each of two pieces of heavy cardboard, spacing them at least 1 inch apart with no overlap. Tape packets to board across both ends of the packet. *Do not* tape across middle of the packet. *Do not* exceed label dosage. Plates and packets must never be subdivided to reduce the amount of phosphine. Plates must never touch each other.

- Take prepared boards into the container and secure one board in each end, bag side up to the load. If load is covered with paper, secure cardboard to paper. As an alternative, boards may be securely nailed to the wall.
- If possible, drape remaining doorway with polyethylene film before door is closed. Secure edges to door jams and floor. Close door and secure. If doorway is draped with polyethylene, it may not be necessary to seal the door from the outside. If doorway is not draped, seal all cracks, openings, and joints with masking tape and/or caulking compound from outside.
- Placard all doors of the container with the appropriate warnings.

Concentration Readings

The officer will take readings at the time indicated in the particular fumigation schedule using sampling tubes appropriate for the phosphine levels to be measured, or by using an electrochemical device approved by the Center for Plant Health & Technology (CPHST) in Raleigh, North Carolina.

Refer to the section for tarpaulin fumigation with methyl bromide for additional information on the following:

- selected fumigation sites
- placing gas sampling tubes
- sealing tarpaulins
- taking concentration readings
- securing fumigation areas

2

Treatment Manual

Chemical Treatments

Aerosols and Micronized Dusts

Contents

Introduction

This section includes information about aerosols and micronized dusts. Use this information with the T409 series of treatments, and with Table 5-5-1: Determine the Amount of Aerosol, to conduct a safe and effective aerosol disinfestation.

Aerosols

When applying an aerosol, the dispenser nozzle(s) should be directed upward at an angle of 45 ° and moved from side to side in order to get uniform distribution of the material. During discharge, the dispensing valve should be depressed fully, and the nozzle held 45 cm (18 inches) or more from all surfaces. Devices are available for depressing the valve and expending all the aerosol in the can or a trigger mechanism for ease in dispensing the material. Aerosol dosages are based on a dispensing rate of 1 g per second, unless otherwise noted. The applicator should use a dust mask, or face mask (with filter) for personal protection. The PPQ quarantine dosage shall not be applied in the presence of passengers, crew, or animals, except as noted in the schedules.

Micronized Dusts

Both domestic and foreign quarantine programs use dust to kill pests such as the Japanese beetle and pests of foreign origin. This method may be used in treating aircraft, railroad cars, trucks, and palletized or containerized cargo. Specific instructions for domestic quarantine use are included in Program Manuals.

Cartridges

Prefilled cartridges are used (available as follows: green–1 g; yellow–3 g; red–5 g; and blue–13 g). Combinations of these sizes will give the correct amount and the dust may be combined into a single cartridge to reduce the number of individual “shots” required. Care must be taken in combining the material to insure no exposure to the dust occurs through dermal contact or inhalation.

Store filled pesticide cartridges in a cool, dry, protected location. Damaged cartridges and empty cartridges should be disposed of by placing them in refuse containers in accordance with recommendations for the safe disposal of pesticide containers. When treating aircraft, refer to T409 of this manual which lists the cubic capacity and application schedules for most commercial and military aircraft. Do not deduct the space occupied by cargo in computing the required treatment rate.

Equipment

Compressed CO_2 or compressed air is used to expel the dust. A modified CO_2 fire extinguisher with a standard release valve may be used. The 10-pound CO_2 capacity extinguisher, which weighs 35 to 40 pounds when full, is convenient and safe for use. Sufficient gas for 25 to 30 releases is contained in this size. Smaller modified extinguishers are also satisfactory. Compressed air units must be specifically designed for expelling dust and are not readily available.

Specifically developed micronized dust guns with proper connections may be available through the Program Support Staff in Riverdale, MD.

Methods and Procedures for Application

Treatment of Passenger Compartments and Cargo Aircraft

All entry doors and other openings should be closed and all ventilation systems stopped before discharge of dust. The door to the pilot’s compartment must be closed. On aircraft with a baggage compartment immediately behind the pilot’s and no door to separate these compartments, place a screen of plastic or other suitable material between the baggage compartment and the pilot's compartment. Galleys shall be closed off by means of doors or a screen of plastic, etc., which will prevent the entry of the pesticide.

The single nozzle gun recoils or kicks back when discharged. Therefore, it must be held firmly with one hand while the other hand is used to trigger the release of the CO_2. Keep the host between the extinguisher and the gun as straight as possible to reduce kickback. A position should be taken much like that used when firing a large caliber pistol. Rest the bottom of the gun on a solid object if possible. Kneeling on one knee may be necessary if the host to gun is short. A 1-second blast is sufficient. The discharge nozzle should be directed above the top of the seats or cargo to assure unimpeded flow of the dust cloud from the release point.

On smaller types of aircraft, stand behind the first seat to discharge the dust. Leave the aircraft immediately after release; close the door quickly to avoid disturbing proper dust distribution.

In larger aircraft, discharge the dust from the front behind the pilot's compartment or from the rear depending on location of exit doors. Remain in the craft only long enough for the dust cloud to appear to have reached the other end of the craft—about 1 minute. The dust cloud may not return from the opposite end of the large aircraft. Judgment should be used by the inspector as to the best location for firing if partitions are present.

A recently designed gun has two nozzles facing in opposite directions. Since the gas and dust are expelled from both nozzles, no "kick" results. The operator should stand in the middle of the large compartment when firing the charge.

After dust has been discharged, the officer will leave the aircraft, close the door, and hold the aircraft closed for 10 minutes.

Unless responsible personnel remain near the craft to prevent inadvertent entry by others, place a treatment notice, PPQ Form 468, on the entry door. Cargo or passenger area ventilation systems shall not be in operation during the application and settling periods. After a 15-minute aeration period, the aircraft may be reentered.

Treatment of Separate Cargo Compartments and Containerized or Palletized Cargo

Cargo compartments in bellies of aircraft will be treated by opening the doors sufficiently to insert the applicator nozzle. After firing, close the door quickly and do not open for at least 10 minutes. Treatment of such compartments may require two people, one to operate the doors and the other to operate the gun. Containerized cargo is treated by lifting the cover or otherwise inserting the nozzle in the container. After discharge, the cover should be quickly closed.

Precautions for Both Aerosols and Micronized Dusts

1. Treatment shall not be applied when animals or people are present.
2. Food should be removed or covered prior to treatment.
3. Food preparation surfaces and equipment shall be covered to prevent contamination.
4. A suitable respirator, approved by the National Institute of Safety and Health shall be worn by the person applying the pesticide. **EXCEPTION:** A respirator is not required when the pesticide label or this manual specifies that use in the presence of people is acceptable.
5. Goggles are optional equipment and should be worn if the person applying the pesticide experiences any eye irritation.
6. Do not smoke or eat during application and not until after washing. Wash as soon as possible after application of pesticides.
7. Any pesticide residue noted on smooth surfaces after treatment should be wiped away using a clean damp cloth. (If a deposit of dust is noted on the floor immediately after discharge, a blast of compressed air or CO_2 will usually clear the area.)

Precautions in Use of CO_2 Fire Extinguishers

1. Discharging CO_2 chills metal and can cause freezing injury to bare hands. Do not touch the nozzle immediately after discharge. It may be advantageous to wear a glove on the gun hand if several discharges are to be made in close succession. Do not hold the release valve open longer than necessary to expel the dust (about a second).
2. Replace the safety pin in the CO_2 tank valve after each use and secure with wire or tape. Accidental release could result in severe injury.
3. Keep the face away from openings when applying material in a luggage compartment or to containerized cargo to avoid dust backlash.
4. Check the flexible hose between the CO_2 tank and dust gun. Pay particular attention to the areas near the connections. Replace the host when it shows wear.

2

Treatment Manual

Chemical Treatments

Dips

Contents

Overview

As with other treatments, chemical dips require careful planning and preparation. Make sure you have all the necessary safety and treatment equipment and materials ready before you start the dip treatment procedure. When you handle pesticides, always comply with the pesticide Label instructions, and State and local regulations.

Safety and Dip Treatment Equipment and Materials

The following lists include safety equipment (Personal Protective Equipment, PPE) and basic material that you will need for dip treatments. However, other materials may be required by additional Label requirements that are specific to chemical being used.

Personal Protective Equipment (PPE)

Always check the Label and Material Safety and Data Sheet (MSDS) for additional requirements of personal protective equipment. The following is a basic list of PPE that you will need for dip treatments:

- protective eye wear (goggles)
- chemical resistant headgear for overhead exposure
- chemical resistant rain suit with hood
- chemical resistant footwear (rubber or neoprene boots)

- chemical resistant gloves (neoprene)
- respirator (per Label and MSDS requirements)

Dip Treatment Equipment and Materials

Always check the Label for additional requirements for equipment and materials. The following is a basic list of equipment and materials you will need for dip treatments:

- Newspaper or any other absorbent paper

Important

> Place plastic backed paper on pallets prior to covering with paper and/or absorbent paper to preclude the pesticide being absorbed onto the wood.

- Pesticides

Important

> Pesticides should be fresh (not over 1 year old). Labels and MSDS must be attached to the pesticide container and all instructions must be followed.

- Mixing containers and dipping containers must be provided with lids to prevent spills during transportation and storage.
- New boxes (when reconditioning or excess contamination of original boxes is not possible)
- Fans[1]

Important

> A mechanical exhaust is the preferred method of aeration when it is specifically installed to remove chemical fumes from the treatment area. Fans may be used if they do not cause airborne pesticides to contaminate the treatment facility or the breathable air. The flow of air should be across the dip vat/container and away from people in the treatment area.

- Pallets[1]

Important

> Place plastic backed paper on pallets prior to covering with paper and/or absorbent paper to preclude the pesticide being absorbed onto the wood.

- Plastic bags (4 to 6 mil plastic)[1]
- Shear scissors
- Sponges
- Liquid soap[2]

1 This equipment will be provided by USDA when available.

- Packing material[1]

Dip Treatment Procedures

Step 1—Plan for the Dip Treatment

Before you start the dip treatment, inform the customer (Broker/ Importer) of the specific material and personal protective equipment (PPE) that will be needed to perform the dip treatment procedure. All required materials and equipment must be available at the time of treatment.

Step 2—Designate Restricted Use Areas

Designate the following restricted use areas:

- **Measuring and mixing area-** The measuring and mixing area for the specific pesticide(s) must be in a well ventilated area away from food preparation, eating areas, and offices. Areas that contain mechanical exhaust systems are preferred.
- **Plant Material Dipping Area-** The plant material dipping area must be an area where access is limited by a barricade or warning signs. Areas that contain mechanical exhaust systems are preferred.
- **Plant Material Drying Area-** The plant material drying area must have proper air circulation and exhaust ventilation. These areas should be closed to the dipping area. The route from the plant dripping area to the drying area should be lined with plastic backed absorbent paper or plastic and paper to catch excess pesticide solution.

Step 3—Prepare Plant Material

Prepare the plant material for the dip treatment according to the PPQ Treatment Manual and pesticide Label requirements.

Step 4—Prepare the Pesticide Solution

CAUTION

Wear personal protective equipment (PPQ) and keep the exhaust system running when you are preparing pesticide solutions. To minimize your exposure to the pesticide dust or airborne particles, keep the pesticide between you and the exhaust.

1. Measure the amount of water required for the treatment

2 This equipment will be provided by USDA when available.

2. Measure the amount of pesticide required for the treatment

Important

It is important to use fresh chemicals for every solution. If questions arise during this procedure, stop and seek assistance from the Center for Plant Health Science & Technology (CPHST) (Tel: 919-513-2496)

3. Prepare a pesticide paste as follows:
   - **A.** Add the previously measured amount of water into a clean and empty container, for example, an empty can or plastic container.
   - **B.** Form a paste (with dry pesticides) by adding the measured pesticide to the small amount of water and mix gently
   - **C.** Dilute the paste by slowly adding more water from the previously measured water
   - **D.** Slowly add the concentrated solution(s) to the rest of the measured water
4. Add some drops of liquid soap to the solution (soap is used as a sticking agent)
5. Mix the final solution by stirring it gently

Step 5—Dip the Plants in the Pesticide Solution

Dip the plants in the solution for the time required by the PPQ Treatment Manual.

Step 6—Remove the Plants from the Pesticide Solution

Remove the plants from the solution and allow excess solution to drip into the dipping container.

Step 7—Dry the Plants

Place the plants on newspaper covered pallets and allow them to dry (make sure to space the plants out for maximum drying).

CAUTION

Plants should be dried thoroughly before releasing them to the customer.

Step 8—Disinfect Original Shipping Containers

Disinfect the original shipping containers with a sponge containing the pesticide solution. The plant material may be packed with new packing material in a previously used container that has been disinfected.

Step 9—Clean Up the Treatment Area and Equipment

Discard all empty containers, excess pesticides, packing materials, plastic bags/backing materials, and newspaper/absorbent paper in compliance with instructions on the Label and State/Local regulations. Decontaminate all treatment areas and equipment while you are wearing your PPE.

Step 10—Release the Cargo

After the plant material is dry, release it to the customer or broker if agreed to by the airline and if it has been released by Customs.

Safety Responsibilities

The PPQ Officer is responsible for the following safety issues:

- Make the broker/importer aware of their responsibilities as it pertains to:
  - materials
  - Personal Protective Equipment (PPE)
  - health hazard and safety concerns when performing the dip treatment process
- All personnel involved in the dip treatment process are required to wear the appropriate and Label required PPE while performing the treatment. PPQ Officers may need to wear PPE if the dip treatment process area prevents them from observing the process from outside the restricted area.
- Designated dip treatment process areas must be located away from food preparation, eating areas, and offices. Al efforts should be made to place dip treatment processes in an area containing a mechanical exhaust.
- The broker/importer personnel involved with treatments must be aware and briefed on the location of the emergency eyewash and all other required safety equipment. They also need ti be aware of the areas that they will be limited to working within and any other specific restrictions determined by the PPQ Officer in charge of the process. The PPQ Officer monitoring the process should be aware of procedures to be followed in the event of an accidental release of the pesticide or an injury to one of the broker/importer's personnel.
- The broker/importer's personnel should shower as soon as possible after performing a dip treatment. The PPQ Officer should ensure that personnel are aware of the location and route to the shower. Guidance should also include instruction on how to disrobe and dispose of clothing used during dip treatment

processes. All contaminated clothing and PPE must be removed before entering the shower room. Contaminated clothing should be placed in plastic bags and PPE in Separate plastic bags.

- Broker/importer personnel should be informed that clothes wore during treatment must be washed in hot water with detergent and that they should be washed separately from other clothes
- The plant material should be released to the Broker/importer only if they are using/provide a vehicle that has a compartment physically separated from the cab, for example, a pick-up truck of tractor trailer.

6

Treatment Manual

Certifying Facilities

Overview

Contents

The Certification of Facilities section of this manual is organized by the following categories:

- Vacuum Fumigation Chambers
- Atmospheric Fumigation Chambers
- Cold Treatment Facilities
- Hot Water Immersion Facilities
- Forced Hot Air and Vapor Heat Treatment Facilities
- Niger Seed Treatment Facilities
- Irradiation Treatment Facilities

Domestic and foreign treatment facilities must be certified by APHIS before they can perform treatments to meet United States quarantine requirements. Specific requirements for each type of facility are included in this section.

After the Center for Plant Health Science and Technology (CPHST) has approved blueprints or drawings of a treatment facility, the treatment facility can request certification from Plant Protection and Quarantine at local ports or State Plant Health Directors.

Important

Blueprints or drawings of **domestic** treatment facilities should be sent to:

Peter Witherell
USDA-APHIS-PPQ-CPHST
Treatment Support & Certification
1017 Main Campus Drive, Suite 2500
Raleigh, NC 27606
tel: 919-513-2496, ext. 236

Request for certification can be sent to State Plant Directors listed at the following URL:

http://www.aphis.usda.gov/travel/aqi.html

Important

Blueprints or drawings and request for certification of **foreign** treatment facilities should be sent to:

David Reeves
Director, Preclearance Programs
USDA, APHIS, PPQ
4700 River Road, Unit 60
Riverdale, MD 20737
tel: 301-734-8295
fax: 301-734-8318

For foreign treatment facilities, the company requesting certification is responsible for paying money into a trust fund account to pay the salary, travel costs, and per diem of a PPQ Officer to be sent on temporary duty.

Sea-going vessels that participate in the APHIS cold treatment program for fresh fruit may be certified at a port in the USA or at a foreign port. Also, if the certification is to be carried out overseas, a trust fund account will be needed to cover the costs. (For details call Stephanie Hyatt, PPQ Quarantine Policy, Analysis and Support (QPAS), tel: 301-734-6404.

6

Treatment Manual

Certifying Facilities

Certification of Vacuum Fumigation Chambers

Contents

Construction and Performance Standards

Fumigation by vacuum consists of placing the commodity in a gas-tight steel chamber, removing most of the air, and replacing a small portion of it with a gas which is lethal to insects and other pests. Vacuum fumigation provides a more rapid penetration of commodities undergoing treatment than is obtained in atmospheric fumigations. The length of exposure in vacuum fumigation may range from 2 to 4 hours as compared with 12 to 24 hours under atmospheric conditions.

Chamber

Vacuum chambers are usually of welded steel construction. A rectangular chamber may be preferred for more effective use of space. Reinforcement of the chamber body by means of steel ribs, or other supports, is usually required to enable the chamber to withstand the difference in pressures when the vacuum is drawn. Doors may be provided at one or both ends of the chamber. In cylindrical chambers, the doors may be either concave or convex, but in rectangular chambers flat doors are commonly used with suitable reinforcements. The doors may be hinged at the side, or at the top and counterbalanced. Many doors are fitted with special mechanisms for rapid closing. Door gaskets should be durable and at the same time provide gas-tight seal. The efficiency of a chamber depends to a large extent upon the tightness with which the door or doors will seal. All other chamber openings must be equally tight to sustain the prescribed vacuum over a specified period of time.

To permit circulation beneath the load, the chamber must be designed to enable the loading of commodities stacked on pallets, skids, or small trucks. Small chambers which are usually hand loaded should be provided with removable floors.

Vacuum Pump

Each installation required a high quality, high capacity vacuum pump. The vacuum pump should have the capacity to reduce the chamber pressure to 1–2 inches (25–51 mm) of mercury (28–29 inch or 711–737 mm vacuum) in 15 minutes or less.

Fumigant Introduction Systems

The introduction system needed will vary with the type of fumigant in use and the size of the chamber. For small chambers and for introducing fumigants in small quantities, the fumigant may be measured by volume using a graduated dispenser. For larger chambers the gas supply cylinder is placed on a platform scale and the amount of fumigant required is measured by weight.

For most fumigants, a volatilizing unit is required to insure fumigant introduction in a gaseous state. The volatilizer is located outside of the chamber between the gas cylinder or dispenser and the introduction port of the chamber. The volatilizer consists essentially of a metal coil submerged in water which is kept hot enough to vaporize the fumigant. If more than one fumigant will be used in the chamber, a separate volatilizer and gas introduction line should be used for each in order to reduce the possibility of corrosion or formation of precipitates.

Within the chamber the gas introduction system should consist of tubing with multiple graduated openings which will provide uniform distribution of the fumigant throughout the length of the chamber. The tubing shall be installed along the ceiling.

Circulation and Exhaust System

Adequate distribution of the gas is often hindered by the cargo placed in the chamber. To overcome this, vacuum chambers should be equipped with a circulatory system. If fans are employed, the number of fans required would depend upon the chamber design, volume, and loading arrangements. A minimum of two would normally be required for chambers of over 1,000 cu ft capacity (28.31 m^3). The fans are to be placed at opposite ends of the chamber facing each other—one high, one low. Additional fans may be required for larger chambers. Their combined capacity should be such that they are capable of moving each minute a volume of air which is equal to approximately one-third the volume of the chamber. Non-sparking, explosion-proof type circulation systems are required with some fumigants.

In most installations, the vacuum pump is used to remove the fumigant following the exposure period. The air-gas mixture is pumped out of the chamber through exhaust ducts or stacks installed for that purpose. The actual height of these stacks will vary with the location of the chamber, and may be regulated by local safety ordinances.

Accessories

Chambers must be equipped with a vacuum gauge and an instrument for measuring and recording the vacuum drawn and maintained during the exposure period. A temperature instrument must be installed in chambers used for quarantine treatments with long exposure periods. Combination temperature and vacuum recorders are available.

Performance Standards

To qualify for program approval, vacuum chambers must be able to meet or exceed specified vacuum leakage tests. The tests are listed below and determine the classification under which the chamber qualified.

Classification	Initial vacuum equivalent to inches of mercury	Allowable vacuum loss			
		4 hr	6 hr	16 hr	24 hr
Superior	28 1/2	—	1/2”	—	1"
A	28 1/2	1/2”	—	1"	2"
B	28 1/2	1"	—	2 1/2”	3"
C	26	1"	—	2 1/2”	3"

In addition, ***ALL*** chambers must be capable of meeting the following requirement: A vacuum equivalent to 26 inches (660 mm) of mercury is drawn. The vacuum is then reduced to 5 inches (127 mm) and held for a period of 4 hours. A vacuum of 2 inches (55 mm) or more after 4 hours is considered adequate for this test.

Chambers classified “Superior” or “A” are approved for all vacuum treatments. These chambers are to be tested annually.

Chambers classified “B” are approved for all vacuum schedules up to and including 28-inch (711 mm) sustained vacuum. These chambers are to be tested semiannually.

Approval of a chamber for vacuum fumigation does not include approval for atmospheric (NAP) fumigations. If the vacuum chamber will also be used as a normal atmospheric pressure chamber, then it must also pass a pressure leakage test (see **page-2-5-6**).

Actual detailed instructions for constructing a vacuum chamber are not included in this discussion. The information presented is designed to list the component parts that are needed in the chamber and the function of each. Instructions and additional information can be obtained from the following list of vacuum chamber manufacturers. In furnishing the names of these dealers, no discrimination is intended against any firm whose name may have been omitted. Neither does this program endorse the firms mentioned nor guarantee the reliability of their products. The list is furnished solely for information and convenience.

Partial List of Manufacturers of Vacuum Chambers

Cos-Med Group
(a.k.a. ETO Sterilization, Inc.)
250 Brunswick Avenue
Linden, NJ 07036

Slack Associates, Inc.
540 South Longwood Street
Baltimore, MD 21223

Vacudyne Altair
375 East Joe Orr Road
Chicago Heights, IL. 60411

6 Certifying Facilities

Treatment Manual

Certification of Atmospheric Fumigation Chambers

Contents

Construction and Performance Standards

Discussion (Overview)

The primary purpose of a program fumigation is to obtain quarantine control of the pests in all stages of development in or on the product being fumigated. A properly constructed fumigation chamber will provide an enclosure into which the product can be loaded and where the fumigant will be maintained at the prescribed concentration for the required exposure period.

The primary consideration in the construction of an atmospheric fumigation chamber is to make it as gas tight as possible. In addition, circulation equipment must be installed to distribute the fumigant properly throughout the chamber. The chamber must retain these qualities of tightness and fumigant circulation during every fumigation.

Although chamber sizes are not restricted to specific dimensions, chambers should be sized according to the volume of material to be fumigated. Experience has shown that two moderately sized chambers would be preferable to one large facility.

The construction material may be selected according to the type of product to be fumigated and the method of operation involved. Wood construction of wood frame with light metal sheathing could be utilized if the products to be fumigated are lightweight and are to be hand loaded. Heavy products often loaded by machinery or handtrucks would require that the construction be of heavy gauge sheet metal, masonry, or metal plates. It is advisable to construct the chamber in the most durable manner consistent with its intended use.

Auxiliary equipment will be required to measure, vaporize, circulate, and exhaust the fumigant. Such equipment should be sized according to the volume of the chamber. When a relatively small amount of fumigant is used, it is often measured by volume in graduated dispensers (MB only). When larger amounts are used, the fumigant is most often measured by weight.

For the fumigant methyl bromide (MB) a volatilizing unit through which the fumigant passes is located outside the chamber.

For the fumigant sulfuryl fluoride (SF), no volatilizer or graduated dispenser should be used. For phosphine (PH), a chamber is generally not used because phosphine will corrode copper and brass (including tubing, fans, and electrical wiring).

Fans or blowers developing the prescribed minimum air movement are essential to the proper distribution of the fumigant.

Chambers may be equipped with heating or refrigeration units depending on the climatic environment and the products to be fumigated. Product injury or an ineffective fumigation may occur within certain temperature ranges. Although provisions for temperature control are not generally mandatory, in certain fumigation operations temperature control is necessary and therefore must be considered in the design and construction.

While complete construction details for an atmospheric fumigation chamber are not contained in the following narrative and illustrations, sufficient information is available to develop specifications for a proposed structure. Firms considering chambers for approval by the U.S. Department of Agriculture should submit drawings to the Center for Plant Health Science & Technology (CPHST) in Religh, North Carolina.

Basic Elements for Design and Construction of Chambers

- Must be gas tight and must remain so during every use.
- Must be provided with an efficient system for circulating and exhausting the fumigant.
- Must be provided with an efficient system of dispensing the fumigant.
- Must be provided with suitable fittings to facilitate a pressure-leakage test and gas concentration sampling.
- Should be provided with a recording thermometer when product temperatures are critical or treatments are of such duration that temperature variations could affect the efficiency of the fumigation.

- Should be provided with heating or refrigeration units when they are required for fumigation efficiency or to prevent product injury.
- Should be equipped with removable, slatted floors unless all material placed in the chamber is on pallets or carts.

The criteria listed above deal primarily with the efficiency of the fumigation chamber itself. In determining the ultimate design and construction, it is essential to give consideration to the safe and practical operation of the facility.

Gas-Tight Construction

Interior surfaces must be impervious to the fumigant. Joints must be sealed with proper compound, solders, or welds. All doors and vents must be provided with proper gaskets. All openings such as for wiring, thermometer, tubing, ports for pressure-leakage tests, etc., must be made gas-tight.

Interior surfaces whether metal, cement, concrete block, tile, or plywood must be painted with epoxy resin, vinyl plastic, or asphalt base paints. Such paint coverings make the surfaces less sorptive, an important factor in maintaining gas concentrations.

Important

Aluminum base paints are **not** acceptable because of the corrosive effect caused by a reaction between such paints and the fumigant. A list of sources for approved paints is available from the Riverdale office.

When wood or wood and sheet metal are used in construction, it is critical that all joints and seams be sealed with nonhardening mastic. This makes a gas-tight seal and allows for expansion and contraction without leakage. In masonry construction, the mortar between all courses of cement blocks should be jointed to produce a smooth compact surface. Poured concrete structures should also have smooth compact surfaces.

The construction and fastening of chamber doors is most critical. Doors may be hinged from the top or side, or on a davit. A chamber door hinged at the top is less apt to sag. Refrigerator hinges should be used if the door is hinged at the side. A high quality gasket, such as neoprene must be provided along the entire perimeter of the chamber facing. To obtain maximum tightness, the doors must be fastened uniformly against the gaskets.

Circulation and Exhaust Systems

Various methods can be used to circulate the fumigant within the chamber. Equipment should be capable of circulating air at the rate of at least one-third the volume of the chamber per minute. The rate of airflow of the blower should give approximately one complete change of air per minute, based on the volume of the empty chamber. For smaller chambers, a suitable circulating fan will usually provide the necessary air movement. For larger chambers, effective gas distributions can be obtained by using a circulating or squirrel cage fan which picks up the air/gas mixture from a duct reaching near the floor and blowing it across the top of the load. A blower located outside the chamber may also be used, but this method considerably increases the possibilities of leakage. Non-sparking explosion-proof units are required with some fumigants.

Exhaust blowers should also be sized according to the volume of the chamber. Volume of enclosure (in cubic feet) divided by the sum of cubic feet per minute (cfm) of the exhaust fan(s) or exhaust blower equals the number of minutes required per complete gas volume exchange. (2) Sixty minutes divided by the number of minutes per gas volume exchange equals the number of complete gas exchanges per hour. The result should be in the range of 4 to15. The faster the rate of aeration the better, particularly for perishable commodities. If the exhaust flow is connected to a methyl bromide recovery system, this device must not impede the flow rate to less than 4 volumes per hour. Frequently, circulation and exhaust systems are designed to utilize the same blower. Venting to the outside is essential, and the exhaust stack should extend well above all nearby structures. Compliance with local safety ordinances is essential.

Fumigant Dispensing System

The dispensing system needed will vary with the types of fumigants in use. The fumigant MB is usually introduced into the chamber through a tube extending from the supply cylinder. Within the chamber this tube should be provided with properly spaced openings through which the fumigant is dispersed. Fumigants in small quantities are generally measured by volume using a graduated dispenser. The dispenser is located in the introduction line between the supply cylinder and the volatilizer. For larger quantities the supply cylinder is placed on a platform scale and the fumigant used is measured by weight. The measured amount of fumigant must pass through a volatilizer where it is converted from a liquid to a vapor. The volatilizer is most often constructed of copper tubing immersed in a hot water bath which should be kept near the boiling point. The introduction tube for MB should be located in the uppermost part of the chamber.

Pressure-leakage Test for NAP Fumigation Chambers

Before a chamber is used for fumigation, the manometer can be used during a pressure-leakage test as a measure of tightness. An opening (usually 1 inch diameter) should be provided in the chamber for the use of a blower or other means for the introduction of air to create a positive pressure in the chamber. An additional opening, such as a gas sampling line opening, must be provided for the manometer. The procedure for testing is as follows:

1. Close chamber as for fumigation.
2. Attach one end of the manometer to the chamber opening.
3. Use vacuum cleaner blower or similar apparatus to create pressure of 25 mm as measured on an open-arm, kerosene or water filled manometer.
4. Discontinue blower and close its entry.
5. Observe time for pressure to recede from 25 to 2.5 mm in the open arm.

The time lapse for the chamber pressure to recede from 25 to 2.5 mm in the open arm must be 22 or more seconds for minimum approval. Chambers shall be reinspected every 6 months when 22 to 29 seconds are recorded. Chambers which retain the pressure for 30 seconds or longer should be tested annually. (Chambers used for fumigating cherries for export to Japan are required to meet a higher standard—the time lapse for the chamber pressure to recede from 25 to 2.5 mm must be 60 or more seconds for minimum approval.) Inability to develop or maintain adequate pressure indicates considerable leakage. In such cases, the chamber operator may use a smoke bomb or other device in an effort to determine the areas of leakage.

Electronic manometers are also available and may be used in lieu of the Open-arm (U-tube) type.

Directions for using this equipment are explained in the Equipment section.

Other Auxiliary Equipment

According to the needs of the operation, other auxiliary equipment should be provided. When heat is required, steam pipes or low temperature electric strip heaters are generally recommended. Open flame or exposed electric coils should not be used as they tend to break down the gas and form undesirable compounds. Refrigeration units should be sized to the volume of the chamber and the type and amount of commodity involved. Recording thermometers when required are usually attached to the outside of the chamber with a remote sensing unit attached to the inside wall or inserted into the product.

Figure 6-1-1 through ***Figure 6-1-4*** illustrate various construction features and auxiliary equipment.

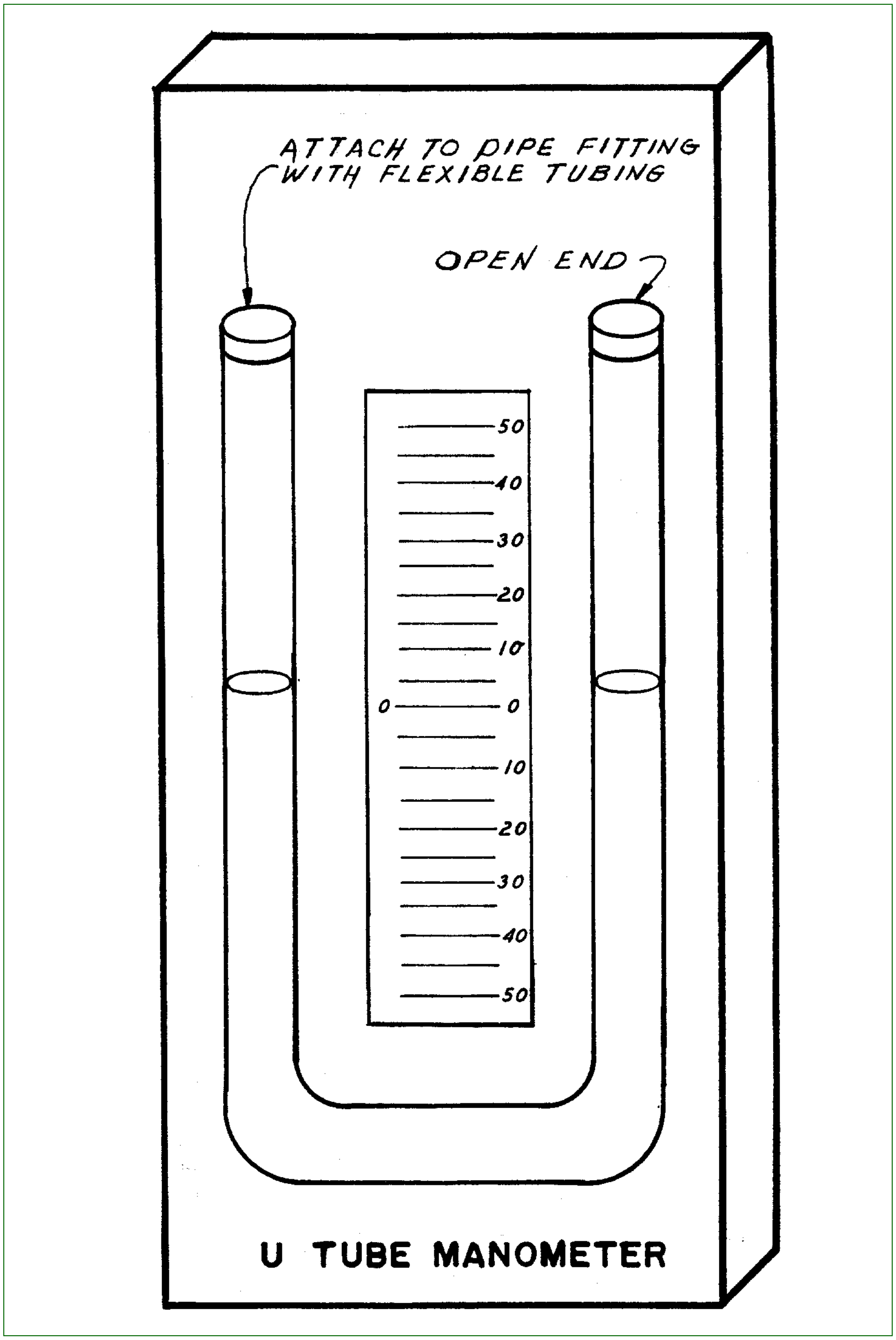


FIGURE 6-1-1: U Tube Manometer

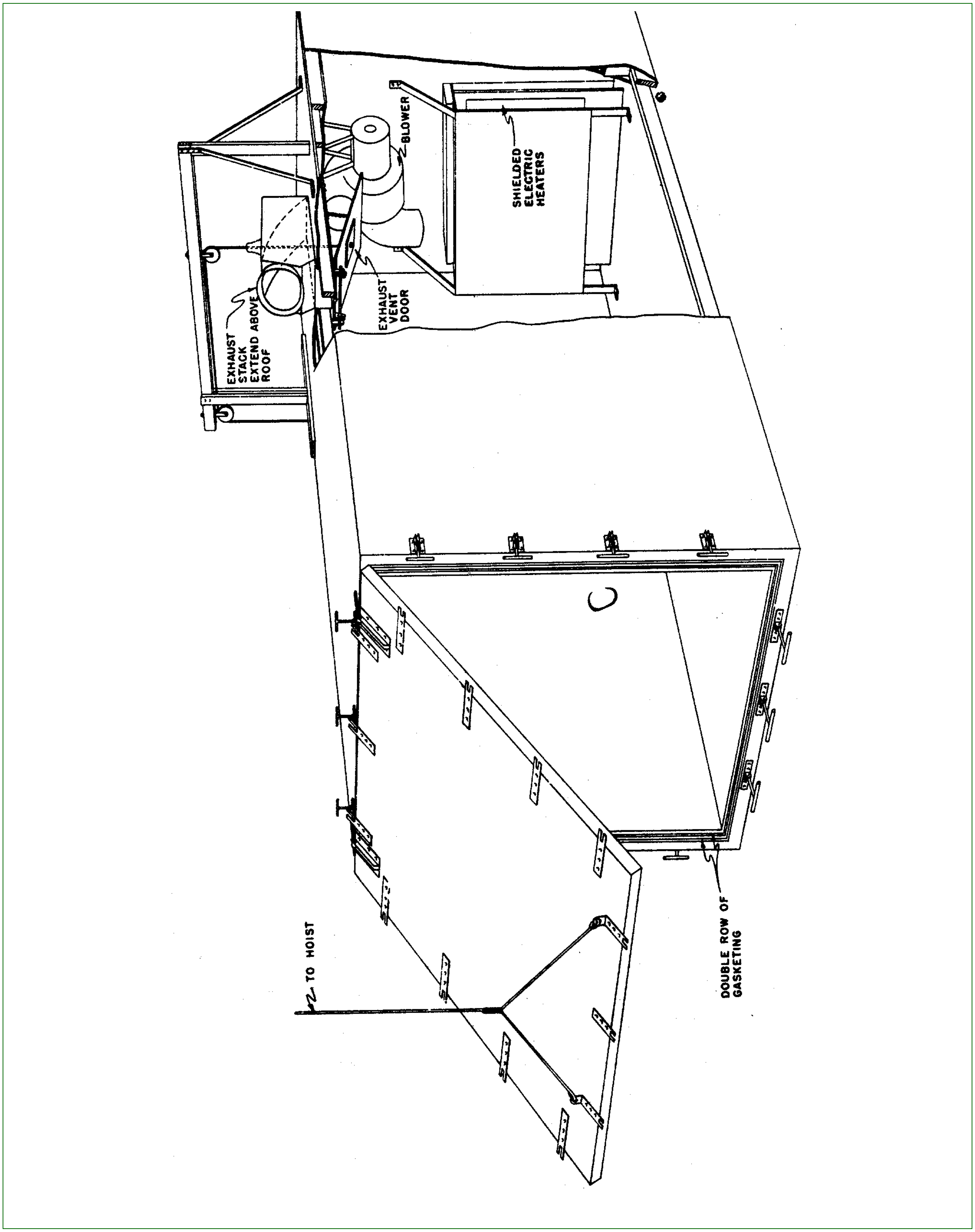


FIGURE 6-1-2: Generalized Plan of Atmospheric Fumigation Chamber Showing Heat and CIrculation Systems

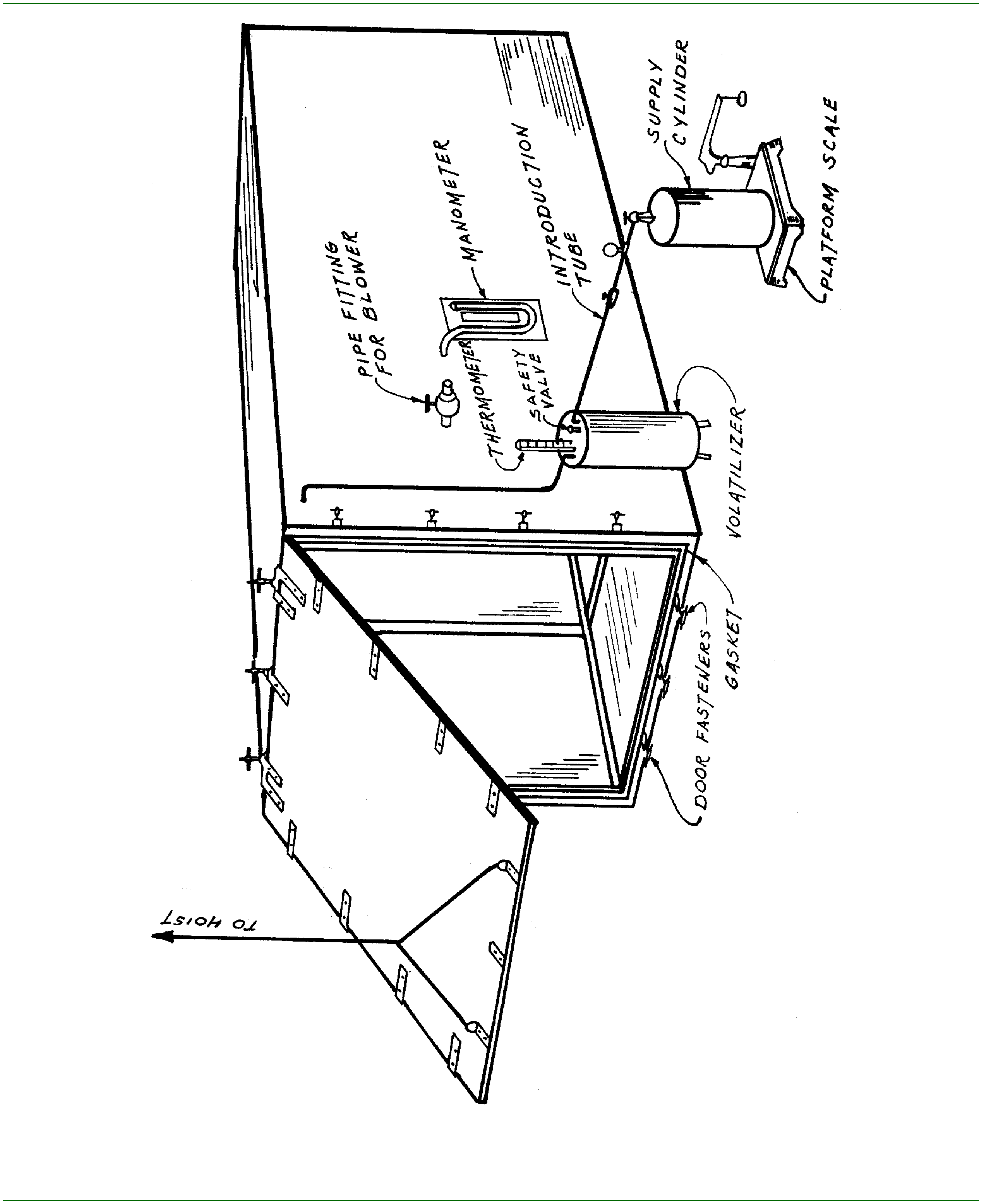


FIGURE 6-1-3: Generalized Plan of an Atmospheric Fumigation Chamber

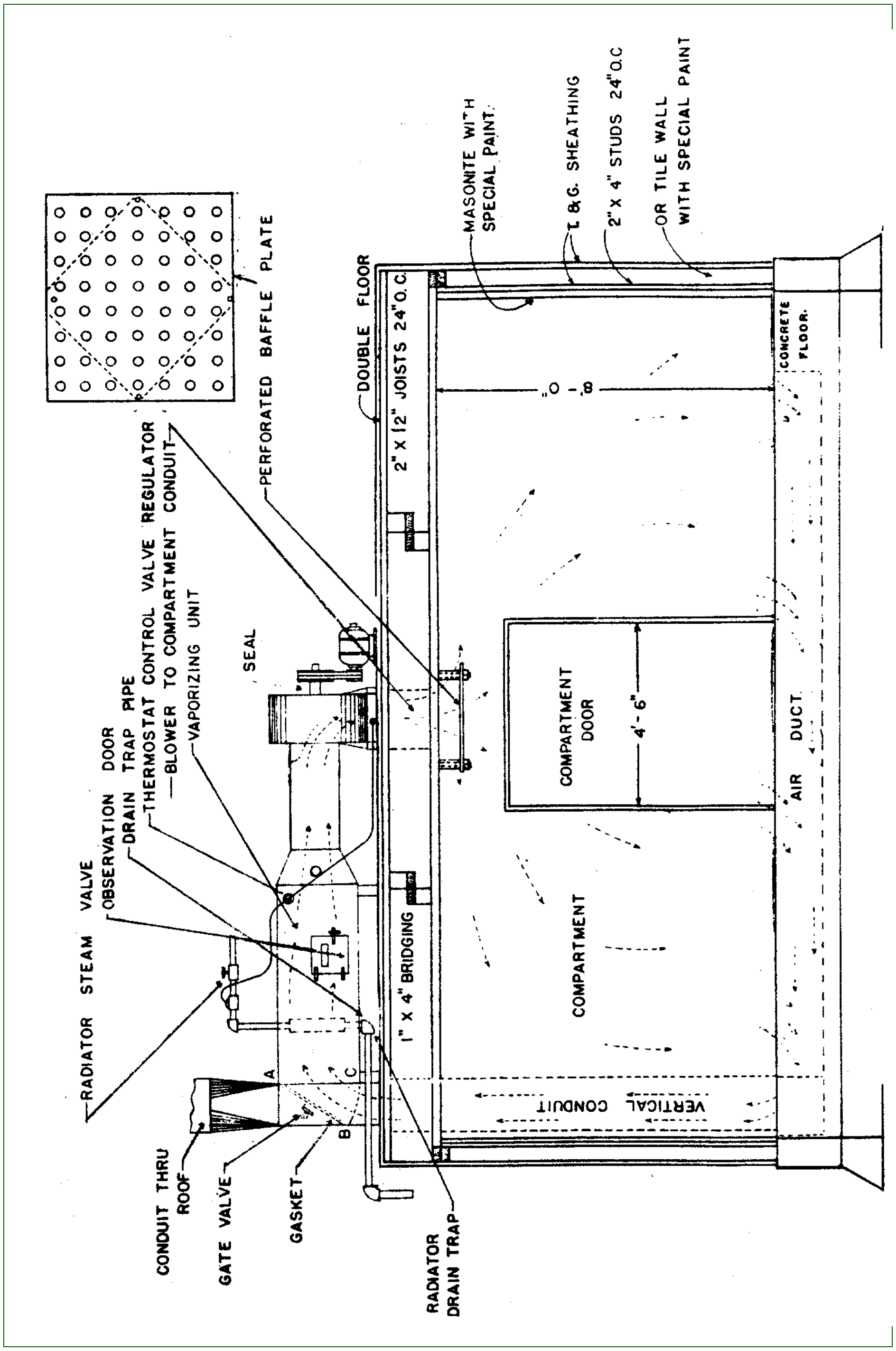


FIGURE 6-1-4: Forced-air Circulation Plan for Fumigation Chamber

7 Emergency Aid and Safety

Treatment Manual

Fumigation Exposure

Contents

Emergency Action—DO NOT HESITATE

You

If exposed to fumigant, immediately move well away from the contaminated area. Notify your coworkers of the danger and that you have been exposed. Onset of symptoms may be delayed in some fumigants. Promptly notify your supervisor of all details.

If liquid fumigants have spilled on skin or clothing—immediately remove contaminated clothing and gently wash the skin with large quantities of water and soap. Do not use abrasive cloths or brushes. Be sure to include areas under finger and toenails. Contaminated skin may also be rinsed with rubbing alcohol.

Contaminated clothing must not be used again until thoroughly aired, washed, and dried. Dangerous vapors will be produced by the liquid fumigant as it evaporates from skin or clothing.

Coworker

If chemical intoxication due to exposure is at any time suspected:

1. Immediately move the victim out of the area to fresh air.

CAUTION

Do not enter contaminated areas without a proper respirator, even to effect rescue.

2. If there is evidence of respiratory weakness, give artificial respiration. Oxygen can be beneficial. **Artificial respiration takes precedence over all other first aid.** (See next page.)
3. Call a physician when symptoms suggest immediate care is needed.
4. Keep patient warm, comfortable, and as quiet as possible.
5. If convulsions occur, use gentle restraint and prevent injury.

First Aid With Rescue Breathing

If you think a person has stopped breathing, don't delay. Give first aid immediately. Ask someone else to get medical help.

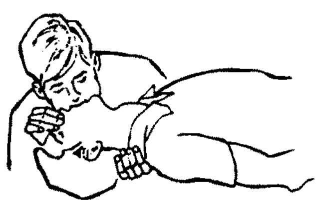
1. Is the person breathing?

To find out if the person is breathing, place him flat on his back and put your ear close to his mouth. If he is breathing, you will feel his breath and see his chest rise and fall.

2. Open the airway.

If the person has stopped breathing, lift up his neck with one hand and push down on his forehead with the other. This opens the airway and the person may start to breathe. If he doesn't, begin RESCUE BREATHING at once.

3. Rescue Breathing. Keep one hand under the person's neck so that his head is tilted backward with his chin up. Pinch his nostrils shut with the fingers of your other hand.



Take a deep breath and cover his mouth completely with yours. Blow air into his mouth. When his chest moves up, take your mouth away and let his chest go down by itself.

Repeat this procedure every 5 seconds. Do not stop until the person starts breathing or medical help comes.

Signs, Symptoms, Emergency Aid, and Medical Treatment for Poisoning by Some Fumigants Used by APHIS

Chloropicrin

Signs and Symptoms

Powerful irritant; affects all body surfaces, lacrimation, vomiting, bronchitis, pulmonary edema. Inhalation causes anemia, weak and irregular heart beat, recurrent asthmatic attacks.

Emergency Aid

Artificial respiration. Oxygen if available.

Medical Treatment

Symptomatic—oxygen. Sample analysis might be helpful in diagnosis and prognosis.

Methyl Bromide

Signs and Symptoms

Central nervous system depression, nausea, fever, dizziness, confusion, delirium, staggering, visual disturbances, abdominal pain, mania, tremors, pulmonary edema, convulsions, coma. ***Onset may be delayed 4-12 hours.*** On skin, severe irritations, skin blisters, dermatitis.

Emergency Aid

Artificial respiration. Oxygen if available. No mechanical resuscitation. If on skin, wash 15 minutes with large amounts of water. If on clothing, vapors may be released in toxic quantities.

Medical Treatment

Symptomatic—Artificial respiration, oxygen without mechanical resuscitator. Analysis of breath and blood may help in diagnosis and prognosis. Nausea, accompanied by vomiting. Give intravenous, glucose-bearing vehicles.

Phosphine (From Aluminum Phosphide)

Signs and Symptoms

2,000 ppm in air, rapidly fatal. Chest pain, headache, dyspnea, restlessness, vomiting, diarrhea, convulsions, coma, paralysis, low blood pressure, slow heart, death may be delayed several days.

Emergency Aid

Artificial respiration. Oxygen if available.

Medical Treatment

Symptomatic—oxygen; control convulsions with sedatives, restore fluid balance with glucose and saline.

Sulfuryl Fluoride

Signs and Symptoms

Central nervous system depression, excitation may follow.

Emergency Aid

Place patient in fresh air, face downward, with head slightly below level of lungs. Keep warm. If breathing stops, give artificial respiration.

Medical Treatment

First symptoms expected are those of respiratory irritation and central nervous system depression. Treat symptomatically.

Fumigant Safety

Specific precautions to be followed when using each of the fumigants are listed on the label and labelling. However, the following general safety procedures can be applied to most applications.

1. Hazards vary with:
   - **A.** Relative toxicity of each fumigant
   - **B.** Dosage rate (concentration)
   - **C.** Size of enclosure
   - **D.** Tightness of enclosure
   - **E.** Physical condition of employee (allergies, heart condition, respiratory ailments, etc.)
2. It is important to:
   - **A.** Know the characteristics of the fumigants you are working with
   - **B.** Have the proper equipment to carry out the fumigation
   - **C.** Be familiar with the emergency aid required should an accident occur
3. Wear protective equipment if there is a chance of exposure to highly toxic liquid fumigants.
   - **A.** Gloves should be impermeable to liquid fumigant being used
   - **B.** Rubber aprons should be long enough to prevent legs from being exposed
   - **C.** A face shield or respirator should be worn when liquids are being transferred and there is a possibility of splattering
4. Dispensers for measuring the amount of fumigant should have shatter-proof shields.
5. The area surrounding the fumigation enclosure should be well-aerated. Operators should be located upwind from treatment.
6. If it is necessary to stay in the area of a treatment, the air should be monitored to determine if harmful levels of the fumigant are present.

7. Under no circumstances should an inspector be exposed to concentrations above minimum safe standards. A self-contained breathing apparatus (SCBA) should always be readily available should an emergency develop.
8. A SCBA is required at all fumigation sites. Use of such respirators is mandatory for PPQ Officers when within 30 feet of tarpaulin fumigation or whenever TLV is exceeded (5 ppm for methyl bromide).. You must have a medical evaluation and clearance to use SCBA equipment. The evaluation must be performed by a physician or licensed health care professional. Also, you must follow OSHA standards for respirator use. (See APHIS Safety and Health Manual, Chapter 11, Section 3)
9. Wash hands and face after leaving area where toxic amounts of fumigants are being used.
10. Do not eat, drink, smoke, or carry tobacco in areas where fumigants are being used.
11. A first-aid kit equipped with the proper materials should be readily available at the treatment site.
12. Persons working regularly with toxic fumigants should have blood tests and physical examinations if warranted by supervisor's consultation with local medical authorities.
13. Have telephone numbers of local hospitals, doctors, and poison control centers prominently displayed.
14. Learn to recognize the signs and symptoms of fumigant poisoning. Training should be given to each inspector.
15. Supervisors should be aware of signs of fatigue. Risk of accidents increases in tired employees.

Guidelines for Using Fumigants Safely

Emergency-Rescue and respirator[1] for each of the fumigants is a SCBA.

TABLE 7-1-1: Fumigant Monitoring Devices and Sources of Exposure

Fumigant/Routes of Entry	Detector Unit or Monitoring Device	Sources of Exposure
Chloropicrin: Inhalation	None	Application of liquid, leakage from enclosure, aeration
Methyl bromide: Inhalation, skin	Gas detector tubes, Halide detector, T/C Unit	Cylinder connection, leaks in tarpaulin, applicators, aeration
Phosphine (from aluminum phosphide): Inhalation	Gas detector tubes	Application of pellets, leakage from enclosure, aeration
Sulfuryl fluoride (Vikane®): Inhalation	T/C Unit	Applicator and cylinder connections, leakage from enclosure, aeration

1 For use outside of enclosure only.

7 Emergency Aid and Safety

Treatment Manual

Pesticide Exposure

Contents

Emergency Action—DO NOT HESITATE

You

If your clothing is soaked with pesticide, remove the contaminated articles quickly. Then gently wash the skin with large quantities of soap and water. Do not scrub the skin or use an abrasive cloth or brush. Include areas under your fingernails and toenails. Contaminated skin can also be rinsed with rubbing alcohol. Call or notify your supervisor or coworker immediately, giving full details of the incident.

Coworker

Move the victim well away from the contaminated area.

1. If there is respiratory weakness or **if breathing ceases, give artificial respiration immediately**. (See next page.)
2. Call a physician as quickly as possible. If you are alone, do not abandon the first-aid treatment.
3. Keep the patient as quiet as possible, warm, and comfortable.
4. When symptoms are moderate or severe and caused by organophosphate or carbamate poisoning, and if the patient is conscious, immediately give two atropine tablets (1/100 grain each). (See number 13 under Pesticide Safety, **page-7-2-3**). Then immediately contact the nearest medical help and request assistance, even if symptoms disappear.
5. If pesticide is splashed in the eyes, immediately wash with large volumes of clean water. Continue for at least 15 minutes.

6. If medical help cannot be obtained or is delayed, transport the patient to the nearest hospital, physician's office, or urgent medical clinic. If possible, use a radio or other means of communication to alert authorities and the hospital. Drive safely if you must transport a patient. Take the pesticide label or any available records of pesticides used and any other information which may aid in diagnosis and treatment.

First Aid With Rescue Breathing

If you think a person has stopped breathing, don't delay. Give first aid immediately. Ask someone else to get medical help.

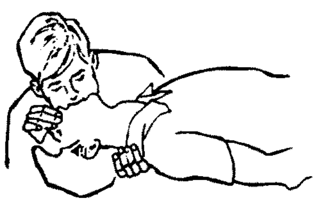
1. Is the person breathing?

To find out if the person is breathing, place him flat on his back and put your ear close to his mouth. If he is breathing, you will feel his breath and see his chest rise and fall.

2. Open the airway.

If the person has stopped breathing, lift up his neck with one hand and push down on his forehead with the other. This opens the airway and the person may start to breathe. If he doesn't, begin RESCUE BREATHING at once.

3. Rescue Breathing. Keep one hand under the person's neck so that his head is tilted backward with his chin up. Pinch his nostrils shut with the fingers of your other hand.



Take a deep breath and cover his mouth completely with yours. Blow air into his mouth. When his chest moves up, take your mouth away and let his chest go down by itself.

Repeat this procedure every 5 seconds. Do not stop until the person starts breathing or medical help comes.

General Symptoms

Mild Poisoning

Any discomfort can be an indication of mild poisoning or some other sickness. Individuals who are exposed to poison and who experience the following symptoms should be aware that more serious indications may follow.

Headache, fatigue, skin irritation, loss of appetite, dizziness, weakness, nervousness, nausea, perspiration, diarrhea, eye irritation, insomnia, thirst, restlessness, irritation of nose and throat, loss of weight, soreness of joints, changes of mood.

Moderate Poisoning

May be the beginning of severe symptoms. Nausea, trembling, muscular incoordination, excessive saliva, blurring of vision, feeling of constriction in the throat and chest, difficulty in breathing, flushed or yellow skin, abdominal cramps, vomiting, diarrhea, mental confusion, twitching of muscles, weeping, excessive perspiration, profound weakness, rapid pulse, cough.

Severe Poisoning

Vomiting, loss of reflexes, inability to breathe, uncontrollable muscular twitching, constriction of pupils (to pinpoint pupils), convulsions, unconsciousness, severe secretion from respiratory tract, fever, intense thirst, increased rate of breathing.

Pesticide Safety

1. Read the label before using any pesticide and follow precautions. If material is transferred to another container for application, a copy of the label should be kept near the dispersing point.
2. Use only proper tools for opening containers. Carefully open bags and use the proper tools to prevent pesticide from spilling onto your face or hands.
3. Pesticides should be opened in an area where any spills can be cleaned up properly. Mixing and pouring should be done in a well-ventilated place removed from other personnel. If there is a breeze, personnel should be upwind of any transfer of pesticides.
4. Pour pesticides properly. If an air vent is provided, use it.
5. A good supply of lime, coarse clay, sand, sawdust, or other absorbent material should be readily available.
6. Do not allow any person to work alone, especially when handling highly toxic materials.

7. Wear clean, dry, long-sleeved shirts and trousers made of cotton or any protective clothing as directed by the label.
8. Wear rubber gloves, well-fitted goggles, a rubber apron, and rubber boots when handling concentrates. Be certain the equipment is adequate for the task. Thin rubber gloves (disposable) should only be used once. An apron or gloves made of permeable material may be hazardous.
9. Be careful not to spill toxic chemicals on skin or clothing. If this happens, remove contaminated clothing at once and wash skin and clothing thoroughly. All operators should have available one change of clean clothes in case of accidental spillage.
10. Wash hands and face immediately after applying pesticide, before using toilet, and before eating, drinking, or smoking. Do not eat, drink, or carry tobacco in areas where pesticides are present.
11. Do not use mouth to siphon or to blow out nozzles or clogged lines, etc. on equipment. Do not put fingers in mouth or rub eyes while working with pesticides.
12. Never use arms to stir or to reach into a container of pesticides to retrieve tools or other accidentally dropped items.
13. When applying the more toxic organophosphates and carbamate insecticides, be prepared to contact a physician. In case of poisoning, the physician can prescribe atropine tablets. Also, read the label to learn what additional actions to take in case of poisoning—like giving liquids or inducing vomiting.
    - **A.** If symptoms from poisoning include blurred vision, abdominal cramps, or tightness in the chest, and if a physician is not readily available, then immediately have the patient transported to the nearest doctor, hospital, posion control center, or urgent care clinic, even is symptoms subside.
    - **B.** Further symptoms may include nausea, vomiting, diarrhea, pinpoint pupils, bronchial edema, muscle twitches, giddiness, drowsiness, confusion, difficulty in speech, and finally, coma.
    - **C.** The acute emergency lasts 24 to 48 hours. The patient should be under the observation of a physician during this period. Illness caused by carbamate poisoning does not last as long as organophosphate poisoning symptoms.
14. A supply of detergent soap, clean water, rubbing alcohol, skin lotion, and a nail file (if possible) should be readily available.
15. Persons working regularly with or frequently exposed to the more toxic organophosphate pesticides should have periodic cholinesterase level checks and physical examinations if warranted by supervisor in consultation with local authorities, and Chapter 7, APHIS Safety and Health Manual.

16. Respirators or filter masks with proper canisters approved or the particular type exposure noted in the label directions should be used when such pesticides are handled. Rubber boots may be needed in an area drenched with pesticides.
17. Know the limitation of the protective clothing and equipment, especially respirators.
18. Learn to recognize the symptoms of pesticide poisoning and know the first-aid measure to be taken in case of accident. Training in emergency measures should be given to all employees who work with pesticides.
19. Have the telephone numbers of local hospitals, doctors, or poison control centers prominently displayed.
20. Fatigue lowers the standards of pesticide safety. Key personnel should be aware that risk increases after long hours of work.
21. If an employee feels any sign of illness suspected as being due to poisoning, he should contact a doctor immediately. However, certain circumstances such as consuming large amounts of liquids following excessive heat exposure may cause nausea, vomiting, dizziness, and cramps. Such signs mimic pesticide poisoning.

7 Emergency Aid and Safety

Treatment Manual

Guidelines for Managing Pesticide Spills

Contents

Introduction

This document provides instructions for dealing with pesticide spills during program operations. “Pesticide spill” refers to any unplanned spill or leakage into the environment that occurs during storage, use, transport, or disposal of pesticide. Examples include aircraft and surface vehicular crashes, jettisoning pesticide cargoes from the air, and leaks or other equipment failures. After a pesticide spill, the responsible program person should evaluate the situation and begin appropriate corrective measures. (Use **Figure 7-3-2** to identify your responsible program contact.)

The Officer-in-Charge (OIC), Contracting Officer’s Representative (COR), or other responsible program official should prepare a site-specific plan based on the generic plan, **Emergency Spill Procedures**. (See **Figure 7.4.1** for an abbreviated plan. Make a copy of this figure, and keep it for your pocket reference.) Prepare the plan before program operations begin by filling in the names, telephone numbers, and other required information. Specific objectives of each plan include:

- Protecting people working in the spill area.
- Preventing or minimizing the risk of further pesticide exposure to people, animals, and the environment.
- Cleanup of the area and disposal or detoxification of residual material.
- Notifying Federal, State, and local government officials of the magnitude and details of the pesticide spill.
- Evaluation of the potential impact to the environment based on chemical residues found in environmental components.

____
Responsible Program Contact (Name)

____
(Work telephone number)

____
(Home telephone number)

IF A PESTICIDE SPILLS TAKE THE FOLLOWING STEPS:

1. **Evaluate**. (Take care of people first!!!)
2. **Safety and First Aid**. The most immediate concern is for the health and well-being of persons in and around the area.
3. **Call 911** for fire/rescue squad to obtain medical assistance for injured or contaminated persons.
4. **Contamination Control**. Consult pesticide label & MSDS for appropriate protective clothing and hazards (or **CHEMTREC Emergency Hotline (800) 424-9300**).

FIGURE 7-3-1: Abbreviated Spill Plan, Personal Reference Card (Wallet-size)

Emergency Spill Procedures

Use this section as your guide to prepare a site-specific plan for pesticide spills. (Please, complete the blanks for your specific program.) The following is a summary of factors you must consider when a pesticide spill occurs (details follow this summary):

- Identify Contacts and Telephone Numbers
- Evaluate the Situation
- Safety and First Aid
- Crash Notification

- Contamination Control
- Notification
- Site Security
- Cleanup Techniques
- Decontamination

Identify Contacts and Telephone Numbers

You must know who to contact and where to call if a pesticide spill occurs. **Figure 7.4.2** identifies preliminary information that you will need in case of an emergency. Fill in the blanks for your site-specific plan.

(Program name)
Responsible Program Contact (Name)
(Work telephone number)
(Home telephone number)
Alternative Program Contact (Name)
(Work telephone number)
(Home telephone number)

FIGURE 7-3-2: Emergency Contacts for Pesticide Spills

Evaluate the Situation (Take care of people first!!!)

1. Injury/pesticide exposure. Go to **Safety and First Aid** (below).
2. Vehicle or aircraft crash. Go to **Crash Notification** (below).
3. Spill containment. Go to **Contamination Control** (below).

Safety and First Aid

The most immediate concern is for the health and well-being of persons in and around the area.

1. Call **911** for fire/rescue squad to obtain medical assistance for injured or contaminated persons.

2. Evacuate the immediate area, if necessary get upwind.
3. Remove injured people from the area. (Do not move a seriously injured person unless absolutely essential because of the risk of further injury.)
4. Consult the pesticide label and/or MSDS for appropriate protective equipment and hazards.
5. Administer first aid as necessary. See the pesticide's MSDS or contact the nearest poison control center. **Figure 7-3-3** identifies information that you will need in case of an emergency. Fill in the blanks for your site-specific plan.

(Center Name)

(Telephone)

FIGURE 7-3-3: Poison Control Center

6. Remove contaminated clothing and wash affected area with soap and water. If eyes are contaminated, flush with clean water.
7. If individuals experience pesticide poisoning symptoms (blurred vision, trembling, nausea, etc.) then transport them to the nearest medical emergency facility. **Figure 7-3-4** identifies information that you will need in case of an emergency. Fill in the blanks for your site-specific plan.

(Address)

(How to get there)

FIGURE 7-3-4: Medical Emergency Facility

8. Eliminate sources of ignition (e.g., pilot lights, electric motors, gasoline engines, or smoking) to prevent the threat of fire or explosion from flammable vapors.

Crash Notification

1. If the spill involved a vehicle or aircraft crash, contact the local police (911) as soon as practical.
2. If the spill involved an aircraft crash, notify the nearest Federal Aviation Administration (FAA) office. **Figure 7.4.5** identifies information that you will need in case of an emergency. Fill in the blank for your site-specific plan.

____
(Telephone number)

FIGURE 7-3-5: Federal Aviation Administration (FFA) Office

Contamination Control

1. Consult the pesticide label and/or MSDS for appropriate protective clothing and hazards (**or call the CHEMTREC Emergency Hotline at (800) 424-9300**).
2. Try to contain the spilled pesticide at the original site, and prevent it from entering streams, rivers, ponds, storm drains, wells, and water systems as follows:
   - **A.** If possible, reposition the pesticide container to stop further leakage.
   - **B.** Prevent the spill from spreading by trenching or encircling the area with a dike of sand, sand snakes, absorbent material, soil or rags.
   - **C.** If a liquid formulation spills, cover it with absorbent material; however, use absorbent sparingly, since it also becomes hazardous waste. Use no more than necessary.
   - **D.** If a dry formulation spills, securely cover it with polyethylene or plastic tarpaulin to prevent tracking or airborne spreading of dust.

Notification

1. Notify by telephone state officials and the PPQ regional office. Headquarters management will be notified through normal channels.
2. Contact the local Community-Right-To-Know or Emergency Planning Coordinator (often the Fire Marshall). **Figure 7.4.6** identifies information that you will need in case of an emergency. Fill in the blanks for your site-specific plan.

(Name)

(Telephone number)

FIGURE 7-3-6: Community-Right-To-Know or Emergency Planning Coordinator (Fire Marshall)

3. Call the CHEMTREC Emergency Hotline at **(800) 424-9300**.
4. Notify by telephone the National Monitoring and Residue Analysis Laboratory (NMRAL) in Gulfport, Mississippi, Area Code (601) 863-8124 or (601) 863-1813. NMRAL will provide any supplies needed for sampling environmental components.
5. If the spill involves a large area (4 hectares (10 acres) or more) or you judge that it could affect a large area through runoff or other movement, notify the State Fish and Game Department or equivalent through appropriate channels. **Figure 7.4.7** identifies information that you will need in case of an emergency. Fill in the blank for your site-specific plan.

(Telephone number)

FIGURE 7-3-7: Fish and Game Department

6. If animal poisoning may occur, notify the Regional Veterinary Services (RVS) Office. **Figure 7.4.8** identifies information that you will need in case of an emergency. Fill in the blank for your site-specific plan.

(Telephone number)

FIGURE 7-3-8: Regional Veterinary Services (VS) Office

7. If the spilled product is a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) classified hazardous substance or a Superfund Amendments and Reauthorization Act of 1986 (SARA) Title III classified extremely hazardous substance, spills of active ingredient exceeding the reportable quantities may be reportable (see Appendix 8 for information on determining whether to report).
8. If you are unsure as to reporting under CERCLA or SARA look at the product's MSDS or call the National Response Center **(800) 424-8802** for CERCLA, and for SARA call the at **(800) 535-0202**.
9. Notify your Regional Safety and Health Coordinator. **Figure 7.4.9** identifies information that you will need in case of an emergency. Fill in the blank for your site-specific plan.

(Telephone number)

FIGURE 7-3-9: Regional Safety and Health Coordinator

Site Security

Secure the spill site from unauthorized entry by roping off the area and posting warning signs. If necessary, request assistance from local police. **Figure 7.4.10** identifies information that you will need in case of an emergency. Fill in the blank for your site-specific plan.

(Telephone number)

FIGURE 7-3-10: Local Police

Cleanup Techniques

The following are general techniques. You should consult local hazardous waste officials, the pesticide's label, or its MSDS to determine specific cleanup and disposal techniques. (See State Hazardous Waste Management Agencies for a list of local hazardous waste officials.) **Figure 7.4.11** identifies information that you will need in case of an emergency. Fill in the blanks for your site-specific plan.

FIGURE 7-3-11: Local Hazardous Waste Official

(Name)
(Telephone)

FIGURE 7-3-11: Local Hazardous Waste Official

Adequate cleanup of spilled pesticides is essential to minimize health or environmental hazards. When cleaning pesticide spills, **NEVER WORK ALONE**. Be sure to ventilate the area and use appropriate protective equipment. Clean up dry spills (dusts, wettable powders, granular formulations) as follows:

- Immediately cover powders, dusts, or granular materials with polyethylene or plastic tarpaulin to prevent them from becoming airborne. If outside, weight the tarp ends, especially the end facing into the wind. Begin cleanup operations by rolling up the tarp while simultaneously sweeping up the spilled pesticide using a broom and shovel or dust pan. Avoid brisk movements to keep the dry pesticide from becoming airborne. When practical, lightly sprinkle the material with water to minimize dust. Always use an approved dust mask or respirator when working with dry pesticide materials.
- Collect the pesticide and place it in heavy-duty plastic bags. Secure and label the bags, properly identifying the pesticide and possible hazards. Set the bags aside in a secured area for disposal.
- Clean up liquid spills by placing an appropriate absorbent material (floor-sweeping compound, sawdust, sand, etc.) over the spilled pesticide. Work the absorbent into the spill using a broom or other tool to force the absorbent material into contact with the pesticide. Collect all spent absorbent material and place into a properly labeled metal drum for disposal.

Depending upon the pesticide, the size of the spill, and local conditions, you may need to remove the top ∫-inch layer of contaminated soil with a shovel and dispose of it.

Decontamination

As soon as practical, decontaminate crashed aircraft, wrecked vehicles, and pavements. See the pesticide's MSDS or label for specific instructions. For aircraft, coordinate with investigating officials and FAA authorities. For automobile wrecks, coordinate with appropriate law enforcement agencies or investigative bodies.

Chlorine bleach, caustic soda (lye, sodium hydroxide) detergents, or burnt or hydrated lime effectively decontaminate most spill areas (see attached MSDS sheets for precautions when using these substances).

CAUTION

Use bleach or lye, but never both together since this combination may liberate poisonous chlorine gas. Lye or lime readily decomposes many pesticides, especially the organophosphates, and carbamates. Clean up and remove as much of the spilled pesticide as possible prior to applying any decontaminate. Allow 1 to 6 hours reaction with the decontaminate before using an absorbent material.

Spread decontaminates thinly and evenly over the spill area. Then, lightly sprinkle the area with water to activate the decontaminate. Repeat the cleanup procedures until all the spilled pesticide is removed.

Clean all equipment used for spill cleanup with detergent and appropriate decontaminates. Collect all used decontaminates and rinse water and place them in labeled metal drums. Place clothing and gloves that cannot be decontaminated in the drums for proper disposal.

It may also be necessary to completely remove and dispose of contaminated porous materials.

If pesticides have leaked or spilled on the soil, removal of the visibly contaminated soil (top 1-inch) may be required using a shovel. In such cases, place the contaminated soil in metal drums for disposal. Chemical analysis of monitoring samples may govern removal of additional soil.

Post-Spill Procedures

Disposal of Contaminated Material

You may contact the pesticide's manufacturers for specific instructions regarding their product. Also contact the State or Federal EPA office with jurisdiction over the pesticide spill location about disposal, and consult with the U.S. Department of Transportation (DOT) prior to shipping/transporting across state lines. Shipping by licensed transporters may be required.

In general, place contaminated materials in sealed leak-proof metal disposal drums. Label all drums properly and dispose of in an approved hazardous waste disposal facility (incinerator, landfill site, etc.) under current EPA or State permit. The pesticide's labeling and MSDS contain specific information concerning disposal.

Environmental Monitoring

After cleanup and disposal, if the pesticide spilled into the environment, collect environmental monitoring samples. See M390.1403, ***Collecting Environmental Monitoring Samples*** for specific instructions. Contact the Region and request an Environmental Monitoring Coordinator if you need help with sample collection.

Reporting

Report information regarding pesticide spills in accordance with the program's specific monitoring plan, and as required by state and federal law. In general, reports should include:

1. Detailed map with the site of the pesticide spill clearly marked.
2. Information on location, time, spill area, terrain, pesticide spilled, how spill occurred, and how managed.
3. Any other information the writer deems pertinent to the pesticide spill.

Upon completion of the chemical analyses NMRAL will report its findings to Technical and Scientific Services (TSS). TSS will include the spill residue data in its programmatic environmental monitoring report and distribute as appropriate.

Planning for Pesticide Spills

Pesticides vary in toxicity as described in the pesticide's labeling and MSDS. Actions taken following an accidental spill will depend upon the pesticide toxicity involved. Always consult the labeling and MSDS for your program's pesticides when planning for spills. Check the telephone book for the telephone number of the local poison control center and enter it on your plan.

The Environmental Protection Agency (EPA) under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA); Resource Conservation and Recovery Act (RCRA); and CERCLA or Superfund assigned the primary responsibility for enforcing safe pesticide use and disposal to most States. States may therefore acquire primary responsibility for determining pesticide spill, cleanup, and disposal procedures.

Not all States will perform or react to pesticide spills in the same way. Therefore the Port Director or COR should assist with cleanup, sample collection, sample analysis, securing affected area, etc. The Port Director or COR must monitor such activities to assure PPQ that the responsible parties take proper actions during and after a spill. Keep in mind that legal actions as a result of a pesticide spill may place liability on the cooperating Federal Agency.

Program Managers should inform the PPQ Assistant Regional Director's office of procedures to follow when pesticide spills occur within their jurisdictions so they may support field operations when needed. The Port Director, COR, or Senior Staff Officer for any given PPQ operation, is responsible for implementing pesticide spill procedures. These officers must be familiar with these guidelines and should make contingency plans for such pesticide spills in advance of field operations.

Useful information for completing your spill plan is found in the appendices to these guidelines. Copies of the MSDS (obtainable from the manufacturer) for your program's pesticides should be included in your spill plan.

State Hazardous Waste Management Agencies

When a pesticide spill occurs, you should consult local hazardous waste officials, the pesticide's label, and its MSDS to determine specific cleanup and disposal techniques. The following is a list of State Hazardous Waste Management Agencies:

ALABAMA
Land Division
Alabama Department of Environmental Management
1751 Congressman W. L. Dickinson Drive
Montgomery, Alabama 36130
(205) 271-7730

ALASKA
Division of Environmental Quality
Alaska Department of Environmental Conservation
P.O. Box 0
Juneau, Alaska 99811-1800
Program Manager: (907) 465-2666
Northern Regional Office (Fairbanks): (907) 452-1714
South-Central Regional Office (Anchorage): (907) 563-6529
Southeast Regional Office (Juneau): (907) 789-3151

AMERICAN SAMOA
Solid Waste Division
Environmental Quality Commission
Government of American Samoa
Pago Pago, American Samoa 96799
Overseas Operator (Commercial call (684) 663-2304)

ARIZONA
Office of Waste and Water Quality Management
Arizona Department of Environmental Quality
2005 North Central Avenue, Room 304
Phoenix, Arizona 85004
Hazardous Waste Management: (602) 257-6829

ARKANSAS
Hazardous Waste Division
Arkansas Department of Pollution Control and Ecology
8001 National Drive, P.O. Box 8913
Little Rock, Arkansas 72219
(501) 570-2858

CALIFORNIA
Toxic Substances Control Division
Department of Health Services
400 P Street, P.O. Box 806
Sacramento, California 95812-0806
(916) 324-1826

COLORADO
Waste Management Division
Colorado Department of Health
4210 East 11th Avenue
Denver, Colorado 80220
(303) 331-4830
Emergency Response: (303) 377-6326

CONNECTICUT
Hazardous Material Management Unit
Department of Environmental Protection
State Office Building
165 Capitol Avenue
Hartford, Connecticut 06106
(203) 566-5148

DELAWARE
Division of Air and Waste Management
Department of Natural Resources and Environmental Control
P.O. Box 1401, 89 Kings Highway
Dover, Delaware 19903
(302) 739-3672

DISTRICT OF COLUMBIA
Pesticides and Hazardous Waste Management Branch
Department of Consumer and Regulatory Affairs
Room 505
614 H Street, NW
Washington, D.C. 20001
(202) 404-1167

FLORIDA
Solid and Hazardous Waste Section
Department of Environmental Regulation
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400
(904) 488-0190

GEORGIA
Land Protection Branch
Industrial and Hazardous Waste Management Program
Georgia Environmental Protection Division
Floyd Towers East, Suite 1154
205 Butler Street, S.E.
Atlanta, Georgia 30334
(404) 656-2833

GUAM
Hazardous Waste Management Program
Guam Environmental Protection Agency
P.O. Box 2999
Agana, Guam 96910
Overseas Operator [Commercial Call (671) 646-8863]

HAWAII
Environmental Management Division
Department of Health
Five Waterfront Plaza
500 Ala Moana Boulevard, Suite 250
Honolulu, Hawaii 96813
(808) 543-8225

IDAHO
Hazardous Materials Bureau
Department of Health and Welfare
1410 North Hilton Street
Boise, Idaho 83706
(208) 334-5879

ILLINOIS
Division of Land Pollution Control
Illinois Environmental Protection Agency
2200 Churchill Road,
P. O. Box 19276
Springfield, Illinois 62794-9276
(217) 782-6760

INDIANA
Office of Solid and Hazardous Waste
Indiana Department of Environmental Management
105 South Meridian, P. O. Box 6015
Indianapolis, Indiana 46204
(317) 232-7959

IOWA
Air Quality and Solid Waste Protection
Department of Water, Air, and Waste Management
Henry A. Wallace Bldg.
900 East Grand Ave.
Des Moines, Iowa 50319-0034
(515) 281-8852
(contact EPA Region VII, below, for Iowa generator ID#)
—or—
U.S. EPA Region VII
Hazardous Materials Branch
726 Minnesota Avenue
Kansas City, Kansas 66101
(913) 236-2888
Spills: (913) 236-3778
Iowa RCRA Questions, Toll Free: (800) 223-0425

KANSAS
Hazardous Waste Section
Department of Health and Environment
Forbes Field, Building 740
Topeka, Kansas 66620
(913) 862-1607

KENTUCKY
Division of Waste Management
Department of Environmental Protection
Frankfort Office Park
18 Reilly Road
Frankfort, Kentucky 40601
(502) 564-6716

LOUISIANA
Hazardous Waste Division
Office of Solid Waste and Hazardous Waste
Louisiana Department of Environmental Quality
P.O. Box 44307
Baton Rouge, Louisiana 70804-4307
(504) 342-1354

MAINE
Bureau of Oil and Hazardous Materials Control
Department of Environmental Protection
State House Station #17
Augusta, Maine 04333
(207) 289-2651
Spills, Toll Free: (800) 482-0777

MARYLAND
Hazardous and Solid Waste Management Administration
Maryland Department of the Environment
2500 Broening Highway
Baltimore, Maryland 21224
(301) 631-3343
Emergency:
(301) 225-5700 [Business Hours]
(301) 243-8700 [After Hours]

MASSACHUSETTS
Division of Hazardous Waste
Department of Environmental Protection
One Winter Street, 5th Floor
Boston, Massachusetts 02108
(617) 292-5589,-5851
Emergency Response:
(617) 292-5649 [Business Hours]
(617) 566-4500 [After Hours]

MICHIGAN
Waste Management Division
Hazardous Waste Program
Michigan Department of Natural Resources
Box 30038
Lansing, Michigan 48909
(517) 373-2730
Emergency Response: (800) 292-4706

MINNESOTA
Ground Water and Solid Waste Division
Minnesota Pollution Control Agency
520 Lafayette Road, North
St. Paul, Minnesota 55155-3898
(612) 296-7282
Emergency Response: (612) 296-8100

MISSISSIPPI
Hazardous Waste Division
Bureau of Pollution Control
Department of Natural Resources
P.O. Box 10385
Jackson, Mississippi 39289
(601) 961-5062
Emergency Response: (800) 222-6362

MISSOURI
Waste Management Program
Missouri Department of Natural Resources
205 Jefferson Street
Jefferson City, Missouri 65102
(314) 751-3176
Missouri Hotline: 1 (800) 334-6946

MONTANA
Solid and Hazardous Waste Bureau
Department of Health and Environmental Sciences
Cogswell Building, Room B-201
Helena, Montana 59620
(406) 444-2821
Emergency Response: (406) 444-6911

NEBRASKA
Hazardous Waste Section
Department of Environmental Control
P.O. Box 98922
Lincoln, Nebraska 68509
(402) 471-2186

NEVADA
Bureau of Waste Management
Division of Environmental Protection
123 West Nye Lane
Room 120
Carson City, Nevada 89710
(702) 687-5872
Emergency Response:
(702) 687-4240 [Business Hours]
(702) 885-5300 [Weekends]

NEW HAMPSHIRE
Waste Management Division
Department of Environmental Services
6 Hazen Drive
Concord, New Hampshire 03301-6509
(603) 271-2942

NEW JERSEY
Hazardous Waste Management Programs
Department of Environmental Protection
CN-028
Trenton, New Jersey 08625
Hazardous Waste Advisement Program: (609) 292-8341
Emergency Response: (609) 292-7172

NEW MEXICO
Ground Water and Hazardous Waste Bureau
Environmental Improvement Division
New Mexico Health and Environment Dept.
1190 St. Francis Drive
Santa Fe, New Mexico 87503
(505) 827-2714
Emergency: (505) 827-9329

NEW YORK
Division of Hazardous Substance Regulation
Department of Environmental Conservation
50 Wolfe Road, Room 209
Albany, New York 12233-7250

NORTH CAROLINA
Hazardous Waste Section
Division of Solid Waste Management
Department of Environment, Health, and Natural Resources
P.O. Box 27687
Raleigh, North Carolina 27611-7687
(919) 733-2178
Emergency Response: 1 (800) 662-7956

NORTH DAKOTA
Division of Waste Management
Department of Health
1200 Missouri Avenue
P. O. Box 5520
Bismarck, North Dakota 58502-5520
(701) 221-5166
Emergency Response: 1 (800) 472-2121

NORTHERN MARIANA ISLANDS, COMMONWEALTH OF
Division of Environmental Quality
Department of Public Health and Environmental Services
Commonwealth of the Northern Mariana Islands
Office of the Governor
Saipan, Mariana Islands 96950
Overseas Operator 6984

OHIO
Division of Solid and Hazardous Waste Management
Ohio Environmental Protection Agency
1800 Watermark Drive/P.O. Box 1049
Columbus, Ohio 43266
(614) 644-2934
Emergency: 1 (800) 282-9378

OKLAHOMA
Waste Management Service
Oklahoma State Department of Health
P.O. Box 53551
Oklahoma City, Oklahoma 73152
(405) 271-5338
Emergency Response: (405) 271-8056

OREGON
Hazardous and Solid Waste Division
Department of Environmental Quality
811 S.W. 6th Avenue
Portland, Oregon 97204
(503) 229-5356
Emergency Management Response, Toll Free: (800) 452-0311

PENNSYLVANIA
Bureau of Waste Management
Pennsylvania Department of Environmental Resources
P.O. Box 2063
Harrisburg, Pennsylvania 17105-2063
(717) 787-9870

PUERTO RICO
Environmental Quality Board
P.O. Box 11488
Santurce, Puerto Rico 00910-1488
(809) 725-0439
—or—
EPA Region II
Air and Waste Management Division
26 Federal Plaza
New York, New York 10278
(212) 264-5175

RHODE ISLAND
Division of Air and Hazardous Management
Department of Environmental Management
291 Promenade Street
Providence, Rhode Island 02908
(401) 277-2797

SOUTH CAROLINA
Bureau of Solid and Hazardous Waste Management
Department of Health and Environmental Control
2600 Bull Street
Columbia, South Carolina 29201
(803) 734-5200
Emergency Response: (803) 253-6488

SOUTH DAKOTA
Division of Environmental Regulation
Department of Water and Natural Resources
523 East Capitol
Foss Building
Pierre, South Dakota 57501
(605) 773-3153
Emergency Response: (605) 773-3231

TENNESSEE
Division of Solid Waste Management
Tennessee Department of Health and Environment
701 Broadway
Customs House, 4th Floor
Nashville, Tennessee 37247-3530
(615) 741-3424
Emergency Response: (800) 262-3300

TEXAS
Hazardous and Solid Waste Division
Texas Natural Resources Conservation Commission
P.O. Box 13087, Capitol Station
Austin, Texas 78711
(512) 463-7760
Emergency Response: (512) 463-7727

UTAH
Bureau of Solid and Hazardous Waste
Department of Health
P.O. Box 16690
Salt Lake City, Utah 84116-0690
(801) 538-6170
Emergency: (801) 538-6333 [After Hours]

VERMONT
Hazardous Materials Management Division
Department of Environmental Conservation
103 South Main Street
Waterbury, Vermont 05676
(802) 244-8702
Emergency: (800) 424-8802

VIRGIN ISLANDS
Department of Conservation and Cultural Affairs
P.O. Box 4399, Charlotte Amalie
St. Thomas, Virgin Islands 00801
(809) 774-6420
—or—
EPA Region II
Air and Waste Management Division
26 Federal Plaza
New York, New York 10278
(212) 264-5175

VIRGINIA
Division of Technical Services
Virginia Department of Waste Management
Monroe Building, 11th Floor
101 North 14th Street
Richmond, Virginia 23219
(804) 225-2667
Hazardous Waste Hotline:
1 (800) 552-2075

WASHINGTON
Waste Management Programs
Department of Ecology
Mail Stop PV-11
Olympia, Washington 98504-8711
(206) 459-6316
Hazardous Substance Hotline,
In State: 1 (800) 633-7585
24 Hour Spill Hotline,
In State: 1 (800) 262-5990

WISCONSIN
Bureau of Solid and Hazardous Waste Management
Department of Natural Resources
P.O. Box 7921
Madison, Wisconsin 53707
(608) 266-1327
Hazardous Substances Hotline:
(608) 266-3232

WEST VIRGINIA
Waste Management Section
Division of Natural Resources
Department of Commerce, Labor, and Environmental Resources
1356 Hansford Street
Charleston, West Virginia 25301
(304) 348-5393
24 Hour Spill Hotline: (800) 642-3074

WYOMING
Division of Solid Waste
State of Wyoming Department of Environmental Quality
122 West 25th Street
Cheyenne, Wyoming 82002
(307) 777-7752
Emergency: (307) 777-7781

Accident or Spill Emergency Kit

The Port Director, COR, or their designee should have available a fully supplied pesticide emergency spill cleanup/decontamination kit with instructions for its use. The kit will have the label designation “For Use in Handling and Cleanup of Accident Pesticide Spills Only.”

Responsible officials should use their discretion as to what items will be stored in vehicles for immediate use. The following items should be immediately available for responding to a pesticide spill:

Safety

- First aid kit—bus and truck kit, (GSA #6545-00-664-5312, or equivalent)
- Fire extinguisher, 5-lb. size for class A, B, C fires

Cleanup

- One shovel, square-point, “D” handle (GSA 5120-00-224-9326, or equivalent)
- Twenty-five large, heavy-duty plastic bags with ties (GSA 8105-00-848-9631, or equivalent)
- Two pair, unlined vinyl rubber boots
- Four pair, disposable coveralls
- One 5-gallon water container
- Four pair, unlined vinyl rubber gloves

- Two approved respirators with approved pesticide canisters (Self-contained breathing apparatus must also be available in operations where methyl bromide is utilized.)
- One broom and dust pan
- One pint bottle of liquid detergent
- Two scrub brushes (GSA 7920-00-068-7903 or equivalent)
- One plastic cover or tarpaulin (to cover dry spills) (GSA 8135-00-529-6487, or equivalent)
- Twenty-five pound bag, absorbent material (GSA 7930-00-269-1272), or sweeping compound, sawdust, “kitty litter”, or other absorbent materials
- One large metal or heavy duty plastic garbage can with removable cover for storing contaminated materials for later disposal

Important

Use this can to store the spill kit materials during transport.

- Several sand snakes should be kept in storage areas

Obtain many of these items through the GSA Federal Supply System or from a local hardware store. NMRAL will assist in obtaining items not readily available.

7

Treatment Manual

Emergency Aid and Safety

Hazard Communication and Material Safety Data Sheets

Contents

Overview

Material safety data sheets (MSDS) provide information about hazardous chemicals that are used in the workplace. This information is necessary to safely handle hazardous chemicals.

OSHA Requirements

The Occupational Safety and Health Administration (OSHA) requires that the hazards of all chemicals produced or imported be evaluated, and information concerning chemical hazards is communicated to employers and employees by means of a comprehensive hazard communication program. A hazard communication program should include, but not be limited to, the following:

- Developing and maintaining a written hazard communication program for the workplace, including lists of hazardous chemicals present at the workplace.
- Labeling of containers of chemicals in the workplace, as well as containers of chemicals being shipped to other workplaces.
- Preparation and distribution of MSDS to employees and downstream employers.
- Development and implementation of employee training programs regarding hazards of chemicals and protective measures.

Employers who do not produce or import chemicals need only focus on those parts of 29CFR 1910.1200 that deal with establishing a workplace program and communicating information to their workers.

Appendix E of 29CFR 1910.1200 is a general guide for such employers to help them determine the compliance obligations under this rule, and includes the following topics:

- Becoming Familiar With the Rule
- Identify Responsible Staff
- Identify Hazardous Chemicals in the Workplace
- Preparing and Implementing a Hazard Communication Program
    - Labels and Other Forms of Warning
    - Material Safety Data Sheets (MSDS's)
    - Employee Information and Training
    - Other Requirements
- Checklist for Compliance
- Further Assistance

A copy of **Appendix E** is included in **Figure 7-4-1**—**Guidelines for Employer Compliance**.

The Hazard Communication Standard (HCS) is based on a simple concept—that employees have both a need and a right to know the hazards and identities of the chemicals they are exposed to when working. They also need to know what protective measures are available to prevent adverse effects from occurring. The HCS is designed to provide employees with the information they need.

Knowledge acquired under the HCS will help employers provide safer workplaces for their employees. When employers have information about the chemicals being used, they can take steps to reduce exposures, substitute less hazardous materials, and establish proper work practices. These efforts will help prevent the occurrence of work-related illnesses and injuries caused by chemicals.

The HCS addresses the issues of evaluating and communicating hazards to workers. Evaluation of chemical hazards involves a number of technical concepts, and is a process that requires the professional judgment of experienced experts. That's why the HCS is designed so that employers who simply use chemicals, rather than produce or import them, are not required to evaluate the hazards of those chemicals. Hazard determination is the responsibility of the producers and importers of the materials. Producers and importers of chemicals are then required to provide the hazard information to employers that purchase their products.

Employers that don't produce or import chemicals need only focus on those parts of the rule that deal with establishing a workplace program and communicating information to their workers. This appendix is a general guide for such employers to help them determine what's required under the rule. It does not supplant or substitute for the regulatory provisions, but rather provides a simplified outline of the steps an average employer would follow to meet those requirements.

1. Becoming Familiar With the Rule

OSHA has provided a simple summary of the HCS in a pamphlet entitled "Chemical Hazard Communication." OSHA Publication Number 3084. Some employers prefer to begin to become familiar with the rule's requirements by reading this pamphlet. A copy may be obtained from your local OSHA Area Office, or by contacting the OSHA Publications Office at (202) 523-9667.

FIGURE 7-4-1: Appendix E—Guidelines for Employer Compliance

The standard is long, and some parts of it are technical, but the basic concepts are simple. In fact, the requirements reflect what many employers have been doing for years. You may find that you are already largely in compliance with many of the provisions, and will simply have to modify your existing programs somewhat. If you are operating in an OSHA-approved State Plan State, you must comply with the State's requirements, which may be different than those of the Federal rule. Many of the State Plan States had hazard communication or "right-to-know" laws prior to promulgation of the Federal rule. Employers in State Plan States should contact their State OSHA offices for more information regarding applicable requirements.

The HCS requires information to be prepared and transmitted regarding all hazardous chemicals. The HCS covers both physical hazards (such as flammability), and health hazards (such as irritation, lung damage, and cancer). Most chemicals used in the workplace have some hazard potential, and thus will be covered by the rule.

One difference between this rule and many others adopted by OSHA is that this one is performance-oriented. That means that you have the flexibility to adapt the rule to the needs of your workplace, rather than having to follow specific, rigid requirements. It also means that you have to exercise more judgment to implement an appropriate and effective program.

The standard's design is simple. Chemical manufacturers and importers must evaluate the hazards of the chemicals they produce or import. Using that information, they must then prepare labels for containers, and more detailed technical bulletins called material safety data sheets (MSDS).

Chemical manufacturers, importers, and distributors of hazardous chemicals are all required to provide the appropriate labels and material safety data sheets to the employers to which they ship the chemicals. The information is to be provided automatically. Every container of hazardous chemicals you receive must be labeled, tagged, or marked with the required information. Your suppliers must also send you a properly completed material safety data sheet (MSDS) at the time of the first shipment of the chemical, and with the next shipment after the MSDS is updated with new and significant information about the hazards.

You can rely on the information received from your suppliers. You have no independent duty to analyze the chemical or evaluate the hazards of it.

Employers that "use" hazardous chemicals must have a program to ensure the information is provided to exposed employees. "Use" means to package, handle, react, or transfer. This is an intentionally broad scope, and includes any situation where a chemical is present in such a way that employees may be exposed under normal conditions of use or in a foreseeable emergency.

The requirements of the rule that deal specifically with the hazard communication program are found in this section in paragraph (e), written hazard communication program; (f), labels and other forms of warning; (g) material safety data sheets; and (h) employee information and training. The requirements of these paragraphs should be the focus of your attention. Concentrate on becoming familiar with them, using paragraphs (b) scope and application, and (c) definitions, as references when needed to help explain the provisions.

There are two types of work operations where the coverage of the rule is limited. These are laboratories and operations where chemicals are only handled in sealed containers (e.g., a warehouse). The limited provisions for these workplaces can be found in paragraph (b) of this section, scope and application. Basically, employers having these types of work operations need only keep labels on containers as they are received; maintain material safety data sheets that are received, and give employees access to them; and provide information and training for employees. Employers do not have to have written hazard communication programs and lists of chemicals for these types of operations.

The limited coverage of laboratories and sealed container operations addresses the obligation of an employer to the workers in the operations involved, and does not affect the employer's duties as a distributor of chemicals. For example, a distributor may have warehouse operations where employees would be protected under the limited sealed container provisions. In this situation, requirements for obtaining and maintaining MSDSs are limited to providing access to those received with containers while the substance is in the workplace, and requesting MSDSs when employees request access for those not received with the containers. However, as a distributor of hazardous chemicals, that employer will still have responsibilities for providing MSDSs to downstream customers at the time of the first shipment and when the MSDS is updated. Therefore, although they may not be required for the employees in the work operation, the distributor may, nevertheless, have to have MSDSs to satisfy other requirements of the rule.

FIGURE 7-4-1: Appendix E—Guidelines for Employer Compliance (continued)

2. Identify Responsible Staff

Hazard communication is going to be a continuing program in your facility. Compliance with the HCS is not a “one shot deal.” In order to have a successful program, it will be necessary to assign responsibility for both the initial and ongoing activities that have to be undertaken to comply with the rule. In some cases, these activities may already be part of current job assignments. For example, site supervisors are frequently responsible for on-the-job training sessions. Early identification of the responsible employees, and involvement of them in the development of your plan of action, will result in a more effective program design. Evaluation of the effectiveness of your program will also be enhanced by involvement of affected employees.

For any safety and health program, success depends on commitment of every level of the organization. This is particularly true for hazard communication, where success requires a change in behavior. This will only occur if employers understand the program, and are committed to its success, and if employees are motivated by the people presenting the information to them.

3. Identify Hazardous Chemicals in the Workplace

The standard requires a list of hazardous chemicals in the workplace as part of the written hazard communication program. The list will eventually serve as an inventory of everything for which an MSDS must be maintained. At this point, however, preparing the list will help you complete the rest of the program since it will give you some idea of the scope of the program required for compliance in your facility.

The best way to prepare a comprehensive list is to survey the workplace. Purchasing records may also help, and certainly employers should establish procedures to ensure that in the future purchasing procedures result in MSDSs being received before a material is used in the workplace.

The broadest possible perspective should be taken when doing the survey. Sometimes people think of “chemicals” as being only liquids in containers. The HCS covers chemicals in all physical forms—liquids, solids, gases, vapors, fumes, and mists—whether they are “contained” or not. The hazardous nature of the chemical and the potential for exposure are the factors which determine whether a chemical is covered. If it’s not hazardous, it’s not covered. If there is no potential for exposure (e.g., the chemical is inextricably bound and cannot be released), the rule does not cover the chemical.

Look around. Identify chemicals in containers, including pipes, but also think about chemicals generated in the work operations. For example, welding fumes, dusts, and exhaust fumes are all sources of chemical exposures. Read labels provided by suppliers for hazard information. Make a list of all chemicals in the workplace that are potentially hazardous. For your own information and planning, you may also want to note on the list the location(s) of the products within the workplace, and an indication of the hazards as found on the label. This will help you as you prepare the rest of your program.

Paragraph (b) of this section, scope and application, includes exemptions for various chemicals or workplace situations. After compiling the complete list of chemicals, you should review paragraph (b) of this section to determine if any of the items can be eliminated from the list because they are exempted materials. For example, food, drugs, and cosmetics brought into the workplace for employee consumption are exempt. So rubbing alcohol in the first aid kit would not be covered.

Once you have compiled as complete a list as possible of the potentially hazardous chemicals in the workplace, the next step is to determine if you have received material safety data sheets for all of them. Check your files against the inventory you have just compiled. If any are missing, contact your supplier and request one. It is a good idea to document these requests, either by copy of a letter or a note regarding telephone conversations. If you have MSDSs for chemicals that are not on your list, figure out why. Maybe you don’t use the chemical anymore. Or maybe you missed it in your survey. Some suppliers do provide MSDSs for products that are not hazardous. These do not have to be maintained by you.

You should not allow employees to use any chemicals for which you have not received an MSDS. The MSDS provides information you need to ensure proper protective measures are implemented prior to exposure.

FIGURE 7-4-1: Appendix E—Guidelines for Employer Compliance (continued)

4. Preparing and Implementing a Hazard Communication Program

All workplaces where employees are exposed to hazardous chemicals must have a written plan which describes how the standard will be implemented in the facility. Preparation of a plan is not just a paper exercise—all of the elements must be implemented in the workplace in order to be in compliance with the rule. See paragraph (e) of this section for the specific requirements regarding written hazard communication programs. The only work operations which do not have to comply with the written plan requirements are laboratories and work operations where employees only handle chemicals in sealed containers. See paragraph (b) of this section, scope and application, for the specific requirements for these two types of workplaces.

The plan does not have to be lengthy or complicated. It is intended to be a blueprint for implementation of your program—an assurance that all aspects of the requirements have been addressed.

Many trade associations and other professional groups have provided sample programs and other assistance materials to affected employers. These have been very helpful to many employers since they tend to be tailored to the particular industry involved. You may wish to investigate whether your industry trade groups have developed such materials.

Although such general guidance may be helpful, you must remember that the written program has to reflect what you are doing in your workplace. Therefore, if you use a generic program it must be adapted to address the facility it covers. For example, the written plan must list the chemicals present at the site, indicate who is to be responsible for the various aspects of the program in your facility, and indicate where written materials will be made available to employees.

If OSHA inspects your workplace for compliance with the HCS, the OSHA compliance officer will ask to see your written plan at the outset of the inspection. In general, the following items will be considered in evaluating your program.

The written program must describe how the requirements for labels and other forms of warning, material safety data sheets, and employee information and training, are going to be met in your facility. The following discussion provides the type of information compliance officers will be looking for to decide whether these elements of the hazard communication program have been properly addressed.

In-plant containers of hazardous chemicals must be labeled, tagged, or marked with the identity of the material and appropriate hazard warnings. Chemical manufacturers, importers, and distributors are required to assure that every container of hazardous chemicals they ship is appropriately labeled with such information and with the name and address of the producer or other responsible party. Employers purchasing chemicals can rely on the labels provided by their suppliers. If the material is subsequently transferred by the employer from a labeled container to another container, the employer will have to label that container unless it is subject to the portable container exemption. See paragraph (f) of this section for specific labeling requirements.

The primary information to be obtained from an OSHA-required label is an identity for the material, and appropriate hazard warnings. The identity is any term which appears on the label, the MSDS, and the list of chemicals, and thus links these three sources of information. The identity used by the supplier may be a common or trade name (“Black Magic Formula”), or a chemical name (1,1,1,—trichloroethane). The hazard warning is a brief statement of the hazardous effects of the chemical (“flammable,” “causes lung damage”). Labels frequently contain other information, such as precautionary measures (“do not use near open flame”), but this information is provided voluntarily and is not required by the rule. Labels must be legible, and prominently displayed. There are no specific requirements for size or color, or any specified text.

With these requirements in mind, the compliance officer will be looking for the following types of information to ensure that labeling will be properly implemented in your facility.

1. Designation of person(s) responsible for ensuring labeling of in-plant containers;
2. Designation of person(s) responsible for ensuring labeling of any shipped containers;
3. Description of labeling system(s) used;
4. Description of written alternatives to labeling of in-plant containers (is used); and
5. Procedures to review and update label information when necessary.

FIGURE 7-4-1: Appendix E—Guidelines for Employer Compliance (continued)

Employers that are purchasing and using hazardous chemicals—rather than producing or distributing them—will primarily be concerned with ensuring that every purchased container is labeled. If materials are transferred into other containers, the employer must ensure that these are labeled as well, unless they fall under the portable container exemption (paragraph (f)(7) of this section). In terms of labeling systems, you can simply choose to use the labels provided by your suppliers on the containers. These will generally be verbal text labels, and do not usually include numerical rating systems or symbols that require special training. The most important thing to remember is that this is a continuing duty—all in-plant containers of hazardous chemicals must always be labeled. Therefore, it is important to designate someone to be responsible for ensuring that the labels are maintained as required on the containers in your facility, and that newly purchased materials are checked for labels prior to use.

Chemical manufacturers and importers are required to obtain or develop a material safety data sheet for each hazardous chemical they produce or import. Distributors are responsible for ensuring that their customers are provided a copy of these MSDSs. Employers must have an MSDS for each hazardous chemical which they use. Employers may rely on the information received from their suppliers. The specific requirements for material safety data sheets are in paragraph (g) of this section.

There is no specified format for the MSDS under the rule, although there are specific information requirements. OSHA has developed a non-mandatory format, OSHA Form 174, which may be used by chemical manufacturers and importers to comply with the rule. The MSDS must be in English. You are entitled to receive from your supplier a data sheet which includes all of the information required under the rule. If you do not receive one automatically, you should request one. If you receive one that is obviously inadequate, with, for example, blank spaces that are not completed, you should request an appropriately completed one. If your request for a data sheet or for a corrected data sheet does not produce the information needed, you should contact your local OSHA Area Office for assistance in obtaining the MSDS.

The role of MSDSs under the rule is to provide detailed information on each hazardous chemical, including its potential hazardous effects, its physical and chemical characteristics, and recommendations for appropriate protective measures. This information should be useful to you as the employer responsible for designing protective programs, as well as to the workers. If you are not familiar with material safety data sheets and with chemical terminology, you may need to learn to use them yourself. A glossary of MSDS terms may be helpful in this regard. Generally speaking, most employers using hazardous chemicals will primarily be concerned with MSDS information regarding hazardous effects and recommended protective measures. Focus on the sections of the MSDS that are applicable to your situation.

MSDSs must be readily accessible to employees when they are in their work areas during their workshifts. This may be accomplished in many different ways. You must decide what is appropriate for your particular workplace. Some employers keep the MSDSs in a binder in a central location (e.g., in the pick-up truck on a construction site). Others, particularly in workplaces with large numbers of chemicals, computerize the information and provide access through terminals. As long as employees can get the information when they need it, any approach may be used. The employees must have access to the MSDSs themselves—simply having a system where the information can be read to them over the phone is only permitted under the mobile worksite provision, paragraph (g)(9) of this section, when employees must travel between workplaces during the shift. In this situation, they have access to the MSDSs prior to leaving the primary worksite, and when they return, so the telephone system is simply an emergency arrangement.

In order to ensure that you have a current MSDS for each chemical in the plant as required, and that employee access is provided, the compliance officers will be looking for the following types of information in your written program:

1. Designation of person(s) responsible for obtaining and maintaining the MSDSs;
2. How such sheets are to be maintained in the workplace (e.g., in notebooks in the work area(s) or in a computer with terminal access), and how employees can obtain access to them when they are in their work area during the work shift;
3. Procedures to follow when the MSDS is not received at the time of the first shipment;
4. For producers, procedures to update the MSDS when new and significant health information is found; and
5. Description of alternatives to actual data sheets in the workplace, if used.

For employers using hazardous chemicals, the most important aspect of the written program in terms of MSDSs is to ensure that someone is responsible for obtaining and maintaining the MSDSs for every hazardous chemical in the workplace. The list of hazardous chemicals required to be maintained as part of the written program will serve as an inventory. As new chemicals are purchased, the list should be updated. Many companies have found it convenient to include on their purchase orders the name and address of the person designated in their company to receive MSDSs.

FIGURE 7-4-1: Appendix E—Guidelines for Employer Compliance (continued)

Each employee who may be “exposed” to hazardous chemicals when working must be provided information and trained prior to initial assignment to work with a hazardous chemical, and whenever the hazard changes. “Exposure” or “exposed” under the rule means that “an employee is subjected to a hazardous chemical in the course of employment through any route of entry (inhalation, ingestion, skin contact or absorption, etc.) and includes potential (e.g., accidental or possible) exposure.” See paragraph (h) of this section for specific requirements. Information and training may be done either by individual chemical, or by categories of hazards (such as flammability or carcinogenicity). If there are only a few chemicals in the workplace, then you may want to discuss each one individually. Where there are large numbers of chemicals, or the chemicals change frequently, you will probably want to train generally based on the hazard categories (e.g., flammable liquids, corrosive materials, carcinogens). Employees will have access to the substance-specific information on the labels and MSDSs.

Information and training is a critical part of the hazard communication program. Information regarding hazards and protective measures are provided to workers through written labels and material safety data sheets. However, through effective information and training, workers will learn to read and understand such information, determine how it can be obtained and used in their own workplaces, and understand the risks of exposure to the chemicals in their workplaces as well as the ways to protect themselves. A properly conducted training program will ensure comprehension and understanding. It is not sufficient to either just read material to the workers, or simply hand them material to read. You want to create a climate where workers feel free to ask questions. This will help you to ensure that the information is understood. You must always remember that the underlying purpose of the HCS is to reduce the incidence of chemical source illnesses and injuries. This will be accomplished by modifying behavior through the provision of hazard information and information about protective measures. If your program works, you and your workers will better understand the chemical hazards within the workplace. The procedures you establish regarding, for example, purchasing, storage, and handling of these chemicals will improve, and thereby reduce the risks posed to employees exposed to the chemical hazards involved. Furthermore, your workers’ comprehension will also be increased, and proper work practices will be followed to your workplace.

If you are going to do the training yourself, you will have to understand the material and be prepared to motivate the workers to learn. This is not always an easy task, but the benefits are worth the effort. More information regarding appropriate training can be found in OSHA Publication No. 2254 which contains voluntary training guidelines prepared by OSHA’s Training Institute. A copy of this document is available from OSHA’s Publications Office at (202) 219-4667.

In reviewing your written program with regard to information and training, the following items need to be considered:

1. Designation of person(s) responsible for conducting training;
2. Format of the program to be used (audiovisuals, classroom instruction, etc.);
3. Elements of the training program (should be consistent with the elements in paragraph (h) of this section); and
4. Procedure to train new employees at the time of their initial assignment to work with a hazardous chemical, and to train employees when a new hazard is introduced into the workplace.

The written program should provide enough details about the employer’s plans in this area to assess whether or not a good faith effort is being made to train employees. OSHA does not expect that every worker will be able to recite all of the information about each chemical in the workplace. In general, the most important aspects of training under the HCS are to ensure that employees are aware that they are exposed to hazardous chemicals, that they know how to read and use labels and material safety data sheets, and that, as a consequence of learning this information, they are following the appropriate protective measures established by the employer. OSHA compliance officers will be talking to employees to determine if they have received training. If they know they are exposed to hazardous chemicals, and if they know where to obtain substance-specific information on labels and MSDSs.

The rule does not require employers to maintain records of employee training, but many employers choose to do so. This may help employers choose to do so. This may help you monitor your own program to ensure that all employees are appropriately trained. If you already have a training program, you may simply have to supplement it with whatever additional information is required under the HCS. For example, construction employers that are already in compliance with the construction training standard (29CFR 1926.21) will have little extra training to do.

FIGURE 7-4-1: Appendix E—Guidelines for Employer Compliance (continued)

An employer can provide employees information and training through whatever means are found appropriate and protective. Although there would always have to be some training on-site (such as informing employees of the location and availability of the written program and MSDSs), employee training may be satisfied in part by general training about the requirements of the HCS and about chemical hazards on the job which is provided by, for example, trade associations, unions, colleges, and professional schools. In addition, previous training, education and experience of a worker may relieve the employer of some of the burdens of informing and training that worker. Regardless of the method relied upon, however, the employer is always ultimately responsible for ensuring that employees are adequately trained. If the compliance officer finds that the training is deficient, the employer will be cited for the deficiency regardless of who actually provided the training on behalf of the employer.

In addition to these specific items, compliance officers will also be asking the following questions in assessing the adequacy of the program:

Does a list of the hazardous chemicals exist in each work area or at a central location?

Are methods the employer will use to inform employees of the hazards of non-routine tasks outlined?

Are employees informed of the hazards associated with chemicals contained in unlabeled pipes in their work areas?

On multi-employer worksites, has the employer provided other employers with information about labeling systems and precautionary measures where the other employers have employees exposed to the initial employer’s chemicals?

Is the written program made available to employees and their designated representatives?

If your program adequately addresses the means of communicating information to employees in your workplace, and provides answers to the basic questions outlined above, it will be found to be in compliance with the rule.

5. Checklist for Compliance

The following checklist will help to ensure you are in compliance with the rule:

- Obtained a copy of the rule.
- Read and understood the requirements.
- Assigned responsibility for tasks.
- Prepared an inventory of chemicals.
- Ensured containers are labeled.
- Obtained MSDS for each chemical.
- Prepared written program.
- Made MSDSs available to workers.
- Conducted training of workers.
- Established procedures to maintain current program.
- Established procedures to evaluate effectiveness.

6. Further Assistance

If you have a question regarding compliance with the HCS, you should contact your local OSHA Area Office for assistance. In addition, each OSHA Regional Office has a Hazard Communication Coordinator who can answer your questions. Free consultation services are also available to assist employers, and information regarding these services can be obtained through the Area and Regional offices as well.

The telephone number for the OSHA office closest to you should be listed in your local telephone directory. If you are not able to obtain this information, you may contact OSHA’s Office of Information and Consumer Affairs at (202) 219-8151 for further assistance in identifying the appropriate contacts.

[59 FR 6170, Feb. 9, 1994, as amended at 59 FR 17479, Apr. 13, 1994; 59 FR 65948, Dec. 22, 1994; 61 FR 9245, Mar. 7, 1996]

FIGURE 7-4-1: Appendix E—Guidelines for Employer Compliance (continued)

Guidelines on Opening Containers Containing Commodities Under Controlled Atmosphere (CA) Storage

Controlled atmosphere (CA) is being used more and more commonly to preserve the quality of fresh produce during and shipment, especially during long voyages. It also has the advantage of reducing the number of many of the pests that may be present. In most cases, however, insufficient research has been done on enough pest species for APHIS to accept CA as a stand-alone quarantine treatment, although this could change in the future.

Opening and inspecting a container known or suspected to be under CA poses a safety risk to the inspector, and to others in the immediate vicinity. A placard is usually posted on the doors of the container prior to shipment, stating that the fresh produce is being shipped under CA. Also, a monitoring device, indicating the kinds and levels of gases in the mixture, should be present. If the monitor is not functioning properly, it is possible to use gas detector tubes specific for oxygen and carbon dioxide. If the nitrogen or carbon dioxide levels are high, or the oxygen level is low, the inspector must not enter the container immediately, because of the high risk of asphyxiation. This risk is very insidious, because the potential victim usually does not recognize the danger signs.

WARNING

It should be noted that normal air contains 78% nitrogen, 21% oxygen, and 0.03 to 0.04% carbon dioxide (CO^2). Health risk to the inspector occurs when the oxygen level is too low, or the levels of nitrogen or CO^2 are too high.

Oxygen (O^2)

Gases within a CA space normally contain only 3% oxygen or less. The lowest oxygen level considered safe is 19.5%. A personal oxygen monitor (worn by the inspector) would set off an alarm at that level.

An oxygen level of 6% or less causes loss of consciousness within 45 seconds.Breathing is in gasps, followed by convulsive movements, then breathing stops. The heart may continue beating for a few minutes, then stops. If the person attempting to rescue is not equipped with a SCBA, there is a high probability that this person will also become a victim of asphyxiation.

Carbon dioxide (CO^2)

Gases within a CA space often contain high levels of CO2. Although this is a common compound, it can also be deadly--a fact often overlooked. Breathing pure CO2 will cause immediate death. Even at concentrations over 15%, death can be rapid. Above 10%, CO2 causes unconsciousness (coma). At 8%, CO2 causes headache, nausea, vomiting, and may lead to unconsciousness. Concentrations as low as

4 to 5% cause rapid, labored breathing, slight choking, and headache. The threshold limit value (TLV), the highest level at which a person can work without adverse effect, is 0.05% or 5 ppm.

If dangerous gas levels are determined to be present, then the container must be aerated prior to inspection, preferably by using the container's own recirculation system, set in "exhaust" mode. Aeration may also be done passively, or by the use of fans, or by means of a fan-assisted aeration duct.

WARNING

Do not attempt to aerate while the container is parked at a loading dock, because the gases may asphyxiate workers in the area. Have the container moved to an open area. While opening doors and placing fans or a fan-assisted exhaust duct, wear SCBA for personal protection.

Aerate for at least one hour, then recheck gas levels. Proceed with cargo inspection only when safe levels have been reached. The safe waiting time (to achieve at least 19.5% oxygen in the accessible portion of the container) depends upon several factors:

- The type of produce and how it is packed
- The extent of holes in the boxes
- Packing density of the boxes
- Pallet spacing, and return-flow ribs in the floor of the container
- Amount of head-space above the load
- Whether the recirculation blower is on or off
- Percentage of oxygen in the controlled atmosphere

At ports receiving CA containers, periodic training/awareness sessions are needed, and policies clearly spelled out.

Acronyms and Abbreviations Used in This Section

a.i.	active ingredient
ACGIH	American Conference of Governmental Industrial Hygienists
ADI	Acceptable Daily Intake
APHIS	Animal and Plant Health Inspection Service
BBEP	Biotechnology, Biologics, and Environmental Protection
bw	body weight
CAS	Chemical Abstracts Service
cc	cubic centimeters
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
ChE	cholinesterase
CHEMTREC	24-hour emergency telephone service for spills

CNS	central nervous system
COR	Contracting Officer's Representative
CPK	creatine phosphokinase
cu.m	cubic meter
CWA	Clean Water Act
DHEW	U.S. Department of Health, Education, and Welfare
DNA	deoxyribonucleic acid
DOT	U.S. Department of Transportation
DW	drinking water
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
g	grams
GI	gastrointestinal
HDT	highest dose tested
Hgb	hemoglobin
HHS	U.S. Department of Health and Human Services
i.m.	intramuscular
i.p.	intraperitoneal
i.v.	intravenous
kg	kilogram
L	liter
LC50	Lethal Concentration 50; dose lethal to 50% of the animals
LCLO	Lethal Concentration Low; the lowest concentration causing death
LD50	Lethal Dose 50; dose lethal to 50% of the animals
LDLO	Lethal Dose Low; the lowest dose at which death occurred
LDT	lowest dose tested
LEL	lower exposure limit, or lowest-effect level
LOAEL	lowest-observed-adverse-effect-level
m	meter
MED	minimum effective dose
mg	milligram
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mmHg	millimeters of mercury; a measure of pressure
MOE	Margin of Exposure
MOS	Margin of Safety
MSDS	Material Safety Data Sheet
MTD	maximum tolerated dose
MTL	median threshold limit
NFPA	National Fire Prevention Association
ng	nanogram

NIOSH	National Institute for Occupational Safety and Health
NMRAL	National Monitoring and Residue Analysis Laboratory
NOAEL	no-observed-adverse-effect level
NOEL	no-observed-effect level
NTP	National Toxicology Program
OIC	Officer-in-Charge
OSHA	U.S. Occupational Safety and Health Administration
PEL	permissible exposure limit
PHS	U.S. Public Health Service
p.o.	per os (by mouth)
ppb	parts per billion
ppm	parts per million
PPQ	Plant Protection and Quarantine
RBC	red blood cell(s)
RfD	Reference Dose
RfDi	Inhalation Reference Dose
RfDo	Oral Reference Dose
s.c.	subcutaneous
STEL	short-term exposure limit
TLV	threshold limit value
TSS	Technical and Scientific Services
TWA	time-weighted average
UCL	upper confidence limit
UEL	upper exposure limit
UF	uncertainty factor
ug	microgram
ug/cu.	micrograms per cubic meter
ug/L	micrograms per liter
USDA	United States Department of Agriculture

8 Equipment

Treatment Manual

Contents

Thermal Conductivity Gas Analyzers

Fumiscope and Gow-Mac

The thermal conductivity gas analyzer (T/C units) is a scientific instrument specifically designed for determining the concentration of gases within a chamber or other enclosure while the actual fumigation is being conducted. These fumigation gases include methyl bromide, ethylene oxide-carbon dioxide mixtures, and sulfuryl fluoride. The following discussions relating to the T/C unit are under these subheadings:

- Description
- Standardizing the instrument
- Operational procedures
- Repair and calibration
- Maintenance

Description

The Fumiscope® or Gow-Mac® is light in weight, portable, completely contained in a compact metal cabinet. It contains a thermal conductivity cell, scale, gas pump, range switch, and gas flow meter. A gas drying tube is also included. For large enclosures, an auxiliary pump may be needed.

Inlet

This tube connector is the gas inlet for the instrument. The sampling tubes are connected directly to the inlet or through the drying tube.

Flow Rate Meter

Indicates the gas flow rate in "simulated cubic feet per hour (SCFH)." Note: The flow rate should always be read at the middle of the ball.

Flow Rate Adjustment

This dial controls the air or gas flow rate by adjusting the pump. After connecting to the gas sampling tube, the flow rate should be adjusted upward until it reads exactly 1.0. The gas concentration reading should be taken only after the meter that registers "ounces per thousand cubic feet" stabilizes, which may take a minute or more (depending upon the length of the tubing and whether or not an auxiliary pump is being used).

Scale

Indicates the concentration of the MB fumigant in ounces per 1,000 cubic feet (milligrams per liter or grams per cubic meter). For some fumigants, the concentration is calculated as the reading times a specific factor.

Zero Adjustment This dial controls the scale needle which is brought to zero as an air sample is being drawn through the instrument.

Line Switches Control electrical supply to pump and scale.

Range Switch Regulates the scale indicating the concentrations of fumigant measured, for example, 0-100 ounces per 1,000 cubic foot or as 0-400 ounces per 1,000 cubic foot (some models). Digital models can indicate a range from 0-999 ounces per 1,000 cubic feet.)

Exhaust Outlet Always connect a tube to exhaust outlet to carry exhaust gas away from the instrument and operator. When using the T/C unit in confined or poorly ventilated areas, recirculate the exhaust gas back to the fumigation space or exhaust it to the outside.

Drying Tube The drying tube (filter tube) is for use with a prepared chemical for removal of certain contaminant gases or vapors which interfere with correct readings of fumigant concentration. For most fumigations, the tube will contain a desiccant such as Drierite® (granules of anhydrous calcium sulfate), or Ascarite® (soda asbestos). Both are available from scientific supply houses. The tube is inserted in the gas sampling line just before the inlet connection. Drierite®, blue in color when dry, turns pink when moisture is absorbed. When most of the desiccant has turned pink, it should be replaced. In extremely high moisture conditions, two tubes can be connected in tandem. Drying tube openings should be closed when not in use.

When a drying tube is used, a thin layer of glass wool or aquarium filter wool should be placed at the bottom and top of the tube to prevent small particles from sifting into the Fumiscope®. The use of absorbent cotton or similar materials is not recommended. Cotton tends to pick up moisture and to become matted, and once matted, the cotton may restrict normal air flow, thus adversely affecting the T/C unit's operation. (Matting may also cause the flow of air to bypass, rather than flow through the Drierite®.)

Mount the drying tube *vertically* so that the gas mixture moves through the drying material and does not pass over the top. This happens when the tube is mounted horizontally (lengthwise).

Commodities that are actively respiring produce carbon dioxide gas that may interfere with the correct readings of fumigant concentration. During a fumigation, you may use tubes containing Ascarite® to remove carbon dioxide from gas samples. Used filtering material should be discarded. The Ascarite® tube should be connected between the Drierite® tube and the sample inlet. In no instance should Drierite® and Ascarite® be mixed in the same tube. Ascarite® should be replaced when the granules begin to aggregate or become moist.

It is always advisable to use Drierite® when taking concentration readings of SF, MB, or CB. Desiccant should be fresh and frequently changed to ensure correct readings. *Never* use Ascarite® when making readings of SF because a chemical reaction will occur. *Never* use Ascarite® when taking readings of CB because carbon dioxide gas is an integral part of the reading to be obtained.

Standardizing the Instrument

Standardizing the instrument is the first and basic operation. Do the following to standardize the instrument.

1. Connect the instrument to an electrical outlet with proper voltage and set the pump and meter switches to "on." If inoperable, check fuse. (Replacements—Little Fuse or Buss #3AG 1/2 Amp.—should be kept on hand.)
2. Attach the drying tube to the inlet port. The instrument should be given a tightness test. This can be accomplished by placing a finger over the inlet of the drying tube. The flow ball in the flow meter should then fall to zero if the tubing and connections are tight.
3. Warm up the instrument for 15 to 30 minutes.
4. Adjust the gas flow rate to 1 cubic foot per hour (CFH) by adjusting the flow rate knob. If the flow rate knob is turned counter clockwise too far, the pump will emit noises and cease to operate properly. When properly adjusted, the flow ball should float at the center mark or slightly below on the calibrated glass cylinder. Slight fluctuations from a stationary position may occur. Dry, fresh air is now being drawn through the T/C cell by means of the pump, the air entering via the inlet on the face of the instrument, passing through the cell, and leaving through the exhaust outlet.
5. Turn the zero adjustment knob to obtain a zero reading on the meter. Several additional adjustments during the first few minutes may be necessary to obtain a stable zero reading. A check of the meter needle should be made periodically to determine if there is any sticking of the needle. A check is done by slowly turning the adjustment knob clockwise. A clockwise turn will swing the needle from 0 to 100/200 on the meter scale. A counterclockwise twist will return the needle to zero.

Standardization is now complete and readings can be made of fumigant-air mixture drawn through the unit. It may be necessary to replace the desiccant at this point.

The difference in the thermal conductivity of the fumigant-air mixture as compared with fresh air is measured electrically and indicated on the meter as concentration readings in ounces of MB per 1,000 cubic feet. T/C units used in PPQ must be calibrated for MB by the manufacturer or an outside contractor prior to use. You will not get accurate readings when fumigations are under even a small vacuum.

The Gow-Mac® T/C units used by PPQ are equipped to measure MB concentrations up to 400 ounces per 1,000 cubic feet. Since the T/C unit's galvanometer responds linearly to gas concentrations, the MB calibrated instrument may be used for measuring certain other gases by the use of specific multiplication factors determined for each instrument.

Operational Procedures

The proper use of the Fumiscope® is discussed under two headings:

- Selecting Operational Site for the T/C Unit
- Measuring Gas Concentrations With the Standardized Unit

Because of the variety of fumigation situations, some adjustments may be necessary to meet specific needs. Nevertheless, this outline should be helpful in establishing correct operational procedures.

Selecting Operational Site for the T/C Unit

The T/C unit should be close enough to the fumigation site to avoid the use of unreasonable lengths of sampling tubes, to allow for constant surveillance of the fumigation during testing, and to avoid interference with other activities in the area. It should be at a sufficient distance from the fumigation site (at least 30 feet up-wind) to allow the operator to function without the fear of accidental exposure to gas and to allow for easy exit in an emergency. Excessive wiring length should be avoided. When T/C unit readings in multiple locations are necessary, care should be taken to see that each location is the best available.

The T/C unit should be supported on a sturdy, level surface, outside the traffic pattern and protected from wind, rain, excessive cold, and sun in hot weather. Temporary shelter such as a tarpaulin cover may be adequate in some cases. The gas concentration readings indicated by the T/C unit may be inaccurate unless the unit is placed in an area that is approximately the same temperature as the gas mixture in the enclosure being fumigated. Temperature differential may cause moisture to condense inside the gas sampling line.

Most T/C units operate on 110-120 volts alternating current (AC). T/C units operating on 210-220 volts AC on DC are available for overseas or other assignments as necessary. A converter is required to use direct current. To reduce the possibility of electric shock, T/C units repaired at the Center for Plant Health Science & Technology (CPHST) have been converted from the standard two-prong plug to a polarized plug. Extension wiring and gas sampling line length should be kept to a practical minimum and should be raised above floor level when feasible.

Measuring Gas Concentrations With the Standardized Unit

As a protection for the cell and the pump of T/C units, a drying tube should be used at all times.

In making gas concentration checks, the unit is first warmed up for 15 to 30 minutes depending on ambient temperatures. The pump is then turned on and the gas flow meter adjusted to a 1 cubic foot per hour flow. Should the scale needle seem unstable and wander for a short period of time, the flow rate may be reduced slightly below the 1 cubic foot per hour level for zeroing and maintained at that level for measuring. The unit is now ready to measure gas samples drawn through position tagged tubes from the area being treated. The needle will indicate gas concentrations in ounces per 1,000 cubic feet (grams per cubic meter).

Sufficient time to draw a true sample must be allowed. With 150 to 200 feet of 1/4 inch OD tubing and a temperature of 70°F, this will be approximately 7 minutes. Stations equipped with small, auxiliary pumps can draw a sample through the same length of tubing in 12 to 15 seconds.

Readings should be constant for at least 30 seconds before the line is disconnected. As each sampling tube is disconnected from the T/C set and the needle begins to recede toward zero, a new sampling tube may be attached. It is not necessary to wait for the needle to return to zero after each reading.

Re-zeroing the instrument is generally not needed during the course of a fumigation, except under the following circumstances:

- The pump has been turned off for an hour or more since the last reading. (Be sure to warm up the unit for 15-30 minutes before taking the next reading.) During fumigations of 6 hours or less, it is recommended that the unit be kept running constantly.
- Fresh Drierite® has been added to the gas drying tube.
- The weather during the fumigation has drastically changed since the last reading.

The gas concentration readings indicated by the T/C unit's meter will generally be more accurate if the temperature of the gas mixture within the fumigated enclosure is approximately equal to that of the ambient air outside the enclosure. If there are great differences between the two temperatures, water vapor may condense inside the gas sampling leads. Such condensation, if desiccant is saturated, can result in a lower than normal T/C meter reading, thus leading to the unnecessary addition of fumigant to compensate for the apparent shortage. Therefore, if vapor condensation appears inside the gas sampling leads, purge the line and move the T/C unit to a new location where the ambient temperature approximates that of the enclosure.

T/C gas analyzers are sensitive to a number of gases other than MB. For example CO_2 may be troublesome when fumigating fruit where kerosene heaters are placed under the tarpaulin to raise pulp temperatures, or with plant material packed in peat moss or subsoil. Correct MB gas concentration readings may be obtained if a CO_2 absorbent is used in the gas sampling line before the air-gas mixture enters the T/C unit. A CO_2 absorbent which may be used is Ascarite®. Inspectors using Ascarite® should observe the poison warning labels on the containers. Drying tubes containing the granules should be clearly labelled "**Warning—Avoid contact with skin, eyes, and clothing.**" An example where CO_2 is included in our minimum gas concentration readings is the EO-CO_2 (Carboxide) fumigations. Since the concentration readings obtained represent the sum of the individual readings for the EO and CO_2, Ascarite® must not be used in this instance.

After the final reading has been taken, the unit should be thoroughly purged by disconnecting from the sampling tube and allowing the pump to draw fresh air through the instrument for several minutes.

Repair and Calibration

The T/C unit will hold its calibration for a considerable length of time under normal service. To ensure that all units are providing accurate gas concentration readings, T/C units should be recalibrated at least annually; calibrate more often if use is frequent.

The instrument should be sent by Priority Mail or Air Parcel Post directly to the manufacturer or an ouside contractor. Prepare a memorandum to accompany each instrument explaining the need for sending the unit. Make sure all instruments are shipped with the a proper return address, name of a contact person, and telephone number. The T/C unit should be calibrated only for MB, unless the PPQ office requests calibration for CB, SF, or other specified fumigants: All port locations will be responsible for payments to contrators.

Use one of the following contractors for repair and calibration:

Key Chemical and Equipment Co. (BPA# 45-6395-3-2872)
13195 49th St. North
Unit A
Clearwater, FL 33762

tel (727) 572-1159
fax (727) 572-4595
($50.00 plus shipping per unit calibrated)

Cardinal Professional Products (BPA# 45-6395-3-2871)
2641 W. woodland Drive
Anaheim, CA 92801
tel (714) 761-3292
fax (714) 761-2095
($55.00 plus shipping per unit calibrated)

Maintenance

The T/C unit requires the same attention as any other equipment if it is to function properly. While the instrument is designed specifically for field use, the components, particularly the meter, may be damaged easily. Careful handling is essential to maintain an instrument capable of accurate gas concentration readings. If repairs are needed and are extensive, or the parts are not readily available, there will be a delay in returning the instrument. Should the need for a substitute T/C unit occur, the port should be prepared to obtain one from another source.

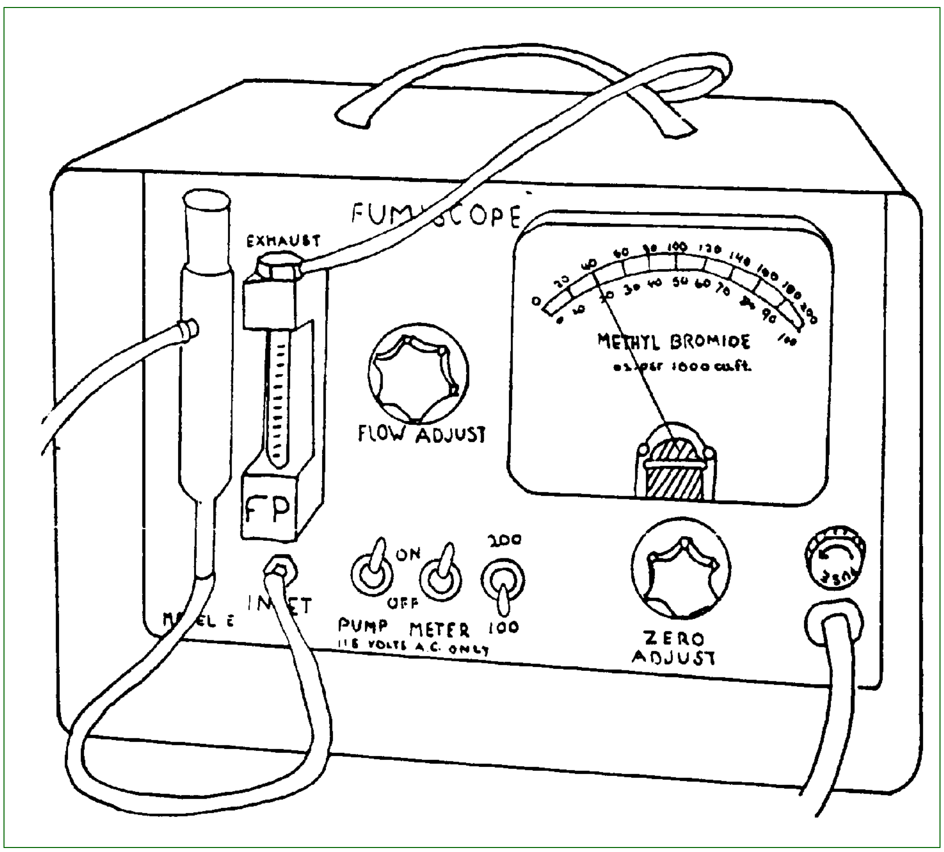


FIGURE 8-1-1: Fumiscope reading of 20 ounces per 1,000ft^3

Halide Detector

The halide gas detector has a long history of commercial usage as a leak detector for halide refrigerant gases. For fumigations, the halide detector has been used both as a leak detector to locate fumigant leakage around chambers, application equipment, temporary enclosures, and as a safety device around fumigation sites. It is also used to indicate freedom from gas concentrations of MB which may be absorbed from treated commodities. As a precautionary safety measure, it should be used regularly in rooms in which MB chambers and MB treated commodities are stored or located.

Principles of Operation

The halide gas detector is used to indicate the presence and approximate concentration of MB or other halogenated compounds in the air. This is accomplished by passing the air-gas mixture over a red hot copper plate or cone through or over which a flame is passing. The color and its intensity imparted to the flame indicates the presence and concentration of the halide gas.

Since the detector will react with other halide gas such as Freon™, a simple demonstration can be shown in the laboratory or office in the following manner:

1. Insert a funnel in the end of the detector search hose.
2. Light the unit (see the following section on Usage).
3. Direct a small amount of Freon™ propelled aerosol across the mouth of the funnel (aerosols used in PPQ aircraft treatments may be used).
4. A blue-green flame will be produced by the Freon™ gas as it contacts the heated reaction plate demonstrating what will occur when MB or other halogen gas is present.

Description

Basically, all halide detectors are quite similarly constructed, differing only in detail by the various manufacturers. Each consists 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 in color to the halogen fumigants. The air mixture to be tested is fed to the burner head assembly by an attached search hose.

The halide detector is relatively trouble free. The burner head orifice is extremely small and must be kept free of clogging with dust or other debris. The reaction plate or cone needs to be replaced when it becomes heavily corroded or burned.

Usage

The halide leak detector is made operable by holding a lighted match in the window opening of the burner tube and turning the valve slowly to the left. After the reaction plate or cone has heated to a red hot color, the flame should be adjusted to the minimum size to maintain that color. The detector is now ready for use. This is accomplished by holding the open end of the search hose in, on, or near the area or article to be tested. As the air sample thus drawn into the burner passes over the heated reaction plate or cone, the flame color changes if MB or any other halogen is present.

Since the operating halide leak detector contains an open flame, there must be strict adherence to obvious safety principles. Even when not in operation, it is advisable not to store the detector in a frequently inhabited room, the fuel being a flammable gas under compression.

The following are the approximate MB concentrations associated with the color intensity of the flame:***

TABLE 8-1-1: Approximate MB Concentration Associated with Flame Color

PPM*	Oz/1,000 ft^3**	Flame color
0	0.0	No color change***
25	0.1	Faint fringe of green
50	0.2	Moderate green
125	0.5	Green
250	1.0	Strong green
500	2.0	Strong green-blue fringe
800	3.2	Strong blue-green
1,000	4.0	Blue

*Threshold limit value for MB for exposure for 8 hours is 5 ppm.
**oz/1,000 ft^3 = mg/liter = g/m^3.
***Propane gas burns with a light blue flame when MB (methyl bromide) is not present.

This table of flame colors for various ppm's of MB holds good only when the detector is operated at its most sensitive rate; i.e., when the flame is reduced to the lowest rate sufficient to keep the reactor plate or cone red hot. Also, particularly when using the detector at night, the flame has a bluish cast which must be taken into consideration.

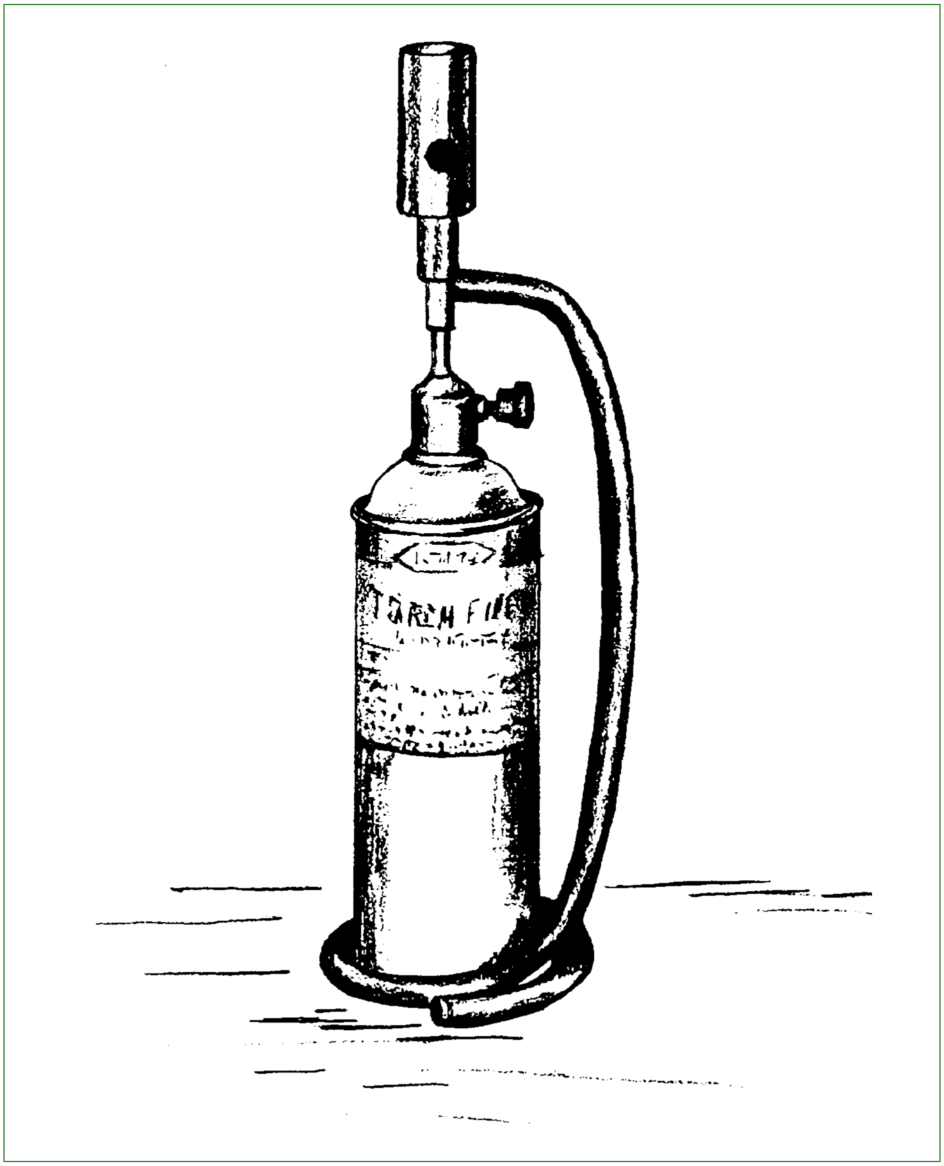


FIGURE 8-1-2: Halide Gas Leak Detector Using Disposable Propane Tank

Respiratory Protection

Introduction

Fumigation or other treatments conducted under the monitored conditions stated in this Manual and other program manuals, are safe operations. The Occupational Safety and Health Administration (OSHA) has ruled that employees with possible exposure to pesticides (including fumigants) shall be provided adequate respiratory protection from such exposure. This section discusses the types, capabilities, limitations, and uses of different respiratory protection available.

Responsibility

Management's Responsibilities

1. Provide respiratory protective equipment when such equipment is necessary to protect the health of the individual.
2. Provide equipment which is applicable and suitable for the purpose intended.
3. Establish a maintenance program for respiratory devices used.
4. Initiate and maintain a regular training program to inform personnel of basic and current information.

Officer's Responsibilities

1. Use and maintain respiratory equipment in accordance with instructions written in this manual and other instructions issued. Adherence or nonadherence to prescribed instructions for the proper use of protective devices and equipment will be a factor in evaluating the quality of an employee's performance. Gross disregard for safety measures may result in disciplinary action. A proper respiratory protection unit is required at the treatment site.
2. Report any damage or malfunction of the device to management.
3. Carry out routine cleaning and care in accordance with instructions in this manual or instructions provided by the manufacturer.

TABLE 8-1-2: Threshold Limit Values of Fumigants

Toxicity	Threshold limit value
Methyl bromide (MB)	5 ppm (skin)* STEL** and ceiling
Sulfuryl fluoride (SF)	10 ppm STEL**; 5 ppm TWA***
Phosphine (PH)	1 ppm STEL**; 0.3 ppm TWA***

*Skin means the potential overall exposure includes absorption through the skin and mucous membranes.
**Short term exposure limit
***Time-weighted average

General

For Fumigants

Every effort will be made by management and workers to prevent exposure of PPQ personnel to atmospheres containing dangerous concentrations of toxic fumigants or other pesticides, or to atmospheres where there is an oxygen deficiency. However, if an emergency situation develops where personnel may be exposed, only respiratory protective equipment with a pressure-demand regulator shall be used. This includes self-contained breathing apparatus (SCBA), air supplied respirators, and units combining these two types. (In this manual the term "SCBA" may be read to include all three of these types.) The pressure-demand respirator affords the best protection currently available because positive air pressure is maintained in the full face mask at all times.

For Pesticides Other Than Fumigants

When there is doubt as to the selection of proper respiratory protection in either of the following categories, the device which offers the best protection must be used. The determination of the type can be made by consulting this manual, the pesticide label, and the supervisor.

Air Purifying Respirators

Air purifying respirators using either a full face mask or half face mask are acceptable in areas where concentrations below maximums designated on the canisters can be expected. They may also be used during application of pesticides with a toxicity or concentration known to pose little or no danger when applied correctly.

Dust Masks

Dust masks may be used when particulate matter such as dust, insect scales, aerosol, spray, or other particles are a nuisance and are of low or moderate toxicity.

Employee Acceptance

The wearer's acceptance of respiratory protection depends on facepiece comfort, clear and full vision, weight of the device, breathing resistance, individual physical condition, and personal preference. If more than one device with the proper facepiece seal is approved for the conditions, then the most comfortable device may be used by the individual. PPQ will use only respiratory protective equipment tested and certified by the National Institute for Occupational Safety and Health (NIOSH), and carrying an approval number prefixed by "TC."

Capabilities and Limitations

Self-Contained Breathing Apparatus (SCBA)

Breathing air is carried in a tank by the user. When properly fitted and used according to instructions, the positive pressure-demand system will prevent harmful contaminants from entering and will provide breathing air in low oxygen areas. A warning device indicates when the air supply is low and allows adequate time for leaving the area. The individual must know that only 5 to 7 minutes air remain at the alarm and that a proper evacuation route must be planned in advance. Each unit should be tested to determine the time remaining at the sound of the alarm.

Limitations

The time which the device will provide respiratory protection is limited by the amount of air in the tank. Rapid breathing due to stress will use the air supply more quickly. There is no protection against skin irritation from toxic gases with the self-contained breathing apparatus. Since some chemicals such as HCN or pesticide groups like the organo-phosphates can be absorbed through the skin, splashes of liquid fumigants or other pesticides must be avoided and protective clothing worn to protect against accidental exposure.

Gas and Vapor Removing Respirators

Canisters and cartridges can be used as protection from most pesticides *other than fumigants*. The type of canister must be selected for a specific gas or vapor or combinations of gases or vapors. These devices have the advantage of being small, light, and simple in operation.

Limitations

Canisters and cartridges are not effective in oxygen-deficient atmospheres. There is no protection from skin irritations or absorption of pesticides through the skin. The capacity of the cartridge or canister determines the maximum contaminant concentration against which a purifying respirator will protect. The maximum concentration for which a canister is designed is printed on the label. Cartridges do not have this information. No protection is provided against particulate contaminants, unless specified on the canister or cartridge label.

The unit will not provide full protection unless the facepiece is carefully fitted to the wearer's face. The time during which protection is provided is dependent on canister or cartridge type concentration of the contaminant, and the wearer's respiratory rate.

A rise in canister or cartridge temperature indicates that a gas or vapor is being removed from the inspired air. However, this characteristic should not be relied on as an indicator of canister performance. An uncomfortably high canister temperature usually indicates a high concentration of gas or vapor and requires an immediate return to fresh air.

Particulate Removing Respirators

Particulate removing respirators may be used only to protect against nonvolatile particles. No protection is afforded against gases and vapors unless a special combination filter and chemical cartridge (canister) system is used. The filter or cartridge shall be replaced when breathing becomes difficult due to plugging by retained particles. Combination respirators using both chemical and mechanical filtering systems are used for dual or multiple exposures to dust and vapors. Normally, filters used for removing dust, mist, or other particulates plug up before the chemical cartridge is exhausted. Both filter and chemical cartridge should be replaced at the same time.

Selection of Respiratory Protection

Work time, including the time necessary to enter or leave a contaminated area, determines the length of time for which respiratory protection is needed. The selection of respirators must be based on all hazards to which the wearer may be exposed.

The only unit with an adequate warning device is the SCBA. The SCBA is equipped with a pressure gauge and audible alarm device. Canisters may have a window indicator which only indicates the presence of moisture. Because canister and cartridge respirators have no indication of remaining service life, used canisters and cartridges should be replaced after each use.

The more active the wearer is, the more rapid his breathing. This shortens the usable working time of all types of respirators. High breathing resistance of air-purifying respirators under conditions of heavy work can result in distressed breathing.

Use of Respirator Protection

Assignment of Respiratory Protection

Every effort will be made to avoid the need for respirators. The supervisor issuing respirators shall be adequately trained to ensure that the correct respirator is issued for each type of possible pesticide exposure. Pesticide labels must be followed regarding respirator use unless more rigid standards are specified by PPQ.

If an officer will use a respirator, the supervisor must ensure that a physician or other licensed health care professional apply one or more of the following tests to determine the officer's fitness to use a respirator:

- Pulmonary Function Test
- Chest X-ray
- EKG
- Examination of nasal passages

Any such examination should be requested and reported as outlined in Section 7.2.8 of the Animal and Plant Health Inspection Service (APHIS) Safety and Health Manual. Use APHIS Form 29 for this purpose. Only a physician or other licensed health care professional can judge whether an officer is physically able to wear a respirator.

Supervisors must ensure that employees who use respirators complete a medical review every 2 years or more frequently if there is a significant change in the medical or physical condition of the officer. Procedures for conducting this review are outlined in Change No. 5 of the APHIS Safety and Health Manual, dated 2/7/86.

Use in Dangerous Atmospheres

In situations where employees may be overcome by a toxic or oxygen-deficient atmosphere, at least one additional person qualified in the use of respirators (such as the commercial applicator) shall be present. The commercial applicator and the employee should cooperate to limit the likelihood of exposure of both individuals at one time. All precautions shall be followed to prevent exposure to any individual at a treatment site. Should exposure occur and an employee be overcome by a toxic atmosphere, rescue should not be attempted without the SCBA.

Facepiece Fitting

All respirator or SCBA wearers must receive prior fitting instructions from their supervisors, fumigation trainers, or others experienced in these procedures. By demonstrations and practice, the wearer will know how to wear the respirator, how to make adjustments, and how to determine correct fit.

Even the same individual fit can vary over time due to weight loss or gain, hair, and scars. Supervisors will schedule periodic fittings to ensure that officers are diligent in observing these conditions. With ideal wearing conditions, leakage may be as low as 1 percent. The wearer must check facepiece fit according to manufacturer's facepiece fitting instructions each time respiratory protection is put on.

Inward leakage is one of the most important considerations in selecting a facepiece. Since conditions such as growth of beard, sideburns, a skull cap that projects under the facepiece, temple pieces of eyeglasses, or the absence of one or both dentures may prevent obtaining an effective face seal, they must be corrected so an effective seal is obtained. Having a clean shaven area for an effective seal, removal, or repositioning of a skull cap, use of an eyeglass adapter kit (contact lenses may not be worn during fumigations), or inserting dentures are some ways which must be used to correct these conditions. Long sideburns, beards, and other facial hair in the sealing area does prevent an effective seal even for positive pressure masks, and is in violation of the Occupational Safety and Health Administration (OSHA) regulations. Since the presence of facial hair in the sealing area is in direct violation of the OSHA regulations and also creates a significant safety hazard for the employees and their co-workers, the sealing area of the face will be cleanly shaven to permit an effective seal. All supervisors and employees must be advised of this policy.

Important

The proper seal can also be attained with a hooded pressure demand SCBA designed to fit over beards and glasses, such as, Survivair's Puma™, which is NIOSH-certified and OSHA-compliant.

All personnel assigned fumigation and/or pesticide duties wear SCBA's during critical portions of treatment procedures and must not have any condition(s) which prevent obtaining an effective face seal. Individual face masks, available in small, medium, and large sizes may be assigned.

Facepiece Fit Tests

The facepiece fit must be checked by the wearer each time the respiratory protection is used. This will be done by following the manufacturer's facepiece-fitting instructions. Two simple field tests are described below.

Negative Pressure Test

Close off the inlet opening of the facepiece or the canister or cartridges by covering with the palm of the hand(s). Inhale gently so that the facepiece collapses slightly and hold your breath for 10 seconds. If the facepiece remains in a slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is probably satisfactory.

Also, leakage can be detected by crushing an ampoule of isoamyl acetate and passing it 1 to 2 inches around the seal area and exhalation valve. In this case, leakage will be noted by a “banana-like” odor in the facepiece. (See Isoamyl acetate in Appendix H, Reference Guide to Commercial Suppliers of Treatment and Related Safety Equipment.)

Positive Pressure Test

Close the exhalation valve and exhale gently into the facepiece. The face fit is considered satisfactory if a slightly positive pressure can be built up inside the facepiece without any evidence of outward leakage of air along the seal. For most respirators, this method of leak testing requires that the wearer remove the exhalation valve cover and then be sure to carefully replace it after the test. The exhalation valve cover must be replaced the correct way to prevent affecting the rubber valve.

Special Problem

Corrective Lenses With Full Facepiece

All facepieces will restrict, to some degree, the wearer’s vision. This will increase accident potential. A proper seal cannot be established if the temple bars of eyeglasses extend through the sealing edge of the full facemask. A prescription spectacle kit for respirators is available to correct this problem. All personnel who must wear prescription eyeglasses must use this kit when wearing equipment with a full facepiece.

It is APHIS policy to supply this adapter kit to all personnel requiring one.

WARNING

Wearing of contact lenses in contaminated atmospheres with a respiratory protection device is prohibited.

Eyeglasses With Half Facepiece

If corrective eyeglasses or goggles are required, they shall be worn so they do not affect the fit of the facepiece. Proper selection of equipment will minimize or avoid this problem.

Use in Low Temperatures

The use of full facepieces at low temperatures presents problems such as poor visibility and freezing of exhalation valves. All full facepieces are designed so that the incoming fresh air sweeps over the inside of the lens to reduce fogging. This makes it possible to wear a full facepiece in ordinary room temperatures without severe fogging. Antifog compounds can be used to coat the inside of the lens to prevent fogging at room temperatures and down to temperatures approaching 32°F. However, below 0°F, antifog compounds will not prevent severe fogging.

Although such instances are not usually encountered, the employee should be aware that it is dangerous to work at temperatures near freezing and below when using respirators not designed for such use.

When using air supplied respirators, the high-pressure connections may leak because of metal contraction at low temperatures. It is important to remember that connections should not be over tightened since they may break when temperatures return to normal.

Communications

The conventional respirator exhalation valve will provide a pathway for some speech transmission over short distances in relatively quiet areas. Talking can induce facepiece or component leakage and, therefore, should be limited while wearing a respirator, especially those with half-facepiece.

Maintenance and Care

Equipment must be properly maintained to retain its effectiveness. A program for maintenance and care include the following basic services:

- Inspection for defects (including leak checks)
- Cleaning and disinfecting
- Repairs
- Storage
- Respirable air for SCBA

Inspection

The user shall inspect the respiratory equipment before and after each use. Respiratory equipment that is not routinely used, but is kept ready for emergency use, shall be inspected at least monthly to ensure that it is in satisfactory working condition. SCBA air cylinders shall be fully charged according to the manufacturer's instructions.

Inspection shall include:

1. Check tightness of connections.
2. Check the condition of the facepiece, headbands, valves, connecting tube, and any canisters or cartridges.
3. Check rubber or other elastic parts for pliability and signs of deterioration.
4. Check the regulator and the warning device to determine proper functioning before each use.
5. Check for leaks.

Keep a record of inspection dates and findings in the unit carrying case.

Cleaning and Disinfection

Clean and disinfect routinely used equipment after each use and those not routinely used as necessary to ensure that proper protection is provided for the wearer. The following is recommended for cleaning and disinfecting respiratory protection devices:

1. Remove any filters, cartridges, or canisters.
2. Wash facepiece and breathing tube with a cleaner-disinfectant or detergent solution (see following paragraphs). Use a hand brush to facilitate removal of dirt.
3. Rinse completely in clean, warm water.
4. Air dry in a clean area.
5. Clean other parts as recommended by manufacturer.
6. Inspect valves, headstraps, and other parts. Replace with new parts when defective. Stretching and manipulating rubber elastomer parts with a massaging action will keep them pliable and flexible and prevent them from warping or sticking during storage.
7. Insert new filter, cartridge, or canister in the unit. Make sure seal is tight.

Cleaner-disinfectant solutions containing a bactericidal agent (generally a quaternary ammonium compound) are available.

Commercial products must be used according to the label to obtain the proper solution. However, different concentrations of the quaternary ammonium salt are required for various hardness of water to obtain a satisfactory disinfectant solution. Dermatitis may occur if the quaternary ammonium compounds are not completely rinsed from the facepiece and associated parts.

Strong cleaning and disinfecting can damage parts. Avoid temperatures above 120°F and vigorous mechanical agitation. Solvents which affect elastomer or rubber parts must be used with caution.

Respiratory protective equipment may be contaminated with toxic materials such as organo-phosphates or other pesticides. If the contamination is light, normal cleaning procedures should provide satisfactory decontamination. If contamination is heavy, a separate decontamination step may be required before cleaning. For complete decontamination of phosphate pesticide residues, wash with alkaline soap, rinse with clean warm water and then rinse with 50 percent alcohol (ethyl or isopropyl).

If commercial materials are not available, respiratory equipment may be washed in a liquid detergent solution, then immersed in one of the following:

- Sodium hypochlorite solution (50 parts per million of chlorine) for 2 minutes; **OR**
- An aqueous iodine solution (50 parts per million of iodine) for 2 minutes; **OR**
- A quaternary ammonium solution with 200 parts per million of quaternary ammonium compounds in water of less than 500 parts per million total hardness (See Quaternary Ammonium in Appendix H, Reference Guide to Commercial Suppliers of Treatment and Related Safety Equipment.)

The sodium hypochlorite and iodine solutions are not stable. You must prepare fresh solution for each use. These solutions age rubber parts and are corrosive to metallic parts, therefore, immersion times should not be extended and the disinfectants should be thoroughly rinsed from all parts with clean, warm water.

Repair

Only experienced persons shall handle replacements or repairs using only those parts specifically designed for the equipment. Make no attempt to replace components or to make adjustments or repairs beyond the manufacturer's recommendations. Reducing or inlet valves and regulators shall be returned to the manufacturer or sent to a trained technician for adjustment or repair.

Storage

After inspection, cleaning, and necessary repair, equipment shall be stored to protect against dust, sunlight, heat, extreme cold, excessive moisture, or damaging chemicals. Respiratory equipment located at stations and work areas for emergency use should be stored in compartments built for that purpose. They should be clearly marked and quickly accessible at all times. Under no circumstances shall a motor vehicle be used for storage of respiratory protective equipment. The excessive and uncontrollable changes in temperature are bad for this equipment.

Routinely used respirators, such as dust respirators, may be placed in resealable plastic bags or heat sealed plastic. Respirators should not be stored in such places as lockers or tool boxes unless they are in carrying cases or cartons and plainly marked. Respirators should be packed or stored so that the facepiece and exhalation valve will rest in a normal position to prevent function impairment by the elastomer taking a permanent set in an abnormal position. It is advisable to rotate the respirator face up, or face down at monthly inspections. Instructions for proper storage of emergency respirators, or self-contained breathing apparatus are found in “use and care” instructions usually mounted inside the carrying case lid. Should the case not have such instructions, obtain them from the manufacturer and place in the case cover.

Respirable Air for Self-Contained Breathing Apparatus

Compressed air shall be of high purity. Breathing air shall meet the requirements for Grade D breathing air as described in Compressed Gas Association Commodity Specification G-7.1-1966. Air tanks can be refilled at most SCUBA diving stores or where local fire departments or rescue squads obtain air for their units. Test data denoting the quality of the compressed air should be available from the air supplier.

There is no need to change the air in the units, even after extended periods of time.

Never use compressed oxygen! (Compressed air may contain a low concentration of oil. When high-pressure oxygen passes through an oil or grease coated orifice, an explosion or fire may occur.)

Have breathing air cylinders inspected and hydrostatically tested as required by the type of cylinder being used. Refer to the manufacturer’s recommendations and comply with the Department of Transportation (DOT) or Interstate Commerce Commission Specifications for shipping containers.

Breathing air cylinders shall be marked in accordance with American National Standard Method of Marking Portable Compressed Gas Containers to Identify the Material Contained.

Detector Kits or Gas Samples

Although thermal conductivity (T/C) units such as the Gow-Mac® and the Fumiscope® are used to measure concentrations of methyl bromide, ethylene oxide-carbon dioxide mixtures, sulfuryl fluoride, and certain other fumigants in ounces per 1,000 cubic feet (milligrams per liter). Concentrations of phosphine and some other fumigants cannot be measured with a T/C unit. However, they may be measured with detector tubes. Residual gas concentrations during aeration of commodities or enclosures can also be determined for most fumigants with detector tubes.

Principles of Operations

Special pumps are used to draw a measured sample (usually 100 milliliters) of an air-gas mixture. The sample is drawn through one or two detector tubes where a chemical reaction with the tube reagent takes place, creating a stain. The length of the stain is proportional to the concentration of the gas. Measurement of the length of the stain is made using a calibrated chart or by simply reading the number from a scale printed on the glass tube.

Gas detector tubes are manufactured with a constant reagent weight with corrections for variations in the diameter of each tube. Detailed operational instructions accompany the equipment.

The detector tubes are specific for each fumigant and usually are available from several manufacturers. However, it is advisable to use the pump supplied by the manufacturer of the tube used. In an emergency, detector tubes available under the trade names of Auer, Draeger, Gastec, Kitagawa, and Mine Safety Appliances can be used with pumps manufactured by any of these companies provided they draw 100 ml. Adapters may be necessary because of the different diameters of the tubes sold by each manufacturer. The Kitagawa pump uses a removable, stainless-steel micro-orifice to reduce the rate of air flow through many of their detector tubes. This is to provide greater accuracy in the chemical reaction within the tube. The orifice should be removed when using tubes manufactured by other companies.

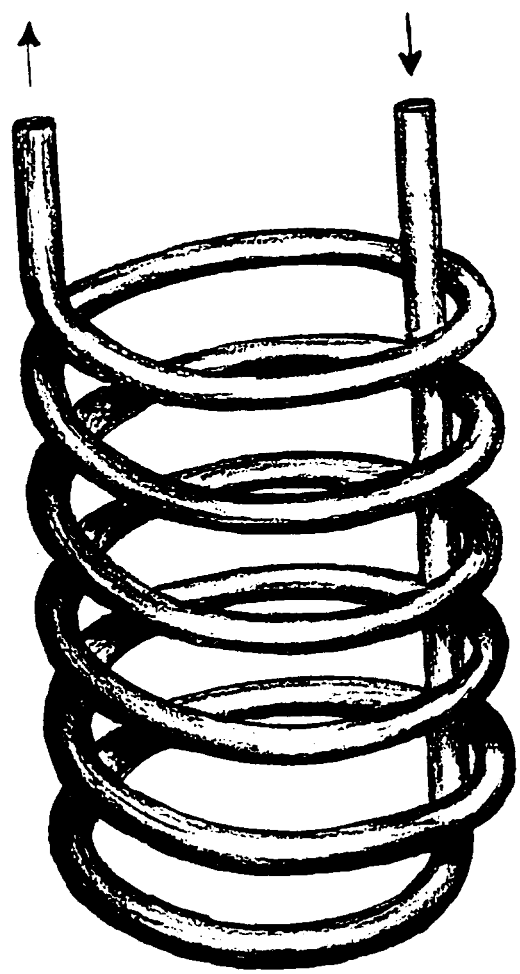
Tubes should be stored under refrigeration to increase shelf life. Before each day's use, pumps should be tested as provided by instructions with each kit and repairs made as necessary. Spare parts and operational instructions should be kept with each kit for use as needed.

When many samples must be drawn to a common point during a large fumigation, an auxiliary pump can be used. If only one sample lead is involved, it may be necessary to pull the fumigant through the line by pumping several times. A used tube can be inserted in the pump to determine when the fumigant has reached the pump.

Volatilizer

It is desirable to pass some fumigants through a vaporizer to assure volatilization at any temperature below 60°F or when large quantities (i.e., a total amount of 5 pounds or more of methyl bromide) are required. The volatilized fumigant should be introduced into or near to the air flow of the blower or fan. A simple volatilizer can be made with a 25-foot coil of 3/8 inch O.D. copper tubing immersed in a container of hot water. For use with amounts greater than 5 pounds of methyl bromide, 50 feet of 1/2 inch O.D. copper tubing can be coiled in a large container of water which has been heated to temperatures of 150°F or above.

The fumigator should be warned that the fumigant should be introduced through the tubing at the rate of 3 to 4 pounds of gas per minute. The gas introduction tube should feel hot to the touch as a good measure of satisfactory vaporization.



The volatilizer should be made of semihard copper tubing. It is important that gas be introduced and discharged as shown by arrows. If applied in reverse order, it may move so rapidly that some liquid will pass into the chamber.

FIGURE 8-1-3: Methyl Bromide Volatilizer Coil

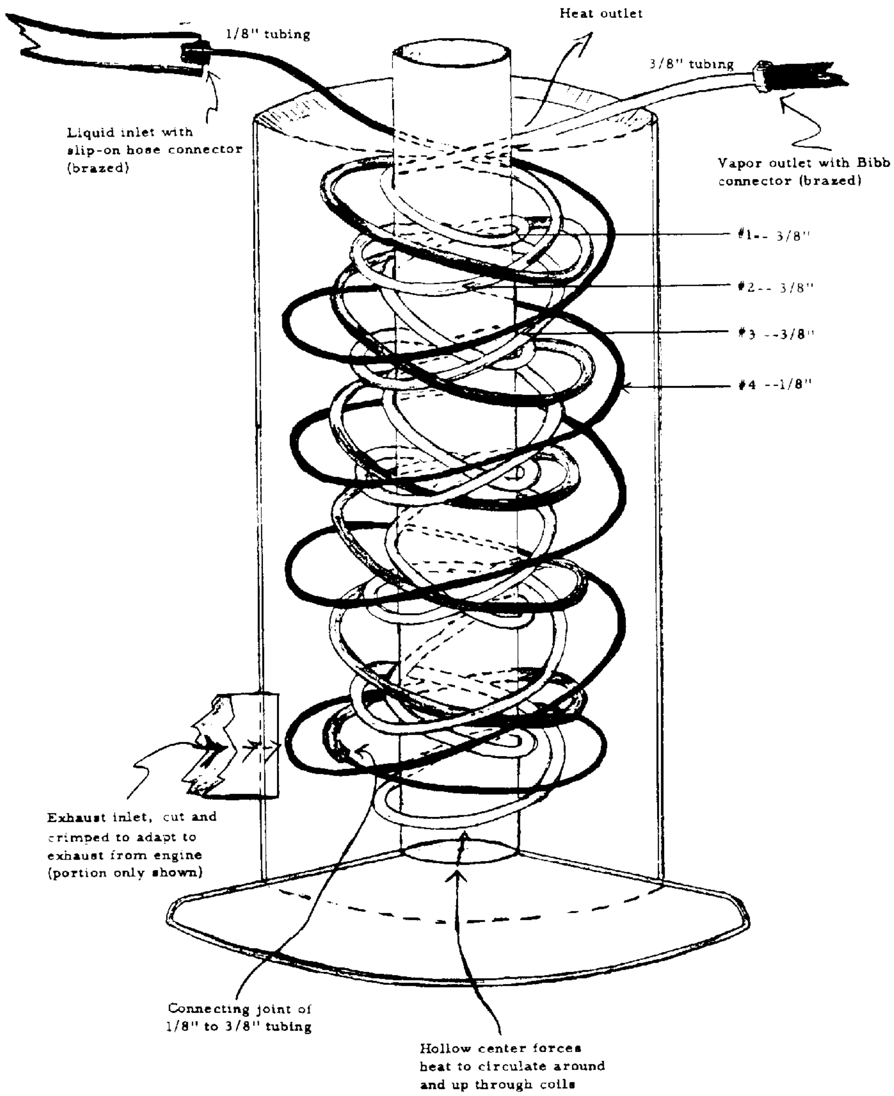


FIGURE 8-1-4: Liquid Fumigant Vaporizer

Air Velocity Measuring Instruments

Anemometer

The cubic feet per minute (cfm) of a fan can be approximated by use of an anemometer or other wind measuring device. Measurements of air movement are taken 12 inches from the face of the fan to be tested. A minimum of three readings should be taken; one from the center and the others from points toward the outside of the fan. Readings are then averaged. If an anemometer is used, each measurement should be for 1 minute, thereby giving the result in feet per minute. If a wind speed indicator is used, the reading in miles per hour should be converted to feet per minute by multiplying the miles per hour by 5,280 and dividing by 60.

Area of the fan is calculated by first measuring the radius (R)—distance from center of fan to end of a blade. Formula for area is ¼ R^2 where ¼ is equivalent to 3.1416 (22/7). The final answer should be given in cfm. Therefore, if the radius of the blade is given in inches and not feet, the factor 1/144 must be multiplied in to convert square inches to square feet. The full formula would be: Feet per minute × R^2 (in inches) × ¼ × 1/144 = cfm.

EXAMPLE: If average air movement is 1,600 feet for 1 minute from a fan having a 7 inch radius (14 inch diameter), the calculations are as follows:

$$1{,}600 \times 7^2 \times 3.1416 \times 1/144 = 1{,}700 \text{ cfm (approximate)}$$

Velometer

The Velometer is the registered trade name of Illinois Testing Laboratories, Inc., Chicago, Illinois, for their air speed indicators. Readings are taken by either holding the instrument itself or jets (probes) in front of the air stream. Velocities are rapidly determined in units of feet per minute without timing or calculations. Units are especially useful for measuring air flow in ducts and in front of grilles.

Auxiliary Pump

During the fumigation of large enclosures, it is necessary to take numerous gas concentration readings from various locations throughout the enclosure. Thus some sample leads may be over 200 feet long. The fumigant must be pumped to the sampling point before an accurate concentration reading can be made. If the inspector must rely on the pump provided with the gas sampler or thermal conductivity unit to pull the fumigant, a great deal of time will be needed between readings.

The auxiliary pump will reduce sampling time to only the reading time since it pumps the fumigant from many areas and keeps a constant pull. Construction of a unit is relatively simple. Petcocks capable of accepting sample leads are tapped and soldered to a short length of pipe. This pipe is connected to the suction side of the pump. The pipe acts as a manifold. Opening or closing the petcocks allows the drawing of the gas samples as required. An exhaust line of sufficient length should be connected to the pump to ensure the fumigant is removed from the sample area.

It is important that all soldering be done in such a manner as to provide gas tight construction of the petcocks. The pump should be of sufficient size to pull 1 cubic foot per minute through all of the leads on the manifold. Therefore, the more leads, the higher the required capacity of the pump. The whole unit should be mounted on a board large enough to keep vibration to a minimum. The unit weight should be kept down to allow easy transport.

Each sampling line is disconnected from the auxiliary pump in turn, and the petcock closed. Line is then attached to the T/C unit or gas detector. A reading is obtained and line reconnected to the auxiliary pump and the petcock opened.

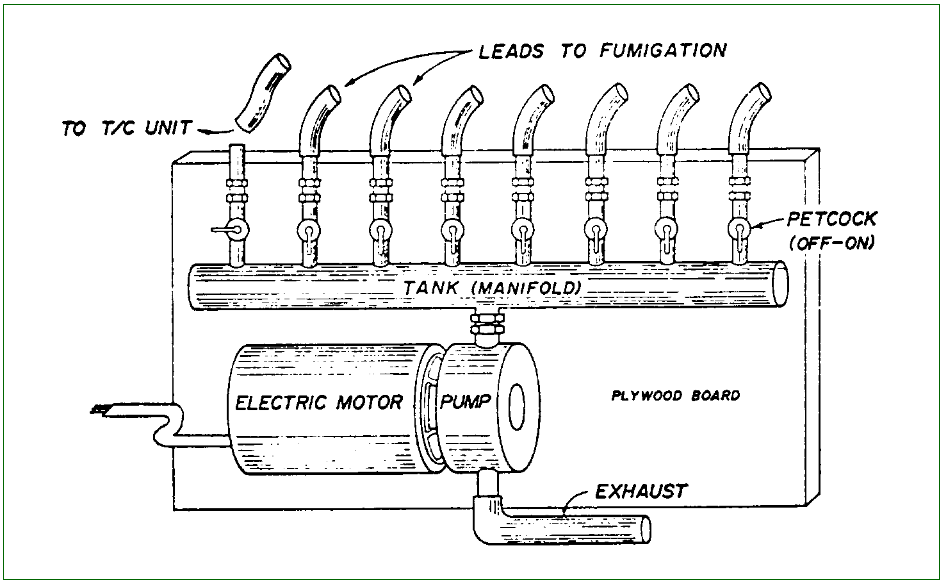


FIGURE 8-1-5: Auxiliary Pump

Open Arm Manometer

The manometer is a U-shaped tube partially filled with kerosene or water. The tube may be of glass or transparent plastic tubing. A ruler calibrated in millimeter (mm) divisions or carefully measured lines on a background is used to measure the difference in level of the kerosene in the two arms (or the level in one arm).

When a fumigant is volatilized in a chamber at atmospheric pressure, a positive pressure is created, which may then be continuously reduced by leakage of the air-fumigant mixture. PPQ approved chambers must be sufficiently tight to retain the fumigant during the exposure period. The manometer is used during the pressure-leakage test as a measure of tightness. An opening (usually 1 inch diameter) should be provided in the chamber for the use of a blower or other means for the introduction of air to create a positive pressure in the chamber. An additional opening, such as a gas sampling line opening, must be provided for the manometer. The procedure for testing is as follows:

- Close chamber as for fumigation
- Attach one end of the manometer to the chamber opening
- Use vacuum cleaner blower or similar apparatus to create pressure of 25 mm as measured on an open-arm, kerosene or water filled manometer
- Discontinue blower and close its entry
- Observe time for pressure to recede from 25 to 2.5 mm in the open arm

The time lapse for the chamber pressure to recede from 25 to 2.5 mm in the open arm must be 22 or more seconds for minimum approval. Chambers shall be reinspected every 6 months when 22 to 29 seconds are recorded. Chambers which retain the pressure for 30 seconds or longer should be tested annually. (Chambers used for fumigating cherries for export to Japan are required to meet a higher standard—the time lapse for the chamber pressure to recede from 25 to 2.5 mm must be 60 or more seconds for minimum approval.) Inability to develop or maintain adequate pressure indicates considerable leakage. In such cases, the chamber operator may use a smoke bomb or other device in an effort to determine the areas of leakage.

Electronic manometers are also available and may be used in lieu of the Open-arm (U-tube) type.

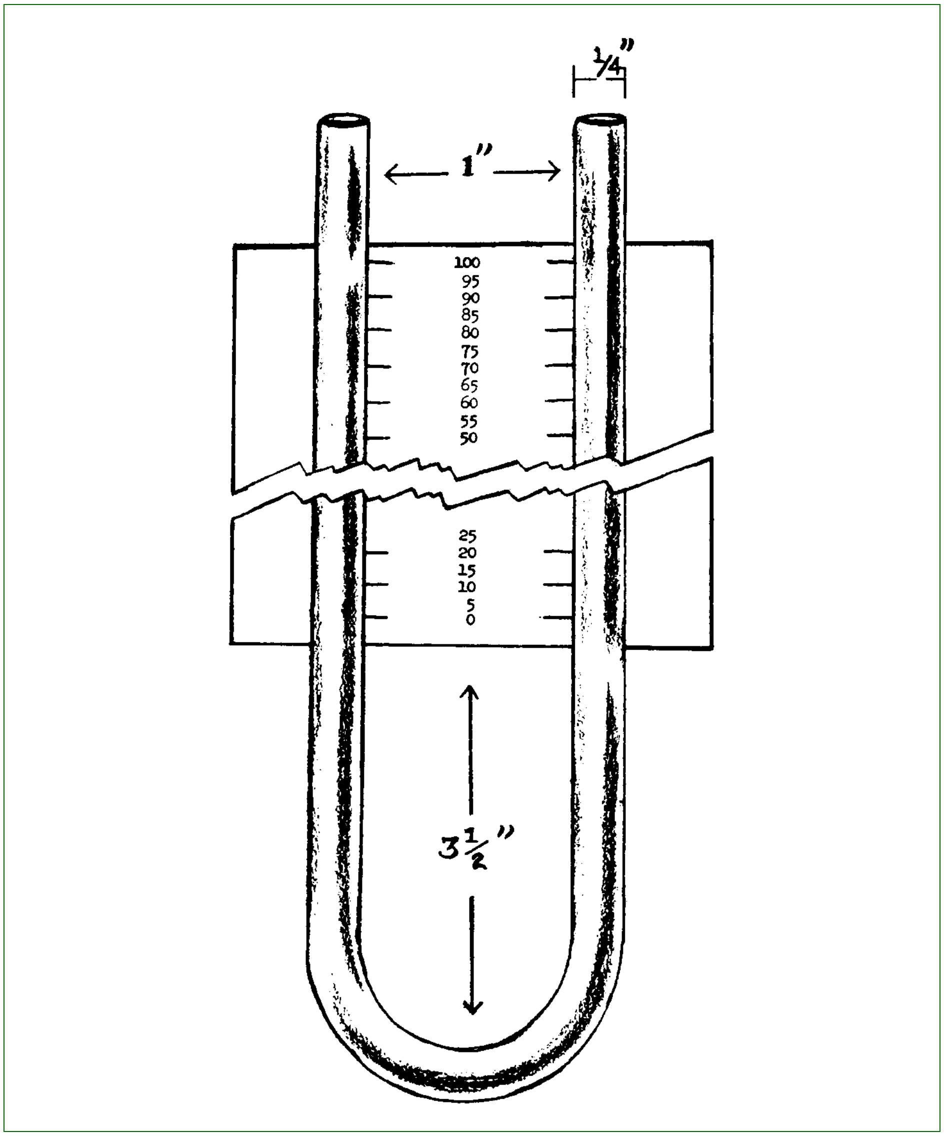


FIGURE 8-1-6: Open-arm Manometer

Vacuum Pump

Mityvac Hand-Held Vacuum Pump

The Center for Plant Health Science and Technology has developed the following procedure to detect blocked monitoring leads with the use of a Mityvac hand-held vacuum pump (for supplier, see *Vacuum Pump*, Appendix 8):

Usage

1. Prior to fumigant introduction, connect the Mityvac hand-held vacuum pump to a monitoring lead.
2. Squeeze the handle on the Mityvac Unit. If the lead is blocked, a vacuum will be indicated on the vacuum gauge of the Mityvac unit. (The handle should be squeezed two or three times for monitoring leads longer than 25 feet. The Mityvac hand-held pump has the capacity to attain and hold 25 inches of Hg vacuum and a minimum of 7 psi pressure.)
3. Disconnect the Mityvac hand-held pump from the monitoring lead, and repeat this procedure for each monitoring lead. (Connect monitoring leads to the gas analyzer prior to fumigant introduction.)

Phosphine Detector

PortaSens Phosphine Detector

Description

Historically, phosphine measurements have been done using detector tubes specific for phosphine (see **Detector Kits or Gas Samplers** in this section). The high cost associated with these tubes have been a deterrent for many ports.

A more accurate, portable unit has been recommended for usage during phosphine fumigations. The Series B16 PortaSens is a portable, battery operated instrument for the measurement of various gas concentrations in ambient air. The instrument can be ordered specifically for phosphine in the 0-1,000 ppm range. Ranges from 0-1 ppm are available also, along with other configurations. The PortaSens is a complete measuring instrument containing an electrochemical sensor, sampling pump, flow cell assembly, microprocessor electronics, and a two line backlit LCD display. The unit is powered by a rechargeable NiCad battery located in the handle, with the charger connection located at the bottom of the handle.

Operation

The PortaSens needs to be calibrated by the Center for Plant Health Science & Technology (CPHST) before usage. After calibration, the instrument is ready to use directly out of the box. Simply remove the instrument from the storage case and press and release the button (instrument switch) on the front of the handle. The LCD display on the front will immediately be activated and the internal pump will begin to pull sample into the flow cell.

The unit comes with a flexible extension wand that screws into the standard inlet fitting. Connect the extension wand and a length of flexible tubing that will reach safely from the item(s) being fumigated to the PortaSens.

Response Time

Response time will vary depending on the gas concentration and ambient temperature. The LCD readout will stabilize when maximum concentration is reached. Readings will be more timely when the monitoring leads are purged using the Mityvac hand held vacuum pump (refer Mityvac Hand-Held Vacuum Pump).

Alarm Function

The PortaSens contains both visual and audible gas concentration alarm functions that are preset at the factory. Refer to B16 PortaSens Operation and Maintenance Manual for specific instructions. For instruments in the 0-1,000 ppm range, the alarm has been disabled to allow for more efficient usage.

Battery Power Supply

The instrument is powered by a rechargeable NiCad battery. With a fully charged battery, the unit will operate continuously for 12 hours at 20°C. Battery capacity will drop with decreasing temperature. Should the battery become weak during operation, the lower line of the LCD display will indicate “LOW BATT.” An audible beeper will begin to sound. At this point, there will be 1 hour of operating time left. When the voltage reaches a level where reliable measurements are no longer possible, the unit will turn itself off. It is good practice to leave the instrument on charge at all times if emergency use is anticipated.

Flow Verification

Proper flow should always be verified before using the PortaSens for leak detection. When the unit is turned on, a pump continuously delivers an air sample to the flow cell. In normal operation, the flow rate is approximately 300 cc/min. In order to allow quick verification of proper flow, a flowmeter is included in the PortaSens kit. Turn the instrument on and connect the sampling wand. Place the tip of the sampling wand into the tubing adapter attached to the flowmeter. Hold the flowmeter in the vertical position and verify that the flow rate is above 150 cc/min.

Power Down

In order to turn the unit off, press and hold the switch for approximately 3 seconds, until the “POWER DOWN” message appears on the display and then release.

9 Glossary

Treatment Manual

Acronyms, Abbreviations, and Terms

a.i.	active ingredient
ACGIH	American Conference of Governmental Industrial Hygienists
ADI	Acceptable Daily Intake
APHIS	Animal and Plant Health Inspection Service
BBEP	Biotechnology, Biologics, and Environmental Protection
bw	body weight
CAS	Chemical Abstracts Service
cc	cubic centimeters
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
ChE	cholinesterase
CHEMTREC	24-hour emergency telephone service for spills
CNS	central nervous system
copra	dried coconuts and whole coconuts without the husk
COR	Contracting Officer's Representative
CPK	creatine phosphokinase
cu.m	cubic meter
CWA	Clean Water Act
DHEW	U.S. Department of Health, Education, and Welfare
DNA	deoxyribonucleic acid
DOT	U.S. Department of Transportation
DW	drinking water
EPA	Environmental Protection Agency
External Feeder	A pest that normally inhabits the outside or outer part of its host. Contrast with hitchhiker and internal feeder.
FAA	Federal Aviation Administration
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
g	grams
GI	gastrointestinal
HDT	highest dose tested
Hgb	hemoglobin
HHS	U.S. Department of Health and Human Services
Hitchhiker	A pest transported by chance and not found inhabiting its host. Contrast with external feeder.
i.m.	intramuscular
Internal Feeder	A pest that normally inhabits the inside or inner part of its host. Contrast with external feeder.
i.p.	intraperitoneal

i.v.	intravenous
kg	kilogram
L	liter
LC50	Lethal Concentration 50; dose lethal to 50% of the animals
LCLO	Lethal Concentration Low; the lowest concentration causing death
LD50	Lethal Dose 50; dose lethal to 50% of the animals
LDLO	Lethal Dose Low; the lowest dose at which death occurred
LDT	lowest dose tested
LEL	lower exposure limit, or lowest-effect level
LOAEL	lowest-observed-adverse-effect-level
m	meter
MED	minimum effective dose
mg	milligram
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mmHg	millimeters of mercury; a measure of pressure
MOE	Margin of Exposure
MOS	Margin of Safety
MSDS	Material Safety Data Sheet
MTD	maximum tolerated dose
MTL	median threshold limit
NFPA	National Fire Prevention Association
ng	nanogram
NIOSH	National Institute for Occupational Safety and Health
NMRAL	National Monitoring and Residue Analysis Laboratory
NOAEL	no-observed-adverse-effect level
NOEL	no-observed-effect level
NTP	National Toxicology Program
OIC	Officer-in-Charge
OSHA	U.S. Occupational Safety and Health Administration
p.o.	per os (by mouth)
PEL	permissible exposure limit
PHS	U.S. Public Health Service
ppb	parts per billion
ppm	parts per million
PPQ	Plant Protection and Quarantine
RBC	red blood cell(s)
RfD	Reference Dose
RfDi	Inhalation Reference Dose
RfDo	Oral Reference Dose
s.c.	subcutaneous
STEL	short-term exposure limit

TLV	threshold limit value
TSS	Technical and Scientific Services
TWA	time-weighted average
UCL	upper confidence limit
UEL	upper exposure limit
UF	uncertainty factor
ug	microgram
ug/cu.	micrograms per cubic meter
ug/L	micrograms per liter
USDA	United States Department of Agriculture

Treatment Manual

Appendixes

Contents

D

Treatment Manual

Appendix D

Conversion Tables

TABLE D-1-1: Conversion Tables

To convert from:	To:	Multiply by:
Acres (a)	Hectares (ha)	0.4047
Acres (a)	Square meters (m^2)	4,047.0
Celsius	Fahrenheit	9/5 (then add 32)
Centimeters, cu. (cm^3)	Cubic inches (in^3)	0.061
Centimeters, sq. (cm^2)	Square inches (in^2)	0.155
Centimeters (cm)	Inches (in)	0.3937
Fahrenheit	Celsius	First, subtract 32, then multiply by $^5/_9$
Feet, cubic (ft^3)	Liters (L)	28.32
Feet, cubic (ft^3)	Cubic meters (m^3)	0.0283
Feet, square (ft^2)	Square meters (m^2)	0.0929
Feet, square (ft^2)	Sq. centimeters (cm^2)	929.0
Feet (ft)	Centimeters (cm)	30.48
Feet (ft)	Meters (m)	0.3048
Gallons (gal)	Liters (L)	3.785
Grams (g)	Ounces (oz)	0.0353
Hectares (ha)	Acres (a)	2.471
Inches (in)	Centimeters (cm)	2.54
Inches, square (in^2)	Sq. centimeters (cm^2)	6.4516
Inches, cubic (in^3)	Cu. centimeters (cm^3)	16.387
Kilograms (kg)	Pounds (lb)	2.205
Kilograms (kg)	Ounces (oz)	35.27
Kilometers, sq. (km^2)	Square miles (mi^2)	0.3861
Kilometers, sq. (km^2)	Acres (a)	247.1
Kilometers (km)	Miles (mi)	0.6214
Liters (L)	Gallons (gal)	0.2642
Liters (L)	Quarts (qt)	1.0567
Meters, cubic (m^3)	Cubic feet (ft^3)	35.314
Meters, cubic (m^3)	Cubic yards (yd^3)	1.308
Meters (m)	Feet (ft)	3.281
Meters (m)	Yards (yd)	1.0936
Meters, sq. (m^2)	Square inches (in^2)	1,550.00
Meters (m)	Inches (in)	39.37
Meters, sq. (m^2)	Square feet (ft^2)	10.764

TABLE D-1-1: Conversion Tables

To convert from:	To:	Multiply by:
Miles, square (mi^2)	Hectares (ha)	258.99
Miles, square (mi^2)	Sq. kilometers (km^2)	2.5899
Miles, statute (mi)	Meters (m)	1,609.347
Miles, statute (mi)	Kilometers (km)	1.609
Milliliters (ml)	Liquid ounces (lq oz)	0.0338
Nautical miles	Meters (m)	1,852.00
Ounces, fluid (fl oz)	Milliliters (ml)	29.57
Ounces (oz)	Kilograms (kg)	0.0284
Ounces (oz)	Grams (g)	28.35
Pounds (lb)	Kilograms (kg)	0.4536
Pounds (lb)	Grams (g)	453.6
Quarts (qt)	Liters (L)	0.9464
Tons, short (2000 lb)	Metric tons (t)	0.9072
Tons, Metric (t)	Tons, short	1.102
Yards, cubic (yd^3)	Liters (L)	764.6
Yards, cubic (yd^3)	Cubic meters (m^3)	0.765
Yards (yd)	Meters (m)	0.9144
Yards (yd)	Centimeters (cm)	91.44

Miscellaneous:

Ounces (weight) per 1,000 cu. ft. = grams per cu. meter (g/m3)
Pounds per acre (lb/a) × 1.1206 = kg/ha
Ounces (liquid) per acre × 73.14 = ml/ha
Gallons per acre (gal/a) × 9.3527 = liters per hectare (L/ha)
Pressure per square inch (PSI) × 6.894757 = kilopascals (kPa)
Inches mercury × 3.38 = kilopascals (kPa)
Grams per cu. meter (g/m^3) = ounces per 1,000 cu. ft. (oz/1,000 ft^3)
Kilogram per hectare (kg/ha) × 0.8924 = pounds per acre
Milliliters per hectare × 0.01367 = ounces (lq.) per acre
Liters per hectare (L/ha) × 0.1069 = gallons per acre
Kilopascals (kPa) × 0.145038 = pounds per square inch (PSI)
Grams per liter × 0.008345 = pounds per gallon
Kilopascals (kPa) × 0.29586 = inches mercury

Index

Treatment Manual

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

A

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

B

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

C

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

D

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

E

G

I

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

J

K

L

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

M

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

N

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

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P

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

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A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

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