

62719-376

01-26-2004

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U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Pesticide Programs
Registration Division (7505C)
1200 Pennsylvania Ave.
Washington, D.C. 20460

EPA Reg. Number

62719-376

Date of Issuance:

JAN 26 2004

Term of Issuance: Conditional

Name of Pesticide Product:

Profume Gas Fumigant

NOTICE OF PESTICIDE:

Registration
 Reregistration
(under FIFRA, as amended)

Name and Address of Registrant (include ZIP Code):

DowAgroSciences LLC
9330 Zionsville Road
Indianapolis, IN 46268

Note: Changes in labeling differing in substance from that accepted in connection with this registration must be submitted to and accepted by the Registration Division prior to use of the label in commerce. In any correspondence on this product always refer to the above EPA registration number.

On the basis of information furnished by the registrant, the above named pesticide is hereby registered/reregistered under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA).

Registration is in no way to be construed as an endorsement or recommendation of this product by the Agency. In order to protect health and the environment, the Administrator, on his motion, may at any time suspend or cancel the registration of a pesticide in accordance with the Act. The acceptance of any name in connection with the registration of a product under this Act is not to be construed as giving the registrant a right to exclusive use of the name or to its use if it has been covered by others.

This product is conditionally registered in accordance with FIFRA Section 3(c)(7)(A) provided that you:

1. Make the following label changes before you release the product for shipment:
 - a. Revise the EPA Registration Number to read, "EPA Reg. No. 62719-376."
 - b. On page one of the label delete "Non-residential structures such as: . . ." and replace with "Non-residential structures: . . .". This change must be made in all cases (such as the introduction section in the Fumigation Manual and again on page 1-1) where the use sites for this product are described.
 - c. After mills on page one specify: "mills (for the commodities listed on the label)". This change must be made in all cases where the use sites for this product are described.
 - d. In the Precautionary Statements section of the label add the restriction: "Profume cylinders must not be shipped in aircraft."

Continued on pages 2 - 6

Signature of Approving Official:

Richard P. Keigwin, Jr.
Richard P. Keigwin, Jr.
Fungicide Branch, Chief

Date:

JAN 26 2004

- e. Add the following sentence to the first paragraph of the General Information section of the label: "Do not use this product without the Fumiguide. The Fumiguide is part of the labeling for this product and must be used to calculate the dosage." This same requirement must be specified in the Dosage and Exposure section of the label and in the Fumigation Manual (Chapter 5) and again on page 7-1 of the Fumigation Manual where it discusses the Fumiguide.
- f. On page 5 of the label, revise the sentence: "Two persons trained in the use of this product, at least one being an applicator licensed/certified by the state, must be present on site at all times during introduction of the fumigant, reentry prior to aeration, and initiation of the aeration procedure." to "Two persons trained in the use of this product, at least one being an applicator licensed/certified by the state, must be present on site at all times during introduction of the fumigant, reentry prior to aeration, initiation of the aeration procedure, and when testing for reentry after aeration (if aerated in an enclosed space)." This revision must be made in all instances where it appears on both the label and Fumigation Manual (e.g., pages 6-2, 8-1, and 8-3).
- g. On page 7 of the label, revise "(ventilation/wearing of SCBA)" to "(ventilation and wearing of SCBA)".
- h. On page 8 of the label, add the restriction under the heading Fumigation of Surface Ships in Port: "Submarines and other below-the-surface ships must not be treated with Profume."
- i. On page 10, revise the phrase: "The maximum target dosage for all normal atmospheric pressure and vacuum chamber fumigations in the Profume Fumiguide is 1500 CT." to "The maximum target dosage for all normal atmospheric pressure (NAP) fumigations is 1500 CT (1500 oz-h/1000 cubic feet) and for vacuum chamber fumigations is 200 CT (200 oz-h/1000 cubic feet)."
- j. On page 10 revise the phrase: "The target insects in the Profume Fumiguide are: " to "The target insects for Profume are: "
- k. The Preparation for Fumigation section of the label and the Fumigation Manual (Chapter 4) must state that: "Prior to fumigation the "Fact Sheet for Profume Gas Fumigation (Sulfuryl fluoride)" must be provided to the property owner/customer and the Fact Sheet must be signed prior to fumigation." The "Fact Sheet for Profume Gas Fumigation (Sulfuryl fluoride)" must be provided with the label and Fumigation Manual.
- l. The introduction of the Fumigation Manual must be revised to indicate that the Fumigation Manual is considered part of the labeling for this product and changes to it are made by label amendments.
- m. On page 1-1 under the heading Profume label, delete the sentence "Labels are periodically revised and available through DowAgroSciences or your authorized Profume distributor."
- n. On the page (which is not numbered) with the heading "Profume Valve Stem Adjustments in the Field, revise the sentence "Only persons appropriately trained for Hazardous Material handling should perform this task. " to "Only persons appropriately trained for Hazardous Material handling are permitted to perform this task."
- o. On page 4-1 delete the sentence "As an additional reference, a compilation of GOOD PRACTICES published by the National Pest Management Association (NMPA) is available." The information can and should be presented in the training for Profume; however is should not appear on the label.

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- p. On page 4-3, of the Fumigation Manual it should be clarified that the Profume concentration in any occupied connected space must never exceed 1 ppm. The following sentence should be added to this section: "If Profume concentrations approach 1 ppm then the sealing of the connected space from the fumigated area is probably not working and the space must either be evacuated or the Profume concentration must be continuously monitored to prevent exposure greater than 1 ppm. SCBA must be worn if the concentration exceeds 1 ppm."
- q. On page 4-6, delete the paragraph: "The question naturally arises: "If Profume penetrates wood so well can it be confined for fumigation?" Surprisingly, the relative ease of confinement is characteristic of the product and one of its major advantages."
- r. On page 5-1, of the Fumigation Manual revise "The maximum target dosage in the Profume Fumiguide is 1500 CT." to: "The maximum target dosage for normal atmospheric pressure (NAP) is 1500 CT (1500 oz-h/1000 cubic feet)."
- s. On page 5-1, of the Fumigation Manual revise "For vacuum fumigations, the maximum target concentration is 128 oz/1000 cu ft, and the maximum dosage is 2000 CT." to "For vacuum fumigations, the maximum target concentration is 128 oz-h/1000 cu ft, and the maximum target dosage is 200 CT (200 oz-h/1000 cubic feet)."
- t. On page 5-8, define "MCF" as 1000 cubic feet (MCF).
- u. On page 6-5 revise the paragraph that states: "The TIF 5750 and XP-1 manufactured by TIF Instruments, Inc., Miami, Florida, can detect Profume concentrations over 50 ppm. If a sustained high concentration of Profume is detected outside the fumigation area during fumigant introduction, stop introducing the fumigant." to "The TIF 5750 and XP-1 manufactured by TIF Instruments, Inc., Miami, Florida, can detect Profume concentrations over 50 ppm. These devices can be only used to check cylinders for significant leaks. A device capable of measuring to 1 ppm Profume must be used for all other tasks."
- v. On page 8-4 (top left), revise the phrase "(i.e., ventilation or respiratory protection)" to "(i.e., ventilation and respiratory protection)"
- w. Add the following to the last paragraph in the Reentry section of the label (page 11): "If large amounts of bulk commodity are fumigated Profume levels could increase in enclosed spaces after initially reaching 1 ppm, especially is active aeration is discontinued. Profume levels must be monitored to make sure exposure does not exceed 1 ppm."

2. Understand that the Agency considers the label, the Fumigation Manual and the Fumiguide as part of the labeling for this product.

3. Submit the following studies conducted in accordance with the Good Laboratory Practice Standards, 40 CFR part 160; the Data Requirements for Registration Regulations, 40 CFR Part 158; and the appropriate test guidelines as referenced in 40 CFR Part 158::

SEE THE ATTACHMENT "CONDITIONS OF REGISTRATION"

4. Submit production information (pounds or gallons produced) for this product for the fiscal year in which the uses are conditionally registered in accordance with FIFRA section 29. The fiscal year begins October 1 and ends September 30. Production information must be submitted to the Agency

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no later than November 15 following the end of the preceding fiscal year. This information must be submitted to:

U.S. Environmental Protection Agency
Office of Pesticide Programs
Registration Support Branch
Registration Division (7505C)
Washington, DC 20460

If the conditions enumerated above are not complied with, the registration will be subject to cancellation in accordance with FIFRA Section 6(e). Your release for shipment of the product constitutes acceptance of these conditions. A stamped copy of the label is enclosed for your records. Submit one copy of the revised final printed label before releasing the product for shipment.

Enclosure:

- 1) Label "Accepted with comments"
- 2) Condition of Registration

CONDITIONS OF REGISTRATION

1. Submit and/or cite all data required for registration of your product under FIFRA Section 3(c)(7)(A) when the Agency requires all registrants of similar products to submit such data; and submit acceptable responses required for reregistration of your product under FIFRA Section 4.

2. Within two years of the date of this registration, conduct and submit an inhalation developmental neurotoxicity study in rats (Guideline No. 870.6300) in order to more clearly and fully characterize the potential for neurotoxic effects of sulfuryl fluoride in young animals. A protocol must be submitted for Agency review within 90-days of the date of this registration.

3. Residue Chemistry
 - a. Additional residue data analyzing for sulfuryl fluoride and fluoride anion must be submitted from samples from at least three different grain mills that were treated according to the proposed maximum use rate. The matrices to be analyzed must include raw and processed commodities of wheat, rice, sorghum, and corn. These data are required within two years of the date of this registration.

 - b. Additional residue data analyzing for sulfuryl fluoride and fluoride anion must be submitted for dried fruit and nut magnitude of the residue studies. The additional residue data are required within two years of the date of this registration. A protocol should be submitted to the Agency within 90-days. This protocol should address how fluoride levels in raisins related to sulfuryl fluoride treatment versus fluoride residues that are present from either treatment of grapes with cryolite and/or naturally present in grapes/raisins.

 - c. Cereal grain commodities, including aspirated grain fractions, are significant livestock feed items. Therefore, the Agency requires data defining possible transfer of fluoride from feedstuffs into livestock commodities be submitted within two years of the date of this registration. A protocol must be submitted for Agency review within 90-days of the date of this registration. The protocol must address the dose levels to be used in the study.

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Profume gas fumigant

Analytical Methods

d. The Agency has concerns related to the ability of the analytical method to extract weathered residues. Data showing the ability of the sulfuryl fluoride and fluoride anion methods to extract and accurately quantify weathered residues in raw and processed cereal grain matrices. In addition, an interference study for sulfuryl fluoride must be submitted as the current method for sulfuryl fluoride is not specific to that chemical. The data are required within one year of the date of this registration.

4. Occupational and Residential Exposure

Data describing actual sulfuryl fluoride exposures to workers involved in fumigation and post-fumigation activities must be submitted within two years of the date of this registration. Additionally, data depicting concentration of sulfuryl fluoride in air from areas surrounding fumigation facilities to determine bystander exposure must be submitted within two years of the date of this registration. A protocol must be submitted for Agency review within 60-days of the date of this registration.

5. Understand that as part of the Office of Water's Six-Year Review of the existing fluoride MCL and SMCL, a subcommittee of the National Academy of Sciences' National Research Council's (NRC) Committee on Toxicology (COT) is currently reviewing toxicologic, epidemiologic, and clinical data, particularly data published since 1993, and exposure data on orally ingested fluoride from drinking water and other sources (e.g., food, toothpaste, dental rinses). Subsequent to this review, the Office of Water will undertake an analysis to assess the adequacy of the current maximum contaminant level goal (MCLG) and secondary maximum contaminant level (SMCL) for fluoride. If the Office of Water determines that revisions to either the MCLG or the SMCL are required or if the Agency subsequently determines that dental fluorosis is an adverse health effect under the Federal Food, Drug, and Cosmetic Act, the Agency may undertake a re-evaluation of the adequacy of the tolerances established for sulfuryl fluoride and fluoride as a result of this or subsequent registration actions for this product.

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G1A / ProFume / Proposed Section 3 / 01-20-04
file: ProFume-XXX Prop Sec 3 20Jan04d.doc

ProFume*

EPA Reg. No. 62719-XXX

Registration Notes:

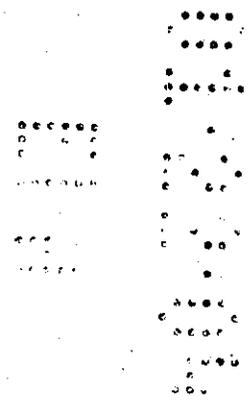
Proposed Section 3 label for fumigation of non-residential structures such as: mills, warehouses, stationary transportation vehicles (railcars, trucks, etc., excluding aircraft), temporary and permanent fumigation chambers, and storage structures.

*Trademark of Dow AgroSciences LLC

**ACCEPTED
with COMMENTS
In EPA Letter Dated:**

JAN 26 2004

Under the Federal Insecticide,
Fungicide, and Rodenticide Act,
as amended, for the pesticide
registered under EPA Reg. No.
62719-376



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(Label)

**RESTRICTED USE PESTICIDE
DUE TO ACUTE INHALATION TOXICITY**

For sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicator's certification. An applicator licensed/certified by the state must be present on site at all times during introduction of fumigant, reentry prior to aeration, and initiation of the aeration procedure.

(Logo) Dow AgroSciences

ProFume*

For control of postharvest insect and rodent pests.

Sites to be fumigated: Non-residential structures such as: mills, warehouses, stationary transportation vehicles (railcars, trucks, etc., excluding aircraft), temporary & permanent fumigation chambers, and storage structures.

When fumigating, all local, state, and federal rules and regulations regarding use of detection devices, positive-pressure self-contained breathing apparatus, security requirements, and placement of warning signs must be observed.

Read the entire label and ProFume gas fumigant Fumigation Manual before use. The ProFume gas fumigant Fumigation Manual for this product contains important information for the safe and effective use of this product and must be read and in the user's possession during fumigation. If the ProFume gas fumigant Fumigation Manual is lost, contact your ProFume distributor or Dow AgroSciences representative to obtain a replacement copy.

Active Ingredient	
sulfuryl fluoride	99.8%
Inert Ingredients	0.2%
Total	100.0%

10.8 lb active ingredient per gallon (liquid in cylinder)

Keep Out of Reach of Children

DANGER  POISON

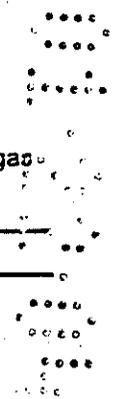
[Editors note: the word POISON must appear in red]

PELIGRO

Si usted no entiende la etiqueta ni el manual de fumigación del gas fumigante ProFume, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label nor ProFume gas fumigant Fumigation Manual, find someone to explain it to you in detail.)

Precautionary Statements

Hazards to Humans and Domestic Animals



Danger • Fatal If Inhaled • Causes Irreversible Eye Damage • Liquid Causes Freeze Burns Of Exposed Skin • May Be Fatal If Swallowed

Do not breathe vapor. Do not get in eyes, on skin, or on clothing. ProFume is odorless and colorless. Exposure to toxic levels may occur without warning or detection by the user.

Personal Protective Equipment for Fumigation

Protective Clothing

Wear splash resistant goggles or full face shield when handling the liquid product during introduction of fumigant or when working around any lines containing fumigant under pressure. Do not wear gloves or rubber boots. Do not reuse clothing or shoes that have become contaminated with liquid ProFume until thoroughly aerated. Wear loose fitting or well-ventilated long-sleeve shirt, long pants, shoes and socks.

Respiratory Protection

If the concentration of ProFume in the fumigated area as measured by an approved detection device with sufficient sensitivity [Limit of Detection (LOD) \leq 1 ppm] such as an INTERSCAN gas analyzer [Model GF 1900] or MIRAN vapor analyzer [SapphiRe] does not exceed 1 ppm, no respiratory protection is required. When this concentration is exceeded, all persons in these areas must wear a NIOSH or MSHA approved positive pressure self-contained breathing apparatus (SCBA, not SCUBA), approval number prefix TC-19C, or combination air-supplied/SCBA respirator such as manufactured by Ranger, Survivair, Scott, or MSA. This SCBA must be on site and operational before fumigation. Before using any make or brand of SCBA, learn how to use it correctly. Determine that it is in good working order, has an adequate air supply for the job at hand, fits properly, and provides an adequate seal around the face.

First Aid

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

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

If on skin or clothing: Immediately apply water to contaminated area of clothing before removing. Once area has thawed, remove contaminated clothing, shoes, and other items covering skin. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

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

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

Have the product label or ProFume gas fumigant Fumigation Manual with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-992-5994 for emergency medical treatment information.

Environmental Hazards

Sulfuryl fluoride is a highly toxic gas. Do not expose non-target organisms. This pesticide is toxic to fish and wildlife.

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Physical or Chemical Hazards

Sulfuryl fluoride is a colorless, odorless toxic gas. ProFume cylinders are under pressure and must not be stored near heat or open flame. Exposures to temperatures above 158°F will cause a fusible plug to melt and the contents will be released. Under high heat conditions (temperatures above 752°F), ProFume can decompose into sulfur dioxide (SO₂), hydrofluoric acid (HF), and other decomposition products. Hydrofluoric acid is highly reactive and can corrode or damage many materials including metals, glass, ceramic finishes, fabrics, etc. Extinguish all flames including pilot lights of furnaces, hot water heaters, dryers, gas refrigerators, ranges, ovens, broilers, and open flames. Turn off or unplug all electrical heating elements such as those in heaters, dryers, etc. Shut off automatic switch controls for appliances and lighting systems that will be included in the space to be fumigated. Contact your local gas company to determine what procedures should be followed in your area for shutting off natural gas or propane service. Gas service should be shut off at the main service valve. Sulfuryl fluoride can react with strong bases such as some photo developing solutions.

Refer to the ProFume gas fumigant Fumigation Manual for additional precautionary information and Directions for Use.

Notice: Read the entire label. Use only according to label directions. Before using this product, read Warranty Disclaimer, Inherent Risks of Use and Limitation of Remedies elsewhere on the label. If terms are unacceptable, return at once unopened.

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

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

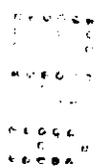
EPA Reg. No. 62719-XXX

EPA Est. _____

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

Gas Fumigant

Net Contents _____



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Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
Read all Directions for Use carefully before applying.

Storage and Handling

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

Pesticide Storage: Store in a dry, cool, well ventilated secured and locked area. Post as a pesticide storage area. Store cylinders upright; secured to a rack or wall to prevent tipping. Cylinders should not be subjected to rough handling or mechanical shock such as dropping, bumping, dragging, or sliding. Do not use rope slings, hooks, tongs, or similar devices to unload cylinders. It is recommended to transport cylinders using hand truck or fork truck to which the cylinder can be firmly secured. Do not transport cylinders in closed vehicles where the same common airspace is occupied by personnel. Transport securely only in an upright position.

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

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

Leak Procedures: Evacuate immediate area of leak. Use a NIOSH or MSHA approved positive pressure self-contained breathing apparatus (SCBA, not SCUBA) or combination air-supplied/SCBA respirator, such as manufactured by Ranger, Survivair, Scott, or MSA, for entry into affected areas to correct problem. Move leaking or damaged cylinder outdoors or to an isolated location, observing strict safety precautions. Work upwind if possible. Do not permit entry into leakage area by unprotected persons until concentration of fumigant is determined to be 1 part per million (ppm) or less, as determined by a detection device with sufficient sensitivity such as an INTERSCAN gas analyzer [Model: GF 1900] or MIRAN vapor analyzer [SapphiRe].

Pesticide Disposal: Promptly return all empty cylinders to the supplier of ProFume. All unused fumigant must be returned to the supplier of ProFume. Follow proper cylinder handling directions above. Supplier must return all cylinders to The Dow Chemical Company, Pittsburg, California facility.

Pesticide wastes are toxic. Improper disposal of excess pesticides is a violation of Federal law. If these wastes cannot be disposed of by use according to label instructions, consult your State Pesticide or Environmental Control Agency or Hazardous Waste office nearest your location.

General Information

Restricted Use Pesticide

Carefully read the label and ProFume gas fumigant Fumigation Manual before using. Never allow untrained individuals to apply ProFume® gas fumigant.

Notify appropriate owners, employees, and/or operators at the facility by providing the Fact Sheet for ProFume where the fumigation will occur. Provide relevant safety and health information to local fire and rescue officials for use in the event of an emergency. All entrances and all sides of the fumigated structure or fumigated space must have warning signs. See the section Posting of Fumigated Areas for details. Do not connect cylinders to introduction equipment until all fumigation warning signs have been posted and the space to be fumigated is clear of people, non-target animals and secured.

Compressed Gas Hazards

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Beechnut
 Butternut
 Cashew
 Chestnut
 Chinquapin
 Filbert
 Nut, Brazil
 Nut, hickory
 Nut, macadamia

Other
 Pistachio

Cereal and Small Grain Processed Products
 Corn, field, flour
 Corn, field, grits
 Corn, field, meal
 Rice, brown
 Rice, polished rice
 Rice, bran
 Rice, hulls
 Wheat, bran
 Wheat, flour
 Wheat, germ
 Wheat milled byproducts
 Wheat, shorts

Fumigation Conditions for Commodities

- For normal atmospheric pressure fumigations, do not exceed a maximum cumulative dosage of 1500 oz-h/1000 cu ft (Concentration [oz/1000 cu ft] x Exposure Time [hours]).
- For vacuum fumigations, do not exceed a maximum cumulative dosage of 200 oz-h/1000 cu ft.
- When fumigating tanks, silos, etc. of stored bulk flour, empty or draw down flour to less than 3 feet deep. Wheat flour not removed from the fumigation area must be blended at a ratio of at least 10:1 or discarded to ensure wheat flour offered to consumers does not exceed commodity tolerances.

Preparation for Fumigation

Note: All flames, including pilot lights, must be extinguished. All electrical heating elements must be turned off or unplugged.

All persons, non-target animals, and desirable growing plants must be removed from the space to be fumigated. When monitoring, place gas sampling lines at representative areas within the fumigated space. Use re-circulation fans as appropriate to rapidly disperse fumigant throughout the structure or enclosure.

Do not fumigate food products that are not listed on this label. All drugs (including tobacco products) and medicinals (including those items in refrigerators and freezers) need to be removed prior to fumigation. Any food or feed in rigid plastic, glass, or metal containers with the original manufacturer's airtight seal intact can remain in the space to be fumigated.

Sealing

Good sealing is necessary for an effective fumigation. Details on tarpaulin, taped and other sealing methods are described below. For additional recommendations on sealing techniques, refer to the ProFume gas fumigant Fumigation Manual.

Tarpaulin Sealing

When tarping a building for a space fumigation or stacked commodity for an enclosure fumigation, use only materials that effectively confine ProFume, such as a vinyl coated nylon or polyethylene sheeting of at least 4 mil thickness. All seams must be sealed. The edges of the cover that contact the floor or soil must be sealed by techniques such as taping the tarp to the floor or placing sand or water snakes over the edges of the tarp. To minimize escape of fumigant through the soil and to avoid injury to nearby plants, wet soil (if not sufficiently moist) around the structure to act as a barrier for the fumigant. When possible avoid walking on tarped, fumigated material to maintain seal during the exposure period.

Taped and Other Spot Sealing



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For fumigation enclosures that can be adequately sealed with materials such as plastic or tape, seal adequately around doors, windows, vents, and other openings. To minimize escape of fumigant through the soil and to avoid injury to nearby plants, wet soil (if not sufficiently moist) around the structure to act as a barrier for the fumigant.

To prevent excessive residues, minimize quantities of wheat flour in the structure or enclosure prior to fumigation. Likewise, special care should be taken to seal off non-target wheat flour storage areas prior to fumigation.

Connected Areas

A connected area is defined as any area connected with the space to be fumigated by construction elements that may allow passage of fumigant between the spaces. Any connected area must be vacated during the fumigation process unless it is isolated from the space to be fumigated by methods that prevent passage of the fumigant from the space to be fumigated into the connected area.

Note: Areas that have been isolated from the fumigated space must be vacated if required by state laws or regulations. When it is necessary to vacate areas that have been isolated, that area shall be considered as a fumigated space, and all applicable rules, regulations and label instructions apply, such as preparation, posting, securing, and aeration.

ProFume concentrations must be measured during the fumigation in any occupied connected space or structure until ProFume concentrations are ≤ 1 ppm to confirm that individuals in connected areas are not exposed to unacceptable ProFume levels. Use only an approved detection device of sufficient sensitivity, such as the INTERSCAN gas analyzer [Model GF 1900] or MIRAN vapor analyzer [SapphiRe], to confirm a concentration of ProFume of 1 ppm or less. Refer to the ProFume gas fumigant Fumigation Manual for additional information.

Securing Structure Entrances

To secure the structure against unauthorized entry during the fumigation, use a locking device or barricade on all exterior doors or doorways. A locking device or barricade must be demonstratively effective in preventing an exterior door or doorway from being opened using normal opening or entering processes by anyone other than the certified applicator in charge of the fumigation or persons in their on-site direct supervision. Consult state and local regulations for any supplementary instructions and local restrictions on securing against entry. Refer to the ProFume gas fumigant Fumigation Manual for additional information.

Posting of Fumigated Areas

All entrances and all sides of the fumigated structure or fumigated space, including vehicles, ships, stacks and chambers and any connected area not monitored must have warning signs. Do not allow entry by unprotected persons into fumigated area until the signs are removed. Signs must remain legible during the entire posting period. Warning signs should be placed in advance of the fumigation in order to keep unauthorized persons away. The warning signs must be printed, in English and Spanish, with:

- The signal word DANGER/PELIGRO and the SKULL and CROSSBONES symbol in red.
- The statement, "Area under fumigation, DO NOT ENTER/NO ENTRE."
- The date and time of fumigation.
- Name of fumigant used.
- Name, address, and telephone number of the fumigation company and licensed/certified applicator.

Transfer of incompletely aerated commodity to a new storage site within the facility is permissible. However, the new storage site must have warning signs if breathing zones around the commodity contain 1 ppm or greater of ProFume. Workers who handle incompletely aerated commodity must be informed and appropriate measures must be taken (ventilation/wearing of SCBA) to prevent any exposure above 1 ppm.

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Only a state licensed/certified applicator may authorize removal of warning signs. The warning signs may be removed only when the concentration of ProFume within the fumigated area is 1 ppm or less. Before introducing the fumigant, verify that all required safety equipment is available and in good working order. Refer to the ProFume gas fumigant Fumigation Manual for additional information.

Fumigation of Surface Ships in Port

Surface ships and barges may be fumigated with ProFume, but all aeration procedures must be completed before these vessels are allowed to sail. Only those persons involved in the fumigation may be on board during fumigation, including the aeration process.

The professional fumigator and the ship's captain (or owner) shall follow all applicable regulations including those listed in the Coast Guard, DOT, Title 46, Shipping, section Parts 147A.1-147A.43. Except for those persons involved in fumigation, no people, desirable plants, or pets may be on-board during fumigation.

The vessel must not be moved during the fumigation and aeration periods. If reentry is necessary before aeration is completed, positive pressure self-contained respiratory protection must be worn.

Stationary Vehicle Fumigation Preparation

Stationary vehicles should be prepared and sealed following general fumigation, tarpaulin and tape sealing instructions above. Trailers, trucks, containers, etc. may be fumigated with ProFume, but all aeration procedures must be completed before these are transported over public roads. Refer to the ProFume gas fumigant Fumigation Manual for additional information.

Note: All flames, including pilot lights, must be extinguished. All electrical heating elements must be turned off or unplugged.

Fumigation of Tarped-Stack and Chambers Outdoors

For fumigation of tarped-stacks or chambers outdoors, follow all instructions in this label and the ProFume gas fumigant Fumigation Manual for structures containing commodities.

Tarped-Stack Fumigations Within Structures

ProFume may be used to fumigate stacked commodities by covering the commodity with highly fumigant-resistant tarpaulins and then sealing them to the subsurface to create a temporary fumigation chamber (tarped-stack). Secure (see Securing Structure Entrances) and post warning signs (see Posting of Fumigated Areas) on enclosing structure. If applicable, follow instructions for Connected Areas above.

All personnel not trained or not involved in the fumigation must be vacated from the structure in which the tarped-stack fumigation is occurring until the fumigation is completed and the structure has been cleared for reentry (see Aeration and Reentry sections below).

The indoor areas around the tarped stack must be monitored for ProFume concentrations when fumigation workers, without proper respiratory protection (SCBA), are present within the structure. Perform air monitoring by utilizing a detection device with sufficient sensitivity such as an INTERSCAN gas analyzer [Model GF 1900] or MIRAN vapor analyzer [SapphiRe] to ensure that workers are not exposed to concentrations of ProFume exceeding 1 ppm.

No one is permitted to be in an area where the concentration is greater than 1 ppm without proper respiratory protection (SCBA). Refer to the ProFume gas fumigant Fumigation Manual for additional information.

Permanent Chamber Fumigations Within Structures

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Fumigations with ProFume may be conducted in permanent fumigation chambers enclosed within, or connected to, a larger structure. A permanent chamber is defined as a durable hard-walled structure engineered specifically for fumigation that effectively confines ProFume.

Monitor indoor areas around the permanent fumigation chamber for ProFume concentrations during the fumigation, especially during introduction. No one is permitted to be in an area where the concentration is greater than 1 ppm without proper respiratory protection (SCBA).

Aerate ProFume from the chamber by venting the fumigant directly to the outside of the structure using a ventilation system that does not release ProFume into the structure in which the chamber is located. Refer to the ProFume gas fumigant Fumigation Manual for additional information.

Introducing the Fumigant

Do not apply for insect control when temperature at the site of the pest is below 40°F. This restriction does not apply when fumigating for rodents. To prevent damage, do not apply liquid fumigant directly to any surface within the fumigation area. Refer to Chapter 5 of the ProFume gas fumigant Fumigation Manual for more information on permissible temperature conditions.

ProFume is packaged as a liquid under pressure and requires a heat source for conversion of the liquid to a gas during introduction. The heat source can be the air around the introduction site or mechanical heat exchanging systems. Consult the ProFume gas fumigant Fumigation Manual and the Fumiguide™ program for ProFume (ProFume Fumiguide) for fumigant introduction options and instructions. The introduction system must:

- Prevent breakdown or contamination of ProFume
- Confine ProFume until it is released into the fumigation area
- Prevent liquid sulfuryl fluoride from contacting surfaces which could be damaged or the commodity within the fumigation area
- Prevent a fog-out in the fumigation area. A fog-out is substantial condensation of moisture inside a fumigated structure that is caused by the air temperature dropping below the dew point.

ProFume must be introduced from the cylinder through a suitable leak-proof delivery system (hoses, connectors, gauges, solenoids, etc.) with a minimum burst pressure of 500 lb per square inch. It is recommended to:

- Release the fumigant into a large open space.
- Direct the fumigant into the blast of air from a fan(s) having a capacity of at least 1000 cu ft per minute per pound of ProFume released per minute.
- Introduce no more than 4 cylinders per introduction site.
- Have one introduction site per every 75,000 cu ft.

Damage to materials can occur if the rate of ProFume release exceeds fan capacity.

The flow of liquid gas in the introduction hose may be a source of static electricity. To prevent the risk of static sparking, securely attach a length of copper tubing with approved fittings to the end of the introduction hose. All tubing and connections must be compatible with liquid ProFume and have a burst pressure of at least 500 psi. Attach the copper tubing with a grounding wire to the fan cage frame or to a neutral ground. The copper tubing mounted at the end of the introduction hose must be securely attached to the fan or some other stable object.

Dosage and Exposure Time

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The target dosage is the product of fumigant Concentration x Exposure Time (CT). However, the impact of concentration (C) and time (T) on control of the target pest varies and is more accurately represented by $C^m T$. The Fumiguide program* for ProFume gas fumigant (ProFume Fumiguide) uses specific $C^m T$ formulas based on the pest, life stage, temperature, and exposure period to determine target dosages for specific fumigation scenarios. The maximum target concentration in the ProFume Fumiguide is 128 oz per 1000 cu ft (for all normal atmospheric pressure and vacuum chamber fumigations). The maximum target dosage for all normal atmospheric pressure and vacuum chamber fumigations in the ProFume Fumiguide is 1500 CT. Read the ProFume gas fumigant Fumigation Manual for additional instructions on calculating dosages using the ProFume Fumiguide.

The target dosage can thus be calculated by inputting into the ProFume Fumiguide the target species, life stage, temperature, and exposure time. The target dosage can thus be calculated by inputting into the ProFume Fumiguide the target species, life stage, temperature, and exposure time. Then, to calculate the amount of fumigant to be introduced, input the estimated fumigant loss rate measured as half-loss time (HLT) and volume of the area to be fumigated. Based on the calculated target dosage, exposure time, HLT, and volume of the area to be fumigated, the ProFume Fumiguide will calculate the initial target concentration and amount of ProFume to be initially introduced.

For fumigation to control rodents, use sufficient gas to accumulate at least 36 ounce-hours following equilibrium, regardless of ambient air temperature.

Monitoring concentrations of ProFume within the fumigated area is recommended for fumigation accuracy. If monitoring, take fumigant concentration readings from the exposure area with an appropriate monitoring device such as a Fumiscope. Input these monitoring results into the ProFume Fumiguide to calculate the actual HLT. The ProFume Fumiguide provides the accumulated dosage and then will calculate any additional amount of fumigant and/or increase in exposure time necessary to achieve the target dosage. Add any necessary fumigant and/or extend fumigant exposure time to achieve the target dosage.

Efficacy

ProFume may be used to control infestations of insect and rodent pests of food, feed, commodities and the structures where these are stored or processed. Total insect control is possible under optimum environmental and fumigation conditions. However, for some less susceptible insects, egg stage tolerance combined with cool temperatures may limit the potential for total control of the infestation. Other contributing factors are fumigation process related including leaky structures, inadequate fumigant distribution, etc.

The target dosage must be calculated with the ProFume Fumiguide. Target species, life stage, temperature, and exposure time unique to each fumigation must be entered into the ProFume Fumiguide. The target insects in the ProFume Fumiguide are: confused flour beetle, red flour beetle, sawtoothed grain beetle, warehouse beetle, Indian meal moth, Mediterranean flour moth, codling moth, navel orangeworm, granary weevil, rice weevil, and other moths and beetles.

Sequential Fumigations

Sequential fumigations are an alternative dosage strategy that may be used to control insect infestations in which eggs are present. Fumigate once at the dosage sufficient for control of the post-embryonic (larva, pupa, adult) stages. After any surviving insect eggs have hatched, but prior to these insects' maturation and deposition of new eggs, fumigate a second time, again at the post-embryonic life stage dosage.

Aeration and Reentry

Aeration

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Aerate the enclosure or structure using active ventilation methods. Control the ventilation process to ensure workers and bystanders are not exposed to concentrations that exceed acceptable levels.

The perimeter of the fumigation area, especially downwind, must be monitored to ensure that sulfuryl fluoride concentrations are kept within acceptable levels outside the fumigation area. Refer to the ProFume gas fumigant Fumigation Manual for additional information on aeration by fumigation type, i.e., chambers, structures, enclosures, etc.

Fumigant may dissipate slower from bulk food commodity than ambient air. Actively aerate food commodity for a minimum of 24 hours prior to offering to consumers. Refer to the ProFume gas fumigant Fumigation Manual for additional information on Handling Un-aerated Commodities.

Reentry

No one shall be in fumigated areas if the level of ProFume is above 1 ppm unless wearing a NIOSH or MSHA approved positive pressure self-contained breathing apparatus (SCBA, not SCUBA) or combination air supplied/SCBA respirator, such as manufactured by Ranger, Survivair, Scott, or MSA. **Note: When in the fumigated area during the aeration procedure, approved respiratory protection must be worn until concentration of ProFume is confirmed not to exceed 1 ppm with an approved monitoring device.**

Only an approved detection device of sufficient sensitivity, such as the INTERSCAN gas analyzer [Model GF 1900] or MIRAN vapor analyzer [SapphiRe], can be used to confirm a concentration of ProFume of 1 ppm or less. The Interscan gas analyzer Model GF 1900 must be calibrated within one month prior to use as a detection device. All other approved detection devices must be calibrated according to manufacturer recommendations. The concentration of ProFume must be monitored in breathing zones. The structure or space being fumigated must remain posted for fumigation until cleared for reentry.

Measure the concentration of ProFume in the breathing zones of the structure or enclosure. When the concentration is measured to be 1 ppm, the structure or space being fumigated is cleared for reentry.

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

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It is impossible to eliminate all risks associated with use of this product. Lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label, such as low temperature, etc.), abnormal conditions (such as excessive winds, tornadoes, hurricanes), presence of other materials (poor sanitation, large amounts of infested product), the manner of application, or other factors, all of which are beyond the control of Dow AgroSciences or the seller. All such risks shall be assumed by buyer.

Limitation of Remedies

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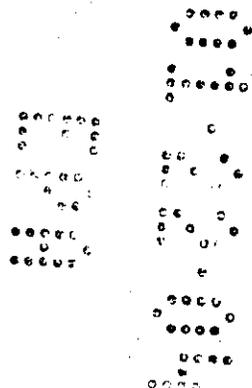
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 Dow AgroSciences

ProFume

Gas Fumigant

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Fumigation Manual

United States Edition

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Appendix Chapter 12

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(Temp, Volume, Wind Speed)

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How to Measure a Space to be Fumigated with ProFume Gas Fumigant

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FUMIGATING WITH PROFUME GAS FUMIGANT.....

INTRODUCTION

ProFume* gas fumigant, (sulfuryl fluoride) is registered to be used exclusively by professional fumigators control existing infestations of stored product insect pests in non-residential structures such as: mills, warehouses, stationary transportation vehicles (rail cars, trucks, etc., excluding airplanes), temporary and permanent fumigation chambers, and storage structures and the commodities and foods within them.

The purpose and objective of this technical manual are to:

1. *Supplement and support the label for ProFume gas fumigant.*
2. *Reinforce the safe and effective use of this product.*
3. *Increase the understanding and adoption of Precision Fumigation™ principles and practices.*

Read the entire label and Fumigation Manual before use. The ProFume Fumigation Manual contains important information for the safe and effective use of this product and must be read and in the user's possession during fumigation. If the Fumigation Manual is lost, contact your ProFume distributor or your Dow AgroSciences representative to obtain a replacement copy.

This manual is not intended to supercede label requirements or state and local regulations. This manual will be periodically revised to reflect additional use patterns or label modifications, and knowledge obtained through continuing research and experience. The manual includes recommendations for using ProFume and describes the safe handling and storage of this product.

Each fumigator using ProFume is responsible for complying with all federal, state, and local regulations or codes regulating the use of this product. The development of this guide included the study and interpretation of many codes and regulations considered relevant to the use of ProFume. However, because regulations and the enforcement of regulations can change, the

fumigator will need to stay informed about state and local regulations in areas where they operate.

State and local government offices, ProFume distributors, or Dow AgroSciences sales representatives from your area can help identify the agencies responsible for regulating fumigation practices in your area.

LEGAL RAMIFICATIONS OF CONDUCTING FUMIGATIONS WITH PROFUME

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

Dow AgroSciences warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions therein under normal conditions of use. THIS IS THE ONLY WARRANTY MADE ON THIS PRODUCT. NO OTHER EXPRESS OR NO IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE IS MADE OUTSIDE OF THIS LABEL. Therefore, neither this warranty nor any other warranty of merchantability or fitness for a particular purpose, express or implied, extends to the use of this product contrary to label instructions (including conditions noted on the label, such as unfavorable temperatures, soil conditions, etc.), under abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes, etc.) or under conditions not reasonably foreseeable to or beyond the control of seller.

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ProFume is a Restricted Use Pesticide.

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When buyer or user suffers losses or damages resulting from the use or handling of this product (including claims based on contract, negligence, strict liability, or other legal theories), buyer or user must promptly notify Dow AgroSciences in writing of any claims to be eligible to receive either remedy given below. The **EXCLUSIVE REMEDY OF THE BUYER OR USER** and the **LIMIT OF LIABILITY** of Dow AgroSciences or any other seller will be one of the following, at the election of Dow AgroSciences:

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

The seller will not be liable for consequential or incidental damages or losses.

The terms of this Warranty Limitations and Disclaimer cannot be varied by any written or verbal statements or agreements. Any employee or sales agent of the seller is not authorized to vary or exceed the terms of this Warranty Limitations and Disclaimer in any manner.

GLOSSARY

To assist the reader, a glossary of terms associated with fumigation activities has been provided in Chapter 13.

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PRODUCT INFORMATION 1

ProFume* gas fumigant is a product developed by Dow AgroSciences to control existing infestations of stored product insect pests in non-residential structures such as: mills, warehouses, stationary transportation vehicles (rail cars, trucks, etc., excluding airplanes), temporary and permanent fumigation chambers, and storage structures and the commodities and foods within them; as well as other structures containing foods and commodities.

PROFUME GAS IS A RESTRICTED USE PESTICIDE DUE TO ACUTE INHALATION TOXICITY.

Due to its toxic and penetrating qualities, ProFume is excellent for controlling a broad spectrum of pests, including insects and rodents. The pests for which ProFume is commonly used include Indian Meal Moth (*Plodia interpunctella*), Mediterranean Flour Moth (*Ephesia kuehniella*), Codling Moth (*Cydia pomonella*), Navel Orange Worm (*Amyelois transitella*), Flour Beetles (*Tribolium spp.*), Saw-toothed grain beetle (*Oryzaephilus surinamensis*), warehouse beetle (*Trogoderma variable*), granary weevil (*Sitophilus granarius*), rice weevil, (*Sitophilus oryzae*) and rats and mice. These are discussed in more detail in Chapter 5.

For detailed information on pests associated with these sites and the recommended practices for fumigating to control these pests, consult the product label or the pest biology information in Chapter 5).

ProFume Label The label is a legal document. Use of the product in any manner inconsistent with the label is illegal. Labels are periodically revised and available through Dow AgroSciences or your authorized ProFume distributor.

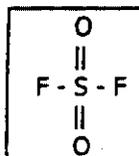
PHYSICAL PROPERTIES

Sulfuryl fluoride is a colorless, odorless toxic gas. ProFume cylinders are under pressure and must not be stored near heat or open flame. Exposures to temperatures above 158°F will cause a fusible plug to melt and the contents will be released. Heaters, pilot lights and open flames must be extinguished as temperatures above 752°F will cause decomposition products to be formed which can be corrosive and can etch glass and metal.

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ProFume is a Restricted Use Pesticide.

Sulfuryl fluoride can react with strong bases such as some photo developing solutions.

Structural formula: SO₂F₂



Molecular Weight: 102.07 AMU

Color: None

Odor: None

Specific Gravity: 1.35 at 20°C (68°F)

Vapor Density: 4.3 g/l at 20°C (68°F) air = 1

Vapor Pressure: 15.2 atm at 20°C (68°F)

Boiling Point: -55.2°C (-67°F)
at 760 mmHg

Gas Solubility at 25°C (77°F) at 760 mm Hg:
In water 0.075% (750 ppm) by weight, only slightly soluble in organic solvents and vegetable oils.

Stability: Stable to temperatures normally encountered in space fumigations. Non-flammable under normal conditions in all atmospheric concentrations. However, heaters and open flames must be extinguished as temperatures over 400°C (752°F) will cause decomposition products to be formed which can be corrosive and can etch metal and glass. (See Troubleshooting, Chapter 11.)

Heat of Vaporization: 81.1 BTU/pound at -55°C (-67°F) or 188.1KJ/kg. 1 lb of sulfuryl fluoride = 4.45 moles. 1.0 pound of ProFume will lower 1,000 cubic feet of dry air by 2.5°C (4.5°F).

Volume per Pound: One pound of gas occupies 3.8 cubic feet at 25°C (77°F) and 760 mm Hg. One pound of gas per 1,000 cubic feet of unoccupied space equals approximately 3,850 ppm at room temperature and pressure (25°C at 760 mm Hg).

Hydrolysis: Hydrolysis slow in water, but more rapid in basic solutions.

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Reactivity: Sulfuryl fluoride is relatively non-reactive as a gas. No malodor or corrosive effects have been detected when the chemical has been used as directed.

Sulfuryl fluoride can react with strong bases such as some photo developing solutions. (See Trouble-shooting, Chapter 11.)

COMPOSITION

ProFume is an inorganic chemical and is composed of (By weight):

Active Ingredient: Sulfuryl fluoride	99.8%
Inert Ingredients:	0.2%
	100%

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CYLINDER STORAGE AND USE 2

ProFume* gas fumigant is toxic to most living organisms including humans. It is colorless, odorless, packaged as a liquid gas under pressure, and has no warning properties. **ProFume must only be used by certified professional applicators that have completed the ProFume training program.**

ProFume is present in each cylinder in both the gas and liquid phases. The product comes out of the tank through the riser or dip tube as a liquid. However, the last 1.5-2 kg (3-5 lbs) of ProFume will be released as gas or a combination of gas and liquid. ProFume introduction in the gas phase often takes longer to move through the hose (see Figure 2a for cylinder diagram).

CYLINDER SAFETY

General Cylinder Information

Cylinders containing ProFume must be properly and legibly labeled at all times. If labels become damaged or lost during shipment or use, additional cylinder labels can be obtained from Dow AgroSciences.

ProFume is sold as a compressed liquid gas in a high-pressure cylinder and must be handled, stored and transported with caution. Every cylinder should be inspected upon delivery for damage. If the cylinder is damaged, immediately return the cylinder to the ProFume distributor.

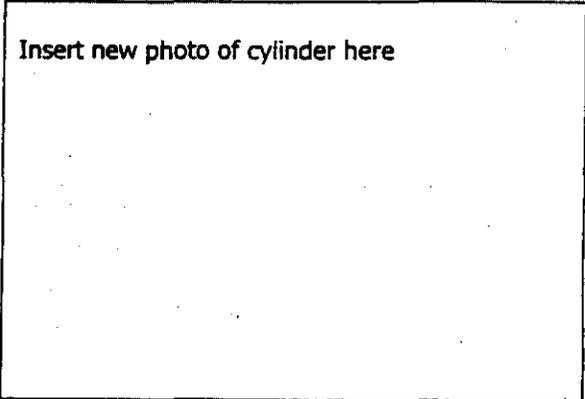
No additional gas is used to pressurize the cylinder. Each *full* cylinder contains 57 kg (125 lbs) of product normally under about 1380-2070 kPa (200-300 psi). Table 2a below shows range of cylinder pressures at various temperatures.

TABLE 2a
ProFume Cylinder Pressure of
At Various Temperatures

Temperature		Pressure	
°F	°C	kPa	(PSIA) ¹
0	-17.8	490	71
10	-12.2	594	86
20	-6.7	710	103
30	-1.1	849	123
40	4.4	1000	145
50	10.0	1173	170
60	15.6	1366	198
70	21.1	1580	229
80	26.7	1822	264
90	32.2	2090	303
100	37.8	2386	346
110	43.3	2712	393
120	48.9	3072	445
130	54.4	3469	502
140	60.0	3906	566
150	65.6	4389	636

¹Pounds per Square Inch Absolute

Figure 2a
ProFume Cylinder Diagram



ProFume cylinders are equipped with a 1.030" right-hand thread, 14 threads per inch, straight thread fitting. This is comparable to a 3/4" NPTS pipefitting thread (pipefitting is not the same as a hose fitting). A gasket supplied with each cylinder must be used at the valve connection to prevent fumigant leakage.

Cylinder Storage

Store ProFume cylinders in a dry, cool, well ventilated, secure, and locked area. Post as a pesticide storage area. All cylinders (full, partially full, or empty) should be stored in an upright (vertical) position with safety caps and protective bonnets securely in place. Secure ProFume cylinders to prevent being knocked over during storage, transport, weighing, and fumigant release. Secure in a manner, which does not deface the label.

Keep the safety cap and protective bonnet on cylinders except when introducing the fumigant

Various state and local authorities may regulate the storage of ProFume. Be certain to check with the appropriate authorities in your area.

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If cylinders are stored in an enclosed area without proper ventilation, the area must be tested for leaks using an Interscan or Miran analyzer so persons entering or working in the general area will not be exposed to concentrations of sulfuryl fluoride over 1 ppm (see Chapter 8, Clearance Testing). Contact your state and local authorities for additional guidelines.

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

Cylinder Transport

Always transport cylinders capped and secured in an upright position. Never transport cylinders unsecured or lying flat. Loose cylinders can become airborne and cause significant damage in an accident.

Because of ProFume's toxicity, cylinders are not to be transported in the same airspace or breathing zone as the driver or other occupants of vehicles, such as in unpartitioned trucks, vans or station wagons.

All Department of Transportation (DOT) regulations must be followed. If you have questions, contact your local DOT.

Always store and transport cylinders in a secure upright position.

ProFume cylinders are not to be transported in the same airspace or breathing zone as the driver or other occupants of vehicles

Air Transportation

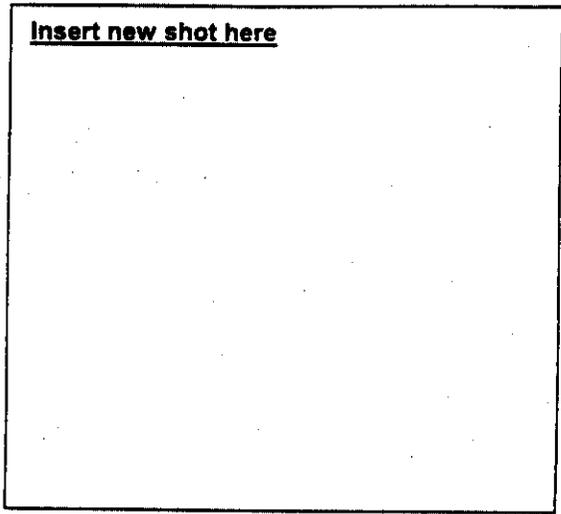
ProFume Cylinders Must Never Be Transported By Aircraft Under Any Circumstance

ProFume Cylinder Valves

ProFume cylinders are fitted with special valves (see Fig 2b). The cylinder is equipped with both a safety cap and a covering called a "bonnet." The safety cap and bonnet should be securely in place at all times except when gas is to be released from the cylinder. This protects the valve system from being damaged and/or prevents accidental release of the fumigant.

Never hang cylinders by the valves during weighing. Use a proper sling or "hanging" bonnet specifically designed for this purpose. Hanging bonnets have openings on two or more sides that a hook strap or cable can be inserted in to support the cylinder during weighing. Hanging bonnets are available through ProFume distributors.

**Figure 2b
ProFume Cylinder Valve**



Empty Cylinders

Handle, store and transport empty cylinders using the same precautions as previously discussed for full cylinders. When the cylinder is empty, fully close the valve and replace the safety cap and protection bonnet before returning to the ProFume distributor and subsequent shipper. Only Dow AgroSciences is authorized to refill cylinders. Do not use cylinders for any other purpose.

**REMEMBER TO
CLOSE VALVE COMPLETELY
ON EMPTY CYLINDERS**

Cylinder Label Protection

Protect cylinder labels from being damaged to ensure label text can be read. Protection measures should prevent knocking or scraping of the labels. It is recommended that plastic-coated or covered chains be used when securing on vehicles.

Leaking Cylinders

If a cylinder is suspected of leaking fumigant, evacuate immediate area of leak. Use a NIOSH or MSHA approved positive pressure self-contained breathing apparatus (SCBA, not SCUBA) approval number prefix TC-19C or combination air-supplied/SCBA respirator, such as manufactured by Ranger, Survivair, Scott, or MSA, for entry into affected areas to correct problem. The SCBA must be worn when exposure is greater than 1 ppm.

Move leaking or damaged cylinder outdoors or to an isolated location, observing strict safety precautions. Work upwind if possible. Do not permit entry into leakage area by unprotected persons until concentration of fumigant is determined to be 1 part per million (ppm) or less, as determined by a detection device with sufficient sensitivity such as an INTERSCAN gas analyzer [Model: GF 1900] or MIRAN vapor analyzer [SapphIRe]. (see Chapter 8, Clearance Testing).

Often tightening the packing nut on the top of the valve to 35-40 N.m (25-30 foot pounds) of torque with a adjustable wrench will stop the leak. Never use excessive force to open a stuck or improperly seated valve. See ProFume Valve Stem Adjustment Procedures at the end of this chapter.

Once the cylinder is empty, contact your ProFume distributor for proper return instructions.

**IN CASE OF
EMERGENCY
CALL 800-992-5994**

Cylinder Return Procedure

One of the more common reasons for returning a cylinder is the perception that the last 1.5-2 kg (3 to 5 lbs) of gas in the cylinder cannot be released. The final pounds of ProFume in a cylinder generally are in a gaseous state and will not move out of the cylinder as rapidly as when it is a liquid. However, it will move through the introduction hose.

Cylinders that are deemed to be "defective" should be returned using the following procedure.

1. Do not continue to use a cylinder if you believe the valve is defective.
2. Contact your ProFume distributor. The distributor will need information about the cylinder (cylinder number, etc.). Complete a Defective Cylinder Report form. Fax the form to Customer Service at Dow AgroSciences.
3. Distributors should identify defective cylinders by spray painting the top and shoulders of the cylinder with red paint and attach a completed red tag to the protection bonnet.

Do not mark functional cylinders with paint, as this could cause confusion when dysfunctional cylinders are returned for repair.

**IN CASE OF
EMERGENCY
CALL 800-992-5994**

ENTERING A STRUCTURE UNDER FUMIGATION

If emergency entry into a structure under fumigation with ProFume is required, the proper respiratory protection (SCBA) must be used. See Chapter 3 for respiratory protection instructions in emergencies.

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ProFume Valve Stem Adjustments in the Field

Introduction When cylinders are filled at the plant, a soap solution is applied to the valve stem (the square shaft area) and valve threads at the top of the cylinder. The cylinder is not released if leaks are present. Each time the valve is opened and closed, the stem works against the packing causing the packing to flow away from the valve stem. Over time this may allow product to escape past the valve stem when the valve is in the open position. This document describes how this situation can be safely corrected in the field.

Hazards & PPE Operators performing the valve stem adjustment should follow all precautions on the product label section for "Leak Procedures." This may include, but is not limited to, immediate evacuation, followed by re-entry using positive pressure self-contained breathing apparatus. Move cylinders outdoors or to a ventilated isolated location prior to adjusting the stem. Allow no unprotected persons in the area during the adjustment procedure until fumigant concentration is verified with detection equipment to be below the levels of concern indicated on the product label.

Indications This procedure is appropriate when a cylinder shows indication of product loss from around the valve stem. Loss may be indicated either by a detection device or hissing / bubbling at the stem when the valve is open. This procedure may not be effective or appropriate for other valve problems.

Training Only persons appropriately trained for Hazardous Material handling should perform this task. While operators who transport ProFume are required to receive Hazardous Material training, individuals should check with their employer if they have any questions regarding required training.

Procedure Listed below are the steps necessary to stop a loss of ProFume from around the valve stem in the field.

Warning: Follow directions in "Hazards and PPE" section above prior to starting this procedure. Make sure all PPE and detection devices are used.

Step	Action
1	If product loss is detected, immediately close the valve. This will stop ProFume from leaking out of the stem.
2	Secure the cylinder against a stationary object (rack, wall, etc.) to prevent tipping. Using the same wrench you use to remove the cap from the valve exit, tighten the packing nut on top of the valve. Turn the packing nut in a clockwise direction to tighten the packing. Note: Do not over tighten this nut. The specification is 34-40 N.m (25-30 foot pounds) of torque, which is easily reached with a 25-30 cm (10-12") adjustable wrench.
3	Open the valve. If product is still leaking from around the valve stem, repeat steps 1 and 2. If product loss still persists, close the valve, red tag the cylinder, and return it for credit. The valve will be replaced at the plant.

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HEALTH AND FIRE EMERGENCIES3

Symptoms in humans from inhalation exposure to ProFume* gas fumigant will depend on the concentration and the length of exposure experienced.

It is obvious from animal experiments that ProFume is toxic and must be handled carefully in regard to the potential hazards it presents. Disregarding the lethal potential of ProFume can result in serious illness, even death.

POISONING SYMPTOMS

ProFume is colorless, odorless and, at low concentrations, non-irritating to mucous membranes. ProFume gives no warning of its presence.

**IN CASE OF
EMERGENCY
CALL 800-992-5994**

The earliest sign of overexposure to ProFume is central nervous system (CNS) depression. Although dose-response data are not available for effects in humans exposed to ProFume, acute inhalation studies have been conducted on laboratory animals. No signs of CNS depression were observed in rats exposed to 450 ppm for four hours, while rats exposed to 750 ppm were lethargic after that time.

Exposures to progressively higher concentrations would be expected to result in convulsions, tremors and/or strychnine-like muscular rigidity. Rats exposed to 1,000 ppm began to show CNS depression 15 minutes after initiation of exposure, and slight eye irritation was evident after two hours; by three-and-one-half hours, the animals were moribund and/or convulsive, and some died shortly after termination of the four-hour exposure. Rats exposed to 1,425 ppm were sedated in 20 minutes, prostrate in 40 minutes, convulsive after one to two hours and dead in four hours.

Humans exposed to high concentrations of ProFume may experience respiratory irritation, nausea, abdominal pain, CNS depression, slowing of movements and speech, and numbness in the extremities. Survival after exposure to high concentrations can occur even following convulsions, if exposure has been brief.

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ProFume is a Restricted Use Pesticide.

NIOSH or MSHA approved positive-pressure self-contained breathing apparatus (SCBA, not SCUBA) or an air-supplied/SCBA respirator is necessary when entering areas being fumigated where the concentration is unknown or is greater than 1 ppm as measured by a detection device with sufficient sensitivity such as an Interscan or Miran.

It is required that a 24-hour telephone number (including weekends) is on the warning signs to allow for prompt communication with a fumigation company representative in case of emergency.

**IN CASE OF
ACCIDENTAL
EXPOSURE,
SEEK MEDICAL
ATTENTION**

FIRST AID TREATMENT

In all cases of over exposure, when symptoms such as nausea, difficulty in breathing, abdominal pain, slowing of movements and speech, or numbness in extremities are exhibited, get medical attention immediately. Take person to a doctor or emergency treatment facility. Have the product label with you when calling a poison control center or doctor, or going for treatment.

If inhaled — If a person potentially exposed to ProFume shows any evidence of departure from normal behavior — respiratory irritation, slow speech or body movements, garbled speech, or dulling of his awareness — They should be *immediately* taken to fresh, uncontaminated air and put at complete rest. Maintain body temperature and check breathing and heartbeat. If breathing stops, give artificial respiration. If heart beat stops, start cardiopulmonary resuscitation (CPR) immediately. Obtain emergency medical assistance or transport individual to a medical facility. Notify the facility ahead of arrival that emergency medical treatment will be needed.

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If on skin or clothing — ProFume is highly volatile and will dissipate rapidly. Damage to the skin, if any, may result from liquid freezing the tissue. If liquid ProFume contacts skin or clothing, immediately apply water to the contaminated area of clothing before removing. Once area has thawed, remove contaminated clothing, shoes, and other items covering skin. Wash contaminated skin area thoroughly or shower. Call a poison control center or doctor for further treatment advice.

If in eyes — Damage to the eye, if any, will result from refrigeration or freezing of the tissue of the eye. If the liquid or cold gas contacts the eye, hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

PHYSICIAN INFORMATION



The prediction of possible effects in human beings is based in part on observations made on laboratory animals. On this basis, depending on length of exposure, it is predicted that persons exposed to ProFume will probably show little evidence of intoxication at first, unless the concentration was moderate to high (>500 ppm).

Initial effects will probably be depression on the central nervous system with slow speech and body movement the first signs noted. Convulsions may ensue with respiratory arrest being a terminal event. Assisted respiration may be necessary.

An exposed patient should be removed to fresh air and put at rest. Keep exposed individual at bed rest and under observation for at least 24 hours. Clinical observation should be directed at the pulmonary, hepatic and renal systems. A postmortem finding in a fatality attributed to sulfuryl fluoride was pulmonary edema. Death was attributed to cardio-respiratory failure.

There is no known antidote. Clinical observation is essential. Treatment is based on the clinical judgment of the physician and the individual reaction of the patient.

**IN CASE OF
EMERGENCY
CALL 800-992-5994**

URINE ANALYSIS FOR FLUORIDES

Urine samples from persons with potential over-exposure to ProFume may be analyzed for total fluorides. However, the interpretation of these levels requires a base line (pre-exposure level) to determine if the increased fluorides are actually from exposure to ProFume. People are exposed to many sources of fluorides every day — water supply fluorination, toothpaste, medicines, and fluorides occurring naturally in food.

Determination of Fluoride in Urine

1. Apparatus

- pH meter, with expanded mv scale or a specific ion meter.
- Fluoride specific electrode. Fluoride ion selection electrodes are available from most laboratory supply houses.
- Reference electrode, single junction, sleeve-type.
- Mixer, magnetic, with a TFE fluorocarbon-coated stirring bar.
- 2-oz Polyethylene bottle.

2. Reagents

- Buffer Solution (pH from 5.0 to 5.5) to approximately 500 ml of distilled water in a 1,000 ml beaker; add 57 ml of glacial acetic acid, 58 g of sodium chloride (NaCl), and 0.30 g of sodium citrate dihydrate. Stir the solution to dissolve and cool it to room temperature. Adjust the pH of the solution to between 5.0 and 5.5 with 5 N sodium hydroxide (NaOH) (about 150 ml will be required). Transfer the solution to a 1,000 ml volumetric flask, and dilute it with water to the mark.
- Sodium Fluoride, Standard Solution (1.0 ml = .01 mg F) — Dissolve 0.2210 g of sodium fluoride (NaF) in water and dilute to 1.0 liter. Dilute 100 ml of this solution to 1.0 liter with water (this solution contains .01 mg F/ ml). Store in chemical-resistant glass or polyethylene.

3. Calibration

- Prepare a series of three standards, 0.5, 2.0 and 5.0 mg/liter using the fluoride standard solution (1.0 ml = 0.01 mg of fluoride). Dilute the following volumes to 100 ml:

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- 5.0 ml Standard = 0.50 mg/liter
 - 20.0 ml Standard = 2.0 mg/liter
 - 50.0 ml Standard = 5.0 mg/liter
- Pipet 5 ml of each standard into a 1-oz polyethylene bottle, then pipet 5 ml of buffer. Mix well.
 - Immerse the electrodes in each standard solution, starting with the lowest. Record the reading after 15 minutes.
 - Using Semilogarithmic graph paper, plot the concentration of fluoride versus the mv reading.

4. Procedure

- Pipet 5 ml of the urine sample and 5 ml of the buffer into a 2-oz polyethylene bottle. Place the solution on the magnetic stirrer.
- Immerse the electrodes and record mv reading after 15 minutes (if a pH meter is used). Determine fluoride level from graph. If a specific meter is used, read the fluoride level directly in mg/liter on the fluoride scale.

5. References

- ASTM 1179-B, Standard Methods of Test for Fluoride Ion in Water. (Method has been validated for urine.)
- Instruction Manual Fluoride Electrodes, Model 94-09, Model 96-09, Orion Research Corporation, Inc.

**IN CASE OF
EMERGENCY
CALL 800-992-5994**

FIRE FIGHTING.....



General Information

ProFume is not combustible. However, in temperatures exceeding approximately 400°C (752°F), ProFume will degrade to form hydrogen fluoride (HF) and sulfur dioxide. Theoretically, a structure containing ProFume would produce 0.4x the concentration of ProFume in HF per 1,000 cubic feet.

For temperatures greater than 400°C, each mole (102 gm) of sulfuryl fluoride will degrade to form 2 moles (40gm) of hydrogen fluoride (HF). However, the HF actually produced during fires involving ProFume may be insignificant because ProFume rapidly escapes from structures unless confined.

Cylinders containing ProFume are designed not to explode in high temperatures. A fusible plug in the cylinder valve body melts at 70-74 °C (158-165°F).

Use of Water: Evolution of hazardous materials during a fire can be minimized by use of water. Water will scrub out part of the HF and sulfur Dioxide (SO₂) formed by decomposition of ProFume by the flame. Water also can be used to cool ProFume cylinders and prevent discharge of the product caused by melted fusible plugs. Avoid runoff into waterways if possible. The toxicity of ProFume in water for fish is unknown.

Fire Fighting Protective Clothing

For Structures under Fumigation: Self-contained breathing apparatus and normal "turn-out" gear should be worn when fighting fires in structures under fumigation with ProFume.

For Fires Involving ProFume Cylinders: A self-contained breathing apparatus (SCBA) and encapsulating protective suits should be worn when fighting fires in atmospheres containing potentially high concentrations of ProFume. Protective suit material should be compatible with exposure to hydrofluoric acid.

PREPARATION, SEALING, AND SECURING 4

No two fumigation jobs are exactly alike. Each job requires the fumigator to establish and maintain an effective fumigation space. The fumigation must be conducted in a manner that will effectively control the pests without causing undue risk to people or property.

The fumigator must conform to the ProFume label and ProFume Manual, as well as to federal, state and local regulations. As an additional reference, a compilation of GOOD PRACTICES published by the National Pest Management Association (NPMA) is available. When in doubt, a fumigator should seek assistance from suppliers, regulators, Dow AgroSciences representatives, or other educational sources.

WORKER SAFETY.....

Government authorities regulate worker safety at the job site and some agencies mandate that the employer must have written safety procedures including standard operating procedures and emergency procedures. Agencies may give special attention to the following areas: self-contained breathing apparatus (SCBA) use and maintenance, working in confined spaces, man-lifts, using ladders, working on roofs/bins, and lifting heavy objects.

Any unprotected exposure to ProFume should result in a visit to your physician (consult label).

Personal Protection Equipment

The ProFume label requires the following personal protective equipment:

Respiratory Protection: must be worn when the concentration of sulfuryl fluoride exceeds 1 ppm.

Prior to introducing fumigant, confirm that SCBA's are available and operational. The respiratory protection must be a National Institute of Occupational Safety and Health (NIOSH) or Mine Safety and Health Administration (MSHA) approved, positive-pressure self-contained breathing apparatus SCBA (not SCUBA) approval number prefix TC-19C or combination air-supplied/SCBA respirator, such as manufactured by Survivair, Ranger, Scott, or MSA.

*Trademark of Dow AgroSciences LLC
ProFume is a Restricted Use Pesticide.

Consult current standards concerning SCBA use and maintenance.

Eye Protection: Wear splash resistant goggles or full face shield when handling the liquid product during introduction of fumigant or when working around any lines containing fumigant under pressure. Liquid ProFume can freeze the eye tissue. Eye protection also helps prevent physical injury if the hose disconnects.

Protective Clothing: Wear loose fitting or well-ventilated long sleeve shirt, long pants, shoes and socks. Do not wear gloves or rubber boots when introducing ProFume, as this type of protective clothing can confine the liquid against the skin that may cause freeze damage.

Do not reuse clothing or shoes that have become contaminated with liquid ProFume until thoroughly aerated. Skin contact with gaseous ProFume is not considered a problem.

PROPERTY OWNER AND CUSTOMER INFORMATION

Notify appropriate owners, employees, and or operators at the facility where the fumigation will occur and provide relevant safety and health information to local fire and rescue officials for use in the event of an emergency.

Property Owner/Customer Checklist: The owners of buildings to be fumigated need to be informed of circumstances and conditions associated with the fumigation process and of their involvement in preparation, vacancy and re-occupancy. Some states require the fumigator to provide the customer with a list of preparations required for the fumigation. The customer may also be required to acknowledge in writing certain liabilities.

The responsibility for proper fumigation procedures lies with the licensed fumigator regardless of who does the work.

Occupants/Customers need to know:

1. To read the Fact Sheet for ProFume provided to them by the fumigator.

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2. Their specific role in preparation for fumigation; what to prepare, turn off, remove, etc.
3. What the fumigation process (introduction, exposure, aeration and clearance) entails, so that there can be absolutely *no* entry by unauthorized personnel into the structure until it is certified clear for reentry by the fumigator.
4. The specific times to leave the structure and when re-occupancy may occur.
5. That the fumigator often requires that the property owners surrender keys to the structure to be fumigated. The fumigator should have access to all areas of the fumigation site during the whole period that the site is under their control.
6. ProFume has no residual effectiveness and so does not control future infestations of pests.
7. To reveal to fumigator known or potential connections to adjacent/other buildings.

Misapplication of ProFume and/or moisture condensation from introduction may cause damage to certain materials. The risk of condensation increases under conditions of high relative humidity and where high dosages of ProFume are required. Proper fumigant release techniques to avoid misapplication and condensation are described on the ProFume label and within Chapter 6 of this Manual.

WHAT TO REMOVE PRIOR TO FUMIGATION

Remove from the structure to be fumigated all persons, non-target animals, and desirable growing plants. Remove all drugs, medicines, food, or feed products other than those permitted by the ProFume label.

If the customer is unduly concerned about a particular item prior to the fumigation, removal is the best approach, since the customer will assume any problem with the item following fumigation is the responsibility of the fumigator.

FLAMES OR HEATING ELEMENTS

ProFume (sulfuryl fluoride) is a very stable compound that is relatively non-reactive and non-flammable. However, under high heat conditions present in gas flames or glowing electric elements, ProFume can decompose into sulfur dioxide (SO₂), hydrofluoric acid (HF), and other decomposition products. Hydrofluoric acid is

highly reactive and can corrode or damage many materials including metals, glass, ceramic finishes, fabrics, etc. Therefore, extinguish all flames including pilot lights of furnaces, hot water heaters, dryers, gas refrigerators, ranges, ovens, broilers, etc. Turn off or unplug all electrical heating elements such as those in heaters, dryers, etc. Shut off automatic switch controls for appliances and lighting systems that will be included in the space to be fumigated.

Contact your local gas company to determine what procedures should be followed in your area for shutting off natural gas or propane service.

Gas service should be shut off at the main service valve. When a single gas meter serves more than one structure, gas service to all sources may be interrupted. The gas lines should be cleared.

Fumigation companies may request that customers have the local gas company turn off the gas prior to fumigation. The local gas company will always need to turn gas service on after it has been turned off, to determine that the gas flow rate and pressure are appropriate.

Before fumigating, ALL pilot lights must be turned off. The heat of gas flames, pilot light flames, or the glowing wires or hot surfaces of electric heaters can cause ProFume to break down to form a corrosive material. Make sure the gas flames and pilot flames of furnaces, gas refrigerators and kitchen ranges are extinguished and that glowing electric heaters are turned off.

Chlorine Gas: Damage to metals can also occur from the inclusion of chlorine gas for bleaching or chlorination processes. Ensure this equipment is turned off with no leaks or excluded from the fumigation.

CHECKING FOR CONNECTED AREAS

Prior to fumigation, fumigators are required to check for connected areas. A connected area is defined as any area connected with the space to be fumigated by construction elements (e.g. pipes, conduits, ducts, etc.) which may allow the passage of fumigant between the spaces.

Any connected area must be vacated during the fumigation process unless it is isolated from the space to be fumigated by methods that prevent passage of the fumigant from the space to be fumigated into the connected area.

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Note: Areas that have been isolated from the fumigated space must be vacated if required by state laws or regulations. When it is necessary to vacate areas that have been isolated, that area shall be considered as a fumigated space, and all applicable rules, regulations and label instructions apply, such as preparation, posting, securing, and aeration.

ProFume concentrations must be measured during the fumigation in any occupied connected space or structure until ProFume concentrations are <1 ppm to confirm that individuals in connected areas are not exposed to unacceptable ProFume levels. Use only an approved detection device of sufficient sensitivity, such as the INTERSCAN gas analyzer [Model GF 1900] or MIRAN vapor analyzer [SapphIRe], to confirm a concentration of ProFume of 1 ppm or less.

Note: connected area must be vacated if required by state laws or regulations.

A connected area is defined as any area connected with the space to be fumigated by construction elements (e.g. pipes, conduits, ducts, etc.) which may allow the passage of fumigant between the spaces.

The INTERSCAN must be calibrated within one month prior to use as a clearance device. All other approved detection devices must be calibrated according to manufacturer recommendations.

STATIONARY TRANSPORTATION VEHICLES SUCH AS RAIL CARS AND TRAILERS

Fumigation of vehicles should be conducted following all general instructions as for fumigating structures with ProFume as described in this manual and the label, as well as instructions below.

Moving Vehicles under Fumigation

In-transit fumigation (including aeration) of any vehicle is prohibited on public roads or waterways. However, vehicles may be moved if necessary on the fumigation site. Moving vehicles while under fumigation on the fumigation site may result in loss of fumigant resulting in a poor fumigation job.

Selection of Fumigation Location

Rail cars and trailers must be placed in a location which is appropriate for conducting a fumigation. It should be a location which is away from other work areas in a secured place. Careful planning must be made for fumigant introduction in rail cars and trailers. Prevent liquid ProFume contacting any part of the vehicle or contents, as it can damage paint, or tarnish metals.

Sealing the Vehicles

Rail cars and trailers may be either sealed by tarps or they can be taped if they are of a type of construction which lends itself to adequate containment of ProFume.

At the end of the aeration time when the vehicle has been cleared for re-entry, the warning signs should be removed, the chocks removed from the wheels, and the vehicle put back into service.

Securing the Vehicles

After the fumigation site has been selected, rail cars and trailers should be moved into position and secured by setting the brakes and blocking the wheels so that the vehicle will not move during the fumigation and aeration periods.

Follow label instructions for securing entrances and posting warning signs on fumigated spaces and structures.

Follow all local, state and federal regulations covering the fumigation of vehicles.

STATIONARY SURFACE SHIPS

Only those persons involved in the fumigation may be on board the ship during fumigation and aeration.

Below-the-surface ships, such as submarines, must **not** be fumigated with ProFume.

Because of its physical properties, ProFume is ideally suited to control pest infestations in surface ships (see Chapter 1). Its high volatility allows the gas to penetrate into all areas of the vessel very quickly, control the pest, and aerate rapidly. However, due to its lack of warning properties and high inhalation toxicity, ProFume must not be used to fumigate ships or other vessels while they are in use. People, desirable plants or pets must not remain on board during the fumigation.

As with all fumigations with ProFume, it is important that ship fumigations be conducted properly to ensure not only control of the pests involved, but also that the fumigation be done without any harm to people or materials.

Follow all local, state, and federal requirements for ship fumigation, including those required by the Coast Guard, DOT, Title 46, Shipping, section Parts 147A.1-147A.43 in the Code of Federal Regulations, Section 46 Shipping and the label for ProFume and this manual. Since the codes listed are for fumigants in general, do not use procedures that are not permissible for ProFume as directed by label instructions and regulations.

Seal the vessel using tarping, taping, and other methods specific for ships to confine ProFume to the fumigation area.

Place warning signs at all entrances to the fumigated space. Only those persons involved in the fumigation may be on board the ship during fumigation and aeration.

Follow proper fumigation procedures as noted on the label. Again, do not re-occupy or move the vessel after the fumigation until it is properly cleared per label instructions (see Chapter 8 and the ProFume label for Aeration instructions).

If conditions of high relative humidity may exist in the vessel during fumigation, great care should be exercised to use the proper sized fan and shooting hose to avoid overshooting the fan capacity causing a "fog out" the vessel causing tarnishing and staining. See instructions for fumigation preparation and fumigant introduction in this Chapter and Chapter 6.

CHOOSING PROFUME INTRODUCTION SITES.....

The specific site(s) of release of ProFume is very important to the success of the fumigation. ProFume should be introduced in a manner to achieve rapid equilibrium, avoid excessive loss, prevent fog-out, and ensure safety to personnel and materials.

During site selection ask, "If ProFume was introduced in this location, how and when will it get to the most remote locations in the commodity or structure?" For most applications, it is often appropriate to use multiple introduction sites to rapidly attain equilibrium.

In structures that are frequently used for fumigation, permanent introduction systems can be built into the structure to ensure safe, effective and adequate fumigant introduction. Be sure to

inspect all components of introduction systems prior to each use.

Key Considerations for Site Selection for Space Fumigations

1. Largest open space.
2. At least one introduction location on each floor of a multi-story structure.
3. Proximity of materials or equipment that may be damaged by fumigant introduction.
4. Recommend at least one introduction site per 75,000 cubic feet of fumigated space.

The size and configuration of the space and the adequacy of the circulation will dictate the number of release sites for ProFume. As a rule of thumb, there should be sufficient circulation to establish fumigant equilibrium in about 2 hours following fumigant introduction in most situations.

Experience with ProFume, measurements discussed in Chapter 6, and data from past monitoring of the fumigation site will help the fumigator judge the amount of circulation needed.

Successful introduction can usually be accomplished by directing the flow into the air stream of a fan that has the capacity of 1,000 cubic feet per minute (cfm) for each pound of ProFume introduced per minute.

Key Considerations for Site Selection for Containers, Railcars, and Ships Fumigation

Empty containers, trucks, railcars, ships, and other transport vehicles may be fumigated in essentially the same way as other storage facilities. However, they must be stationary and cannot be moved over public roads, highways, railways or waterways until they are aerated.

The size and configuration of the space and the adequacy of the circulation will dictate the placement and number of release sites for ProFume. For additional information on fumigating containers, trucks, railcars, ships and other transportation vehicles loaded with food commodities, see Chapter 10.

DISTRIBUTION/AERATION FAN USE AND PLACEMENT

Purpose of Fans: There are three purposes for fans in a structural fumigation:

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1. **Fumigant Introduction**
2. **Circulation and Equilibrium**
3. **Aeration**

Fans ensure that the fumigant equilibrium is achieved in a timely manner and aid in the ventilation and aeration process.

In most instances, the ProFume label requires fan use during fumigant introduction.

Positioning Fans

- > There is no set pattern established for the positioning or the number of fans to use.
- > Fans should be placed to mix the fumigant to rapidly reach equilibrium.
- > At least one fan for each level of the structure.
- > It is good fumigation practice to use more fans in structures that are divided into numerous smaller compartments or rooms

A rule of thumb is to use one fan for each 75,000 ft³ and at least one fan for each area or level of the fumigation.

In structures frequently used or dedicated to fumigation, air circulation equipment and fans can be built into the structure. Examples of some systems include air-handling systems that provide for the fumigant introduction, continuous circulation, and also aid in the quick, effective aeration of the structure. For more information on fans, see Chapter 6.

Continuous Circulation With Fans

A significant benefit of continuous circulation is the movement of ProFume from areas of high concentration to areas of lower concentration. This continuous circulation maintains a more equal concentration within the fumigation space and helps ensure that ProFume will penetrate all areas where infestation may exist.

It is next to impossible to seal a structure so that there are no leaks. Unless there are abnormally large leaks, continuous circulation during the entire exposure period will not appreciably affect the loss rate for ProFume. Obviously, the air stream should not flow directly against "leaky" areas because excessive fumigant loss can occur.

INTRODUCTION MANIFOLDS AND HOSES.....

ProFume must be released only through manifolds and suitable leak-proof hoses with a minimum burst pressure of 500 pounds per square inch (psi) (35 Bars). The hose should be flexible, kink resistant, and be durable.

The ProFume introduction rate is mostly controlled by the inside diameter and the length (resistance) of the fumigant introduction hose. See Section 6 or the ProFume Fumiguide Program.

Protective Sheeting: Polyethylene plastic should be placed under the hose and fan and secured to further protect floors and other materials during application.

MONITORING HOSES

Plans for placement of sampling hoses in the structure should be made prior to fumigant introduction. Clear vinyl hoses (1/8-1/4" ID) should be placed to allow representative sampling of fumigant concentrations. Monitoring lines should be placed on all levels of the fumigated structure. If the structure is compartmentalized into separate rooms or other sub-units, place lines in areas representative of the different units.

The Fumiscope or other appropriate equipment is used to measure ProFume concentrations during exposure. Confirm that electricity is available to correctly operate monitoring equipment during the fumigation.

Preparing For Aeration

When first preparing the fumigation, plan ahead for the aeration period and take steps to aid aeration by strategic placement of fans and other aeration tools. Just as fans are useful in achieving equilibrium of fumigants, they are excellent aids in attaining rapid aeration and are essential where cross ventilation is poor.

Have a detailed plan in place for safe, effective aeration of the structure. Be sure to consult label and local regulations for more restrictive aeration procedures.

SEALING THE STRUCTURE.....

The quality of the seal has a huge influence on the effectiveness of the fumigation. Increasing the seal of the fumigation site is one of the most effective ways to ensure a quality fumigation and reduce the total amount of fumigant needed.

There are several approaches to the challenges of confining the fumigant. The fumigator needs

to make field judgments how to best seal a space. Pay special attention to drains, vents, conduits, wiring, electrical junction boxes, floor cracks, wall/floor or wall/ceiling joints, and damage to outside walls from equipment.

When sealing, keep in mind two basic thoughts:

1. Identify and seal key leakage areas. Careful inspection of the facility/chamber will help identify leaky areas. Be sure to carefully seal protruding equipment on the top floors and roofs. Building eaves also can be very leaky.
2. Ensure you close off all connected structures and install an "air break" to stop gas moving to connected structures.

The fumigator must be guided by the principle of rapidly achieving and maintaining equilibrium for a sufficient period to accumulate the dosage needed to control the target pest.

Tape and Seal

Often, mills, warehouses, processing facilities, and storage bins are too large to be completely tarped for fumigant confinement. The most common practice is to use polyethylene sheeting, non-porous panels, fumigation tape, spray adhesives, foams and insulation materials to seal the structure for fumigation. These techniques are usually used around doors, windows, roof eaves, loading docks, pipes, augers, conveyers, etc. If properly used, these materials can do a very adequate job of confining the fumigant within the structure.

However, even with an excellent job of tape and seal around windows, doors, etc., if the building walls, roof, or basement have holes that are not sealed, the structure will not hold fumigant satisfactorily.

Stucco or masonry block buildings may be sealed by taping laminated paper or plastic film over outside doorways, windows and vents. This sealing method is recommended for structures in which any wooden section, including roofing, is exposed to the outside. Always monitor with a Fumiscope when using these methods.

Taping the cracks at windows, doors and other small openings helps seal buildings. Vents should be sealed around the edges. Always monitor with a Fumiscope to confirm the

effectiveness of fumigant confinement and to calculate the actual HLT.

Foam Sealing

The use of expandable spray foams have been effectively used to help seal structures. Expandable foam is economical and can be used for both permanent and temporary seals. Refer to the foam product directions for proper use and compatibility issues.

Tarping

Tarpaulins (tarps) can be used in the sealing process, used with tapes/adhesives to help seal leaky areas, or to envelop the entire area to be fumigated.

If extremely leaky parts or entire structures exist it may be preferable to cover the space/structure with a tarpaulin that envelops all areas susceptible to pest infestation. This method is effective on almost any size or type of space/site.

The ability of a tarp to contain a gas depends on the condition of the tarp, the material of construction and its thickness.

The question naturally arises: "If ProFume penetrates wood so well, how well can it be confined for fumigation?" Surprisingly, the relative ease of confinement is characteristic of the product and one of its major advantages.

Tarp Material

Plastic tarps are semi-permeable membranes, which permit different fumigants to pass through them at different rates. The passage of ProFume through plastic sheeting is very slow (see Table 4a).

Use only tarps made of materials that will adequately confine ProFume for the required time. Tarps are sold in many colors and sizes. Experience has shown that the following have proved satisfactory:

1. Four-six mil polyethylene for "single use" tarps
2. Laminated (several layers) polyethylene
3. Vinyl coated nylon
4. Neoprene coated nylon
5. PVC (polyvinyl chloride) coated nylon

Thickness

As a minimum, 4 to 6 mil (160-240 microns) thickness of the above materials is able to adequately confine ProFume. A tarp of 100 microns is equivalent to a 400-gauge material.

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Polyethylene tarps less than 4 mil (160 microns) are not of an adequate thickness to confine ProFume because they do not possess the strength and weight needed for the handling, wind resistance and abrasion encountered in most fumigations.

Before tarping, open all openings/vents prior to fumigation, as well as interior doors, access panels, etc. (Always comply with local regulations concerning barriers to entry into the structure during the exposure period.)

One of the most critical operations in tarping a space is achieving a tight seal at the ground where protrusions, debris or rough-textured soil or concrete may provide an opening for gas to escape. Sand or water snakes may be used effectively if the ground surface is very smooth. One method of improving the seal with a sand or water snake is to run a trough of water on the tarps along with the snakes. Vinyl/nylon snake covers do not deteriorate readily.

To achieve an adequate ground seal, allow at least two feet of tarp to clear the ground snakes. This will accommodate movement of the tarps from wind movement.

To reduce the risks of moisture condensation, the following precautions should be observed:

1. Do not tarp or seal a space that is wet.
2. Pay special attention to air circulation in cold weather. Low outside temperatures can induce moisture condensation on uninsulated surfaces such as windowpanes, skylights, machinery, or ducting. To help prevent condensation, fans should be used to maintain temperature equilibrium throughout the structure during the exposure period.
3. Cold temperatures in warm weather may also warrant special attention. A air conditioned structure that is much cooler than the outside air temperature and then opened to introduce hot humid outside air, will form condensation on cold surfaces, such as heavy brass (an example would be the fogging of sunglasses when exiting an air conditioned car in the summer). This condition can be avoided by warming the structure slowly prior to tenting or sealing before opening windows and doors to avoid introducing outside air.

Table 4a

Percent permeation loss and adsorption of 8 oz/1,000 ft³ sulfuryl fluoride, after 24 hrs from 11-oz glass bell jar with lid made of tarp materials.

	Percent permeation loss	Percent adsorption ^a
Tarp material	Sulfuryl fluoride	Sulfuryl fluoride
Polyethylene 4-mil	0.0	1.3
Tarp A, 10.3 oz/yd ²	3.3	6.1
Tarp B, 7.2 oz/yd ²	5.5	3.1
Tarp C, 9.6 oz/yd ²	0.2	3.3
Used tarp	100.0	8.8

^a Values reflect subtraction of fumigant loss due to glass container adsorption (2.2% for sulfuryl fluoride). (n=4)

Source: Scheffrahn, R.H. and E.M. Thoms (1993) "Penetration of Sulfuryl Fluoride and Methyl Bromide Through Substrates During Fumigation." DOWN TO EARTH 48 (1) pp. 15-19.

See the label and Chapter 9 for additional instructions on tarped chamber fumigations.

POSTING AND SECURING FUMIGATED AREAS

ProFume is a toxic gas without a warning agent. The ProFume label requires that the structure be posted with specific warning signs on all entrances and all sides during the exposure and aeration periods until the building is cleared for reentry by the fumigator.

Warning signs must be of weather-resistant material and should be securely affixed to the structure. The warning logo on the sign should be visible from any approach to the structure.

Only a state licensed/certified applicator may authorize removal of warning signs. The warning signs may be removed only when the concentration of ProFume within the fumigated area is 1 ppm or less. The label states the signs must bear in English and Spanish:

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

Preventing Condensation

5. Name, business address and telephone number of the fumigation company and licensed/certified applicator.

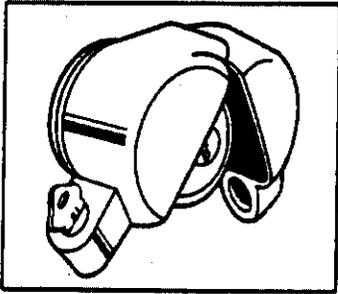
A 24-hour telephone number (including weekends) must be written on the warning signs to allow for prompt communication with a fumigator in case of emergency.

SECURING STRUCTURES

In order to secure against unauthorized entry during the fumigation exposure period, a locking device or barricade must be used on all exterior doors or doorways. A locking device or barricade must be effective in preventing entry of any exterior door or doorway using normal opening or entering processes by anyone other than the licensed applicator in charge of the fumigation or persons in his/her on-site direct supervision. Consult state and local regulations for any supplementary instructions and local restrictions on securing against entry.

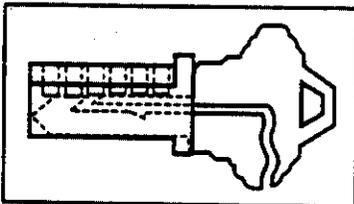
Several additional security options to consider might include:

- **Clam Shell Locks**



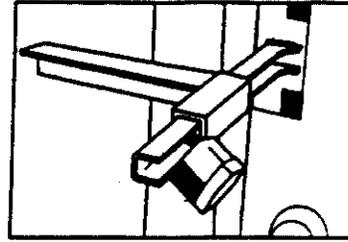
Clam Shell locks are designed to prevent use of the door or occupant's keys to unlock entrance doors.

- **Key-way Locks**



Keyway locks are designed to prevent use of the occupant's keys to unlock entrance doors. These function by inserting a two-part locking key into the door keyhole and removing only half of the key. The other half of the locking key remaining in the door prevents insertion of the occupant's key.

- **J-SAFE locks**



J-SAFE lock or Chains can also be used on certain structures.

GUARDS

Guards may also be considered for some circumstances and may be required in some locations. Consult local regulations.

Best practice is to notify local police, fire department and emergency responders of impending start and finish times for the fumigation.

Rail Cars, Trailers or Ships

Railcars, Trailers or Ships must be secured against unauthorized entry during the fumigation exposure period.

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PROFUME DOSAGE AND PEST BIOLOGY 5

Establishing the Required Dosage

The fumigator is challenged with the task of distributing and maintaining a concentration of fumigant over enough time to achieve the target dosage. Because of the multitude of variations, there are no two fumigations identical, nor are any of them truly gas tight. To specify a single dosage rate for all conditions would seldom be correct — usually it would be either excessive or insufficient for expected pest control.

Precision Fumigation™ Defined

Precision Fumigation is not a new concept, however most fumigators have lacked the tools to consistently plan and conduct precision fumigations. *Precision Fumigation™ can be defined as: "Optimizing fumigant use to maximize efficiency and minimize risk."*

Precision Fumigation Concepts

ProFume* use is not complicated and allows pest managers the ability to use their skills, knowledge, and experience to create and implement successful, flexible IPM programs. Precision Fumigation methods:

- Allow fumigation when/how necessary
- Capitalize on enhanced sealing methods
- Maximize exposure time
- Utilize temperature modification

Fumigant Dosage:

All fumigants utilize some form of the dosage relationship which is often referred to as the "CT Concept":

$$\text{Dosage} = \text{Concentration (C)} \times \text{Time (T)}$$

or

$$CT = C \times T$$

Therefore, the dosage required to kill the target pest(s) is accumulated over a period of time and is measured in *ounce-hours* or *gram-hours*;

$$CT = \text{oz-h} / 1000 \text{ cu ft}$$

the concentration in ounces/1000 cu ft of fumigant multiplied by the exposure time in hours.

*™ Trademark of Dow AgroSciences LLC
ProFume is a Restricted Use Pesticide.

The maximum target concentration in the ProFume Fumiguide is 128 oz/1000 cu ft.

The maximum target dosage in the ProFume Fumiguide is 1500 CT.

For vacuum fumigations, the maximum target concentration is 128 oz/1000 cu ft, and the maximum target dosage is 200 CT

ProFume Concentration Units

$$1 \text{ oz}/1000 \text{ cu ft} = 240 \text{ ppm}$$

Fumigant Dosage Factors.....

The proper dosage for efficacy and the total amount of ProFume* gas fumigant needed for a fumigation is determined by four interrelated factors:

1. Pest Species and Life Stages
2. Temperature at Site of Pest
3. Exposure Time
4. Half-Loss Time (HLT) or Quality of Seal

Pest Factor

ProFume is effective on all key stored product insect pest (SPIP) species and can control all life stages of insects. However, different pest species and life stages require different dosages for effective control. Adult, larval, and pupal stages are controlled with relatively low dosages of ProFume, while the egg stage requires higher dosages.

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For fumigation to control rodents, use sufficient gas to accumulate at least 36 CT (oz-h/MCF) following equilibrium, regardless of ambient air temperature. The temperature restriction of 40°F for insect fumigation, does not apply to rodents, because they are warm blooded.

Biology summaries for the target pests in the Fumiguide™ Program for ProFume gas Fumigant (ProFume Fumiguide) are presented at the end of this Chapter.

Pest Monitoring

To achieve maximum pest population management and control, the facility/commodity should be routinely monitored and data collected to define the actual pest spectrum and levels of infestation present. Successful pest management professionals also use knowledge of the pest's biology, behavior, and the understanding of pest population dynamics to make control decisions and develop integrated control plans. Understanding the customer-defined level of control is very important when developing an integrated control program.

Temperature Factor

Temperature is an important factor for successful fumigation. Insects are cold-blooded, so increasing temperature increases insect metabolism. Increasing insect metabolism greatly improves the efficacy of ProFume. Increasing temperature can decrease exposure time and/or gas needed. Large changes in temperature are not required. Achieving temperatures of 25-30 °C (78-86°F), for example, can have a very positive effect on fumigation efficacy and efficiency.

Do not apply ProFume for insect control when the temperature of the site of the pests is below 40°F.

Temperature Control

It is possible to reduce a substantial amount of ProFume needed by raising the temperature within the structure.

Fumigators can use the following methods for increasing temperature of the fumigated space. Permanent / built-in systems utilizing hot water, steam, electric, fossil, solar heat sources. Temporary / leased units operating on propane or natural gas, electric, or other fuels can be

used. Fans, heater-fans and other electrical equipment should be grounded and have a good protective fusible or breaker system. Planning fumigations during the warmer seasons or even during the warmer periods of the day can positively affect temperature factor.

Heaters, pilot lights and open flames must be extinguished during the exposure period as temperatures above 752°F will cause decomposition products to be formed which can be corrosive and can etch glass and metal.

Dosage requirements for a particular structure should be based on the mean temperature at the coldest site that could harbor the pest.

The measured minimum temperature at the site of the insect pest should be used for dosage calculations.

For rodents, temperature does not affect dosage because they are warm blooded.

Time Factor (T)

The time factor is a key component of $C \times T =$ Dosage formula. The exposure time is defined as the number of hours the target insects is exposed to the fumigant.

If the structure has good gas confinement, increasing the exposure period is one of the most cost-effective practices available to the fumigator.

**Increase time = Decrease gas needed
Decrease time = Increase gas needed**

Doubling exposure time in a well-sealed structure can decrease gas needed by up to 50%. Work with the customers to plan and optimize exposure time to minimize the fumigant needed. The case study in Table 6a shows how exposure time and HLT affect the amount of ProFume needed.

Half Loss Time (HLT)

Half-Loss Time (HLT) is the measurement of how well a fumigated space or area holds fumigant (leaks). HLT is defined as the time in hours that 50% of the initial concentration of fumigant is lost. Research has shown fumigant

retention is often extremely variable between and even among areas within a structure.

The higher the HLT value, the better the fumigant confinement.

If the HLT > 20 hours for processing facilities or warehouses the seal is very good. The HLT is calculated by actively monitoring the fumigation with a Fumiscope* over a period of time and determining the specific loss of gas in that time period. To get an accurate picture of the HLT in a large structure, monitoring points should be established throughout the building. This ensures that each area or compartment of the structure will achieve the required dosage. The ProFume Fumiguide will calculate a HLT by area using the collected monitoring data.

Under conditions of rapid fumigant loss (low HLT), only the initial hours of exposure significantly accumulate dosage. If the HLT is shorter than expected (fumigant leaking faster than planned), to achieve the required dosage, the fumigator must either increase the ProFume gas concentration, increase the time of exposure, or utilize a combination of the two methods. Note: Do not target a concentration greater than 128 oz/1000 cu ft.

Fumigant Loss Rate Contributing Factors

No method presently exists for accurately predicting the loss rate of fumigant. Conditions affecting the fumigant confinement will differ for each job.

Results from numerous measurements for ProFume indicate the main influencing factors to be structural design/features such as concrete, wood, windows, etc.:

1. Condition of seal (wall construction, number and size of leaks, etc.)
2. Type of underseal (slab, soil, wood).
3. Volume of structure (ratio of surface area to volume).
4. Wind velocity.

The combined effect of these factors is difficult to assess prior to fumigation. Best practice is to use monitoring data, from previous fumigations for this or similar sites and conditions, to estimate the HLT, and then monitor to confirm the true HLT. The ProFume Fumiguide will

provide status/recommendations for achieving the target dosage based on the actual calculated HLT.

Fumigators can utilize better sealing techniques to increase HLT substantially. Experienced fumigators probably are familiar with the physical features of the structure that provide opportunities for improving the seal and increasing HLT. See Chapter 4 for more information.

**Table 6a
Dosage Case Studies**

Exposure Time	HLT = 20	HLT = 10
	Fumigant Needed*	Fumigant Needed
48 hrs	1.0X	1.8X
36 hrs	1.2X	1.9X
24 hrs	1.5X	2.1X
18 hrs	1.9X	2.4X

* A HLT of 20 with 48 hr exposure is considered the benchmark. Other values are multiplicative of the 1X benchmark.

Doubling exposure time with good HLT decreased fumigant used by 33-58%

DOSAGE CALCULATIONS

Using the ProFume Fumiguide Program

The ProFume Fumiguide is a computer-based program that requires entry of key information to determine the dosage and amount of ProFume to be used.

The ProFume Fumiguide has been developed to allow fumigators to calculate the correct dosage over a broad range of pest species, life stages, temperatures, and exposure times.

The ProFume Fumiguide determines the necessary dosage (gram-hours or ounce-hours), converts this to pounds of ProFume per 1000 cubic feet (or cubic meter) based on volume of fumigated space for all target pests referenced on the ProFume label.

The maximum target concentration in the ProFume Fumiguide is 128 oz/1000 cu ft.

The maximum target dosage in the ProFume Fumiguide is 1500 CT (oz-h/1000 cu ft).

The program also can calculate the necessary adjustments to the exposure period or pounds of ProFume required to reach the target dosage based on fumigation monitoring data.

ProFume Fumiguide Temperature Range

The ProFume label states for insects, that the lower fumigation temperature limit is 40°F. At present, however, the ProFume Fumiguide calculates specific dosages for temperatures between 68°F (20°C) and 86°F (30°C).

The ProFume Fumiguide will allow the user to input temperatures higher than 86°F, but will calculate the dosage based on 86°F. Since the efficacy of ProFume increases with temperature, the ProFume Fumiguide dosages for temperatures higher than 86°F are conservative.

The ProFume Fumiguide will allow the user to input temperatures below 68°F, but will calculate the dosage based on 68°F and provide

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a warning message that insect control may be less than optimal due to the cooler temperature and decreased insect metabolism. Following the fumigation, monitoring the pest population is recommended to assess control.

ProFume Fumiguide Exposure Time Range

The ProFume Fumiguide will allow the user to input Exposure Times between 1 and 168 hrs. Short exposures of a few hours are best suited for vacuum fumigations, while exposure periods of several days can be appropriate for stored commodity fumigations in tightly sealed storage facilities. Mill fumigations will commonly be 24 hours due to the need to limit shutdown time, but extending the exposure time can decrease the amount of fumigant necessary. Use the ProFume Fumiguide to determine the most appropriate exposure time to meet both the customer's and fumigator's needs.

ProFume Fumiguide HLT Range

The ProFume Fumiguide will accept HLTs from 1 to 1,000 hrs. The fumigator estimates this value prior to the fumigation preferably based on results of monitoring previous fumigations of this structure, or of fumigations conducted under similar conditions. HLTs of greater than 50 hours are normally achieved only in chambers and other tightly sealed silos. Change HLTs in the ProFume Fumiguide to see the impact of HLT on the amount of fumigant needed for a fumigation.

ProFume Fumiguide Area Volume Range

The ProFume Fumiguide will calculate fumigant dosages for structures ranging in volume from 35 to 10,000,000 cubic feet. Errors in measuring the volume can lead to underdosing and not achieving the target dosage, or using more fumigant than is needed to achieve the target dosage.

TEMPERATURE VARIATIONS AND ECONOMICS

Temperature has a major influence on the dosage requirements for successful fumigation with ProFume and is factored into dosage

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calculations. The fumigator should determine the temperature throughout the fumigation site with thermometers before the fumigation. Monitoring temperatures during fumigation also will provide validation of the temperature(s) used for dosage calculation.

Dosage requirements can vary based on changing seasonal temperature conditions. In winter, unless the fumigation environment is heated, higher dosages will be required. The fumigator should understand these variations and figure them into the economy of business practice.

Steps of Operation

Preparation Prior to Fumigant Release:

1. Determine pest species and life stages to be controlled.
2. Measure temperature at pest location with a thermometer. (ProFume Fumiguide operates in both English (°F) and Metric (°C) units.)
3. Calculate volume of fumigation space.
4. Determine the targeted exposure period.
5. In the ProFume Fumiguide program, calculate dosage of ProFume in ounces per 1000 cu ft (or gm/m³) and get pounds (or kg) of ProFume needed for the job.

ProFume Fumiguide Ranges

Temperature	68-86°F
HLT	1-1000 hours
Exposure Time	1-168 hours
Volume	35-10,000,000 cu ft
Life Stage	"Post-Embryonic Plus", or "All Life Stages"
Fumigation Type	"Space" or "Commodity"
Pressure Type	"Normal Atmospheric" or "Vacuum"

Label Limits

Dosage (CT) 29 to 1500 oz-h/1000 cu ft (NAP)
 20 to 200 oz-h/100 cu ft (vacuum)

Concentration 1 to 128 oz/1000 cu ft

ProFume Fumiguide Example

<u>Input</u>	
Species	Navel Orangeworm and Codling Moth
Temperature	86°F
HLT	50 hours
Exposure Time	4 hours
Volume	2,000 cu ft
Life Stage	Post-Embryonic Plus
Fumigation Type	Commodity
Pressure Type	Normal Atmospheric
<u>Output</u>	
Dosage (CT)	226 oz-h/1000 cu ft
Concentration	58 oz/1000 cu ft
Quantity	7 lbs

Using the ProFume Fumiguide Program When Monitoring

During the exposure period, the concentration of ProFume can be measured by a fumigant-measuring instrument such as the Fumiscope. After the fumigant concentration has reached equilibrium, measurements taken over an interval of time will give the actual loss rate from which the half-loss time (HLT) can be determined.

The ProFume Fumiguide program is designed to determine actual HLT based on measurements of ProFume concentrations during fumigation.

In the case of an ounce-hour deficiency between the targeted and predicted dosages, the actual HLT is used in the ProFume Fumiguide program to calculate the required

amount of additional fumigant or exposure time necessary to achieve the target dosage.

Use of the ProFume Fumiguide program during monitored fumigations has shown that significant quantities of ProFume fumigant can be saved and better control achieved. Refer to the ProFume Fumiguide help file for specific directions on how to use this program.

**MAKE SURE TO ACCUMULATE
THE REQUIRED OUNCE-HOURS
FOR THE TEMPERATURE
AND TARGET PEST!**

Monitoring to Determine Status and Updated Dosing Recommendations:

1. Measure (with a gas measuring instrument such as a Fumiscope) concentration of ProFume ounces/1000 cubic feet (gm/m³) (see Chapter 7, Monitoring Information).
2. After one or more hours, take a second measurement of concentration of ProFume. Accuracy of HLT increases as time between monitoring intervals is increased.
3. The ProFume Fumiguide program will calculate the actual measured HLT.
4. If the HLT is shorter than estimated (more rapid loss of fumigant), then either more ProFume needs to be added to finish on time or the exposure time may be extended if sufficient ProFume is present. The ProFume Fumiguide will provide these time and "addgas" recommendations.

FACTS ABOUT STORED PRODUCT INSECT PESTS.....

Many different pests can be found in and around commodities and processing facilities. For successful pest control, it is imperative that proper pest identification to the species level is made. If you are unsure of the exact identification of a pest, consult your local entomologist for confirmation. The following pests are the insects most commonly found

infesting processing and storage facilities and postharvest commodities:

Moth Pests (order Lepidoptera)

Several lepidopterous pests infest stored product commodities. Only the larval stage causes damage, however the recognition of adult moths is important to monitoring infestations, prevention of additional infestations, and makes pest species identification easier.

Indian Meal Moth *Plodia interpunctella* are members of the family Pyralidae. The front set of wings is tan on the front one-third and reddish brown with a copperish luster on the lower two-third. Wing span is approximately 20 mm. Moths often fly in a zig-zag pattern.

Mature larvae are dirty white in color and often show greenish or pinkish tints. Body length is approximately 13 mm long. The larvae have silken white cocoons.

The larvae feeds on all kinds of whole grains, grain based products, seeds, nuts, chocolate, dried fruits and dried foodstuffs.

Life cycle: Each moth lays 100-400 eggs singly or in small groups on food material. Eggs hatch in 4 days (86°F) and larvae begin feeding on food material. Larvae spin silken webbing. At maturity, larvae move away from food source and spin a silken cocoon to pupate. A complete life cycle usually takes from 6-8 weeks under warm conditions (25-30°C). Four to eight generations can occur per year. Larvae seldom colonize whole nuts or grains, rather prefer flour or grain pieces.

Mediterranean Flour Moth *Ephestia kuehniella* are members of the family Pyralidae. The front set of wings is pale gray in color with wavy dark lines. The rear set of wings is dirty white and they are rounded. Wingspan is approximately 25 mm wide. Mature larvae are white in color with pinkish tints. Body length is approximately 13 mm long. Each body segment has small black spots with hairs growing from them. The larvae feed on flour and milled products, nuts, chocolate, dried fruits, and beans.

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Life cycle: Each female moth lays several hundred (up to 700 eggs) on food material. Eggs hatch in 3-6 days and larvae begin feeding on food material. Larvae spin silken webbing. At maturity, larvae move away from food source and spin a silken cocoon to pupate. A complete life cycle usually takes from 9-10 weeks. Four to five generations can occur per year. Larvae seldom colonize whole nuts or grains, rather prefer flour or grain pieces.

Codling Moth *Cydia pomonella* are from the family Tortricidae. Adults are grayish brown with irregular golden brown lines on the forewings with dark spots on the tips and pale fringed hind wings. Wingspan is 12-20 mm. Larvae are pinkish white with a brown head. Body length is approximately 13-20 mm long. Larvae feed on flour and milled products, nuts, chocolate, dried fruits, and beans.

Life cycle: Each moth lays about 30-60 eggs singly on leaves near nuts. Eggs hatch in 5-20 days and larvae bore into nut. Larvae develop within nut and leave after being fully developed. They move to tree trunks or other debris to spin cocoons. Usually, 3 generations occur per year. Usually infested nuts drop from the trees, however, late generations may be present in nuts if harvested prior to full larval development.

Navel Orange Worm *Amyelois transitella* are from the family Pyralidae. Adults are silver grey with irregular dark patches on the forewings. Wingspan is 12-20 mm. Snoutlike palps arise from the head, unlike the codling moth. Larvae are milky white-pink with a dark reddish brown head capsule. Body length is approximately 9-12 mm long. The second segment behind the head has a pair of crescent shaped marks. Larvae feed primarily on the nuts of almond, walnut, pistachios, figs, and other dried fruits.

Life cycle: Each moth lays 85 eggs singly on mummy nuts, codling moth infested nuts, or blighted nuts. Eggs hatch in 4-23 days and larvae bore into nut. Larvae develop within nut and leave after being fully developed. They move to tree trunks or other debris to spin cocoons. Usually, 3-4 generations occur per year. Eggs laid on nuts just prior to harvest will hatch and develop in harvested nuts.

Beetles Pests (order Coleoptera)

Several beetle pests infest processing and storage facilities and damage stored product commodities. Both the adult and larval stage causes damage. Many of the larvae look very similar. Recognition of adult beetles is very important to monitoring infestations and makes pest species identification easier.

Flour Beetles (*Tribolium spp.*) are members of the family Tenebrionidae. The Red and Confused flour beetles are very similar in appearance. Adults are reddish brown in color and 3-4 mm long. *Tribolium* can be separated by counting the number of segments on the antenna club. Confused flour beetles have a 4 segmented, gradual club at the end of their antenna, while the Red flour beetles have more pronounced abrupt 3-segmented club antennae. Adult confused flour beetles do not fly, while the red flour beetle are strong fliers. Larvae are somewhat cylindrical in shape and 4-5 mm long. It is yellowish white except for the darker mandibles and a pair of projections that arise from the last abdominal segment.

Life cycle: Each female lays 2-8 eggs per day (400-500 for lifetime) on food material. Eggs hatch in 5-12 days and larvae begin feeding on food material. At maturity, larvae move to the food source surface and pupate. A complete life cycle usually takes 1-4 months. Four to five generations can occur per year. The red flour beetle tends to be much more prolific than the confused flour beetle.

Saw-Toothed Grain Beetle (*Oryzaephilus surinamensis*) are members of the family Cucujidae. Adults are 3 mm long and brownish. They can be easily distinguished by having six saw-like projections on each side of the thorax. Adults cannot fly. Larvae are less than 3 mm long and the head somewhat flattened. The head almost points straight ahead rather than downward. They nibble on fine food particles and cannot feed on whole grains.

Life cycle: Each female lays 45-285 eggs singly or in clusters on food material over a 2-5 month period. Eggs hatch in 3-5 days and larvae begin feeding on food material. At maturity, larvae construct crude pupal cells and attach to a solid object to pupate. A complete life cycle usually takes 1-12 months. Four to six generations can occur per year.

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Warehouse Beetle (*Trogoderma variable*) belongs to the family Dermestidae. Adults are dark and are variable in size. Larvae of the *Trogoderma* spp. are very similar in appearance; 7-8 mm in length and 2 mm wide at the middle of the body. The body is tapered slightly at both ends. They are yellow to medium brown and the last 4 abdominal segments have dark, dense clumps of setae that have spear shaped tips. *Trogoderma* are very difficult to identify and should be taken to an expert for species identification.

Life cycle: Each female lays 50-90 eggs on food material. Eggs hatch in 6-7 days and larvae begin feeding on food material. Larvae molt up to 10 times and an accumulation of cast larval skins is evident. A complete life cycle under warm conditions usually takes about 32-45 days. Four to six generations can occur per year.

Lesser Grain Borer (*Rhyzopertha dominica*) belong to the family Bostrichidae. They are dark brown in color and have a slim, cylindrical body 2-3 mm in length. The head of the beetle is tucked under the thorax and is not visible from above. The last three segments of the antenna form a loose club. Adults are strong fliers. Larvae are white with a dark head and prominent legs. This pest is considered an internal feeder. Adults feed on a wide range of cereal grains and seeds. The larvae bore into cracks in grain kernels and are often completely hollowed out.

Life cycle: Each female lays single or clusters of eggs on intact grain kernels or individually in cracked grain. Eggs hatch shortly and larvae begin feeding within the kernel. Larvae molt up to 4 times. A complete life cycle under warm conditions usually takes about 30-50 days. Many generations can occur per year.

Granary and Rice Weevils (*Sitophilus spp.*) belong to the family Cucurionidae. Granary, rice, and maize weevil adults are similar in appearance. They are dark brown and have a slightly curved snout (proboscis). Larvae are small, legless, white grubs that completely develop within kernels of cereal grains, nuts, and seeds. Adults feed on a wide range of materials. Adult granary weevils can be differentiated from rice weevils as they are

slightly larger (3-5 mm) vs. (2.3-3.5 mm), the granary weevil is solid in color, but the rice weevil has four reddish spots on the brown wing covers, and finally, the granary weevil cannot fly, whereas the rice weevil is a strong flyer.

The maize weevil is another weevil pest that may also be found infesting grains. It is very similar to the rice weevil, but slightly larger (3-3.5 mm) and the reddish markings on the wing covers are more clearly defined.

Latent Mortality.....

Sometimes live insects may be found immediately after fumigation. Under optimum or favorable conditions, the target pest will be dead or obviously dying by the end of the fumigation period. Researchers have evaluated eventual mortality of several stages of key postharvest pests following exposure to ProFume. Latent mortality in insects occurs for exposures very near mortality threshold levels. Within a species, the latent mortality period for the egg stage is generally longer and more variable than other life stages.

Rodent Pests

Several rodent pests such as rats and mice infest commodities and the processing facility as well as damage materials within facilities. Because rodent pests are "warm blooded" the target dosage is not affected by temperature. The target dosage for rodents is 36 oz-h/MCF.

Non-Target Organisms

Signs of activity or live non-target organisms found within the fumigated space do not mean the fumigation failed to control the target pests.

Consider the following:

- Lethal dosage requirements vary for different organisms and may be higher for non-target organisms than for the target pest.
- The organism may have received a toxic dosage and will eventually die (latent mortality).
- The non-target organism may have entered the structure during the aeration period.

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- Newly hatched larvae of the non-target organism may appear from eggs not killed by the fumigant.

Therefore, judgment of the success or failure of the fumigation should not be made on the presence of live organisms immediately following the fumigation.

PROFUME INTRODUCTION AND DISTRIBUTION 6

The proper introduction of ProFume* gas fumigant (release from the cylinder) is essential to the success, safety and economy of a fumigation. It is imperative that the fumigator understands the principles involved and the conditions that exist for introducing the fumigant on each job.

Outlined below are points that need to be considered when introducing ProFume:

1. The introduction methods used will practically achieve the target dosage (sufficient ounce-hours for the working temperature to control the target pest).
2. ProFume must be introduced in a manner that is safe to personnel and property inside and outside of the fumigation space.
3. The goal is to reach ProFume concentration equilibrium throughout the fumigated space as quickly as is safe and practical.

Prior to ProFume release, make sure a thorough check of the structure and surroundings is conducted and all safety precautions have been taken.

Fumigant monitoring is conducted so that the optimal amount of ProFume* is introduced based on the measured half-loss time. When an accurate estimate of HLT is not available prior to the initiation of exposure, the following Precision Fumigation method should be used. Initially introduce part (i.e., one-half) of the calculated dosage of ProFume, monitoring to determine the actual half-loss time, and then introducing additional ProFume and/or increase exposure time to achieve the target dosage.

CHOOSING PROFUME INTRODUCTION SITES

The specific site(s) of release of ProFume is (are) very important to the success of the fumigation. ProFume should be introduced in a manner to achieve rapid equilibrium, avoid excessive loss, prevent fog-out, and ensure safety to personnel and materials.

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ProFume is a Restricted Use Pesticide.

Site selection should be made using good judgment. Ask, "If ProFume was introduced in this location, how and when will it get to the most remote locations in the commodity or structure?" For many applications, it is often appropriate to use multiple introduction sites to rapidly attain equilibrium.

In structures that are frequently used for fumigation, permanent introduction systems can be built into the structure to ensure safe, effective and adequate fumigant introduction. Be sure to inspect all components of introduction systems prior to each use.

Key Considerations for Site Selection for Space Fumigations

1. Large, open spaces.
2. At least one introduction location on each floor of a multi-story structure.
3. Proximity of materials or equipment that may be damaged by fumigant introduction. Do not direct the stream of ProFume directly onto any materials.
4. Recommend at least one introduction site per 75,000 cubic feet of fumigated space.

The size and configuration of the space and the adequacy of the circulation will dictate the number of release sites for ProFume. As a rule of thumb, there should be sufficient circulation to establish fumigant equilibrium in about 2 hours following introduction in most situations.

Key Considerations for Site Selection for Containers, Railcars, and Surface Ship Fumigations

Empty containers, trucks, railcars, surface ships, and other transport vehicles may be fumigated in essentially the same way as other storage facilities. However, they must be stationary and cannot be moved over public roads, highways, railways or waterways until they are aerated.

The size and configuration of the space and the adequacy of the circulation will dictate the placement and number of release sites for ProFume. For additional information on fumigating containers, trucks, railcars, ships and other transportation vehicles loaded with food commodities, see Chapter 10.

THE FUMIGATION ATMOSPHERE

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The air or atmosphere in which we fumigate has properties that are not always readily evident but should be understood as they relate to site fumigation.

Weight of Air: Air has weight which changes with temperature: the colder the temperature, the heavier the air; the hotter the temperature, the lighter the air. Therefore, cold air will settle to the lowest point, whereas warm air rises to the highest point in the structure being fumigated. Once these different parcels of air are thoroughly mixed they will not tend to separate or stratify. This is an important concept that must be understood as it relates to use of fumigant.

Water Vapor: The concentration of water vapor in the atmosphere varies with temperature. The warmer the air, the more water vapor it can hold. The capacity in air is shown in Table 4b.

Table 4b
Water Vapor in Air at Saturation¹

Temp °C	Temp °F	Lb H ₂ O/MCF	gm H ₂ O / m ³
4.5	40	0.5	38.9
15.5	60	1.0	77.7
26.7	80	1.9	147.7
37.8	100	3.5	272.1

¹ Approximate at standard conditions.

The weight of water in a 1000 cubic feet of saturated air at 27 °C (80°F) is 1.9 pounds. Air chilled to 15.5 °C (60°F) can only hold 1 pound and 0.9 pounds will condense out as visible water (fog, rain or dew).

Relative Humidity (RH) is the amount of water in air relative to the amount it can hold at saturation (100%) at a given temperature. Thus, if air contains 100 oz and could hold 200 oz at saturation, the relative humidity would be 50 percent. A psychrometer (dry and wet bulb thermometer) or a humidity gauge can measure RH.

The **Dew Point** is the temperature at which water vapor condenses from air. The **Dew Point Depression** is the number of degrees in temperature that the air must be chilled to reach the dew point.

Water evaporates into and condenses out of the atmosphere, a function that is largely dependent

upon temperature, concentration and vapor pressure. ProFume use in fumigation involves, and is influenced by, some of these basic principles as it interacts with atmospheric gases.

PROFUME RELEASE

Two persons trained in the use of ProFume, at least one being an applicator licensed/certified by the state, must be present on site at all times during the introduction of ProFume, reentry prior to aeration, and initiation of the aeration procedure.

Worker Safety

Government authorities regulate worker safety at the job site and some agencies mandate that the employer must have written safety procedures including standard operating procedures and emergency procedures. Agencies may give special attention to the following areas: self-contained breathing apparatus (SCBA) use and maintenance, working in confined spaces, man-lifts, using ladders, working on roofs/bins, and lifting heavy objects.

Any unprotected exposure to ProFume should result in a visit to your physician (consult label).

Personal Protection Equipment

The ProFume label requires the following personal protective equipment:

Respiratory Protection: must be worn when the concentration of sulfuryl fluoride exceeds 1 ppm.

Prior to introducing fumigant, confirm that SCBA's are available and operational. The respiratory protection must be a National Institute of Occupational Safety and Health (NIOSH) or Mine Safety and Health Administration (MSHA) approved, positive-pressure self-contained breathing apparatus SCBA (not SCUBA) approval number prefix TC-19C or combination air-supplied/SCBA respirator, such as manufactured by Survivair, Ranger, Scott, or MSA.

Consult current standards concerning SCBA use and maintenance.

Eye Protection: Wear splash resistant goggles or full face shield when handling the liquid product during introduction of fumigant or when working around any lines containing fumigant under pressure. Liquid ProFume can freeze the eye

tissue. Eye protection also helps prevent physical injury if the hose disconnects.

Protective Clothing: Wear loose fitting or well-ventilated long sleeve shirt, long pants, shoes and socks. Do not wear gloves or rubber boots when introducing ProFume, as this type of protective clothing can confine the liquid against the skin that may cause freeze damage.

Do not reuse clothing or shoes that have become contaminated with liquid ProFume until thoroughly aerated. Skin contact with gaseous ProFume is not considered a problem.

When releasing ProFume from the cylinder, the operator must wear a face shield or splash-resistant goggles.

Using the Cylinder

Do not connect cylinders to introduction equipment until all fumigation warning signs have been posted and the space to be fumigated is clear of people, non-target animals and secured.

ProFume is supplied in a cylinder equipped with a dip tube that extends from the bottom of the tank to a valve on the top (see Section 2 for illustration). This valve is opened to permit a free flow of the liquid, which vaporizes as it escapes from the release hose.

The last three to five pounds of ProFume in the cylinder will turn to gas before moving through the hose and the flow rate is markedly reduced (see Section 2 for more details).

During this phase, the cylinder and hose can become frosted or iced. Care should be taken to keep this melting frost from dripping onto surfaces that can be damaged by cold temperatures or water.

Initially, the valve should be opened slightly (using an adjustable wrench works well) until flow has begun. Then open the valve about one full turn, which should give full flow through the fumigant introduction hose. When finished, close the valve tightly with the wrench. A clearance detector or leak detector (see Chapter 8) may be used to test connections for a tight seal.

Weighing The Fumigant

Either platform or hanging scales can be used to weigh the ProFume cylinder during fumigant introduction. If hanging scales are used, hanging bonnets or cylinder slings must be used to hang the cylinder from the scale. Consult the

ProFume distributor or Dow AgroSciences LLC for a source of hanging bonnets.

The cylinder should never be suspended by the valve!

Scales should be routinely calibrated to assure correct readings. Refer to the scale manufacturer for calibration and maintenance details.

Selection and Use of Equipment for Fumigant Introduction

Hoses

Release the fumigant through a suitable leak-proof hose with a minimum burst pressure of 3450 kPa (500 psi). The hose should be flexible, kink resistant, and durable and be compatible with liquid sulfuranyl fluoride. Prior to use, confirm with distributor or manufacturer that the introduction hose meets the above requirements.

The ProFume introduction rate is mostly controlled by the inside diameter and the length (resistance) of the fumigant introduction hose. Flow rates can be easily calculated using the Fumiguide* Program for ProFume gas fumigant.

Preventing Static Electricity

The flow of liquid gas in the introduction hose may be a source of static electricity. To prevent the risk of static sparking, properly attach a length of copper tubing (rated for 3450 kPa (500 psi)) with approved fittings (compression fittings can be functional) to the end of the introduction hose.

Attach the copper tubing with a grounding wire to the fan cage frame or to a neutral ground. The copper tubing mounted at the end of the introduction hose must be securely attached to the fan or some other stable object.

Securing Introduction Hose

A widely used method is to securely attach the introduction hose to a tarp clamp, and then use the tarp clamp to attach the hose to the fan cage (see Figure 6b). The fan cage is angled upward at about 45°. Another successful option is to attach the fumigant introduction hose to a solid heavy object in front of a fan angled upward at 45°.

The ProFume label requires proper fan use during fumigant introduction.

If the introduction hoses are part of a permanent introduction system, be sure to inspect the hoses prior to each use to ensure they are securely mounted and are still in required working order.

Protective Sheeting

Protective sheeting, such as polyethylene plastic, can be placed under the hose and fan to further protect floors and other materials during application from potential moisture condensation.

Change of State

When ProFume evaporates, it cools the air because it takes heat to change state from a liquid to a gas. This phenomenon is easily recognized as the action of an evaporative cooler, such as a perspiring person.

Frozen Valves and Hoses

If the ProFume cylinder valve is "just cracked" to reduce the rate of release, ProFume will expand from a liquid to a gas within the hose and frosting of the outside of the valve and hose may occur.

Frosting can be avoided by allowing full flow through the valve and lines.

The rate of flow of ProFume should only be controlled by the inside diameter (ID) and length of hose and not by restricting flow through the cylinder valve.

Frozen Cylinders

If a break occurs on the dip tube in the cylinder, ProFume will be discharged in the gas phase when the liquid level falls below the break. As the liquid expands in the cylinder, heat will be taken from the surrounding area and the cylinder will frost or freeze at that point. ProFume will still be discharged, but at a much slower rate. Cylinders showing signs of a broken dip tube (a very rare occurrence) should be painted red on the shoulder of the cylinder, red tagged, and returned to the distributor so that the problem can be corrected before refilling (see Chapter 2 for the Cylinder Return Procedure).

Fog-outs

ProFume will also take the heat needed for vaporization from nearby objects. If the temperature of the object reaches the dew point of the surrounding air (see Chapter 4), water

can condense on it. The liquid water that condenses on an object chilled to or below the dew point is called dew, like dew on glass containers of chilled drinks.

A cloud of fine droplets suspended in air near the ground is called fog. It is very important when introducing ProFume that fog and dew formation be prevented. Liquid water absorbs the very small amount of impurities in ProFume and can result in corrosion (see Chapter 11 on Troubleshooting).

If the temperature in the fumigation area drops below the dew point, water will condense out and fog-outs can occur.

Condensation forming on the photoelectric eye of a smoke detector or motion detector can cause the alarm to activate.

Releasing ProFume will cause some condensation near the release point; slow release rate and low humidity will cause less; a fast release rate and high humidity will cause more. After the condensation forms, it will evaporate at a rate that is dependent on the relative humidity, the temperature of the fumigation atmosphere, and the air mixing rate controlled by the introduction fans.

It is very important to use proper fans to help mix the heat of the building and fumigation atmosphere to evaporate the condensation. Consult the label for complete instructions on introducing ProFume.

Fog-out Prevention: There are several potential options to reduce the incidence of moisture condensation when fumigating air-conditioned structures in hot, humid weather:

1. Let structure warm a day or two before fumigation to equalize inside and outside temperature and stabilize the Relative Humidity (RH).
2. Reduce the introduction rate with a smaller diameter hose, longer hose, or pulsed (interrupted) introduction.
3. Reduce the amount of ProFume introduced into one area by using multiple introduction sites. This would be most important in high-dosage fumigations.
4. Use multiple fans or larger fans to hasten the mixing of air and heat exchange.

5. Monitor the fumigation or extend the exposure period to reduce the overall fumigant requirements, if practical.
6. When necessary, use a combination of several of these techniques to reduce the release rate and relative humidity, and increase the heat exchange of the structure to the fumigation atmosphere. The ProFume Fumiguide takes into consideration fan capacity to recommend the fumigant introduction rate.

PRECAUTIONS WHEN INTRODUCING PROFUME

Leak Detection and Repair

During release of ProFume, the fumigator must monitor around the perimeter of the fumigation area (especially downwind) with a leak detector with sufficient sensitivity to ensure a good seal and that sulfuryl fluoride concentrations are kept within acceptable levels (≤ 1 ppm) outside of the fumigation area. An SCBA must be readily available during the fumigant introduction period in case of leaks.

The TIF 5750 and XP-1 manufactured by TIF Instruments, Inc., Miami, Florida, can detect ProFume concentrations over 50 ppm. If a sustained high concentration of ProFume is detected outside the fumigation area during fumigant introduction, stop introducing the fumigant.

If any leak is encountered while using ProFume, clear the area of all personnel. Only persons wearing a self-contained breathing apparatus (SCBA) with full facemask and operating in pressure demand mode or its equivalent are permitted in the area to address the leak. Only after sulfuryl fluoride levels are ≤ 1 ppm are unprotected personnel permitted in the area.

Large leaks must be repaired to minimize loss of fumigant and to reduce risk of exposure to bystanders and/or occupants of nearby structures. This involves walking around the structure or fumigated area with a monitoring device to determine if excessive amounts of fumigant are escaping. Proper respiratory protection must be worn when sealing leaks. Seal leaks from the exterior of the structure whenever possible. If it is necessary to seal a leak from the interior of the structure, the applicator must follow all proper procedures (SCBA).

Reaching Equilibrium

When liquid ProFume is released from the introduction hose, it extracts a substantial amount of heat from the surrounding air as it expands to form a gas. A pound of liquid ProFume changing to the gas phase will drop the temperature of 1000 cubic ft. of dry air 4.5°F. (28.3 m³ of air 2.5 °C)

The chilling causes the formation of a cloud of condensed water (fog) that must be dissipated before it collects on a surface. The rate of dissipation depends upon the release rate, atmospheric conditions, and the mixing rate. The fan capacity, quantity, and placement determine the mixing rate. The chilled ProFume gas is much denser than the surrounding air and can settle to the bottom of the fumigation space unless mechanically mixed with the surrounding air.

All gases tend to move from an area of high concentration to low concentration and will eventually come to equilibrium in a confined space. ProFume will do the same when it is introduced into a fumigation space, regardless of the fact that molecules of ProFume are heavier than air molecules. However, the rate of passive diffusion may be too slow to achieve equilibrium within a practical period. Thus, mechanical mixing by fans is essential.

High capacity fans are needed when introducing ProFume into a space to prevent stratification, to aid in proper dispersion, and to assist temperature distribution.

Safety

There are several safety concerns that arise when introducing ProFume. They are covered in more detail in Section 2, but are also outlined here.

Cylinder Safety

- Avoid "man-handling" the cylinder for moving or weighing — use a hoist with a hanging bonnet.
- Protect the valve from damage; always replace valve cover and safety bonnet.
- Open valve slowly at first, then to open position (one full turn) so valve and the introduction hose do not frost. Use proper size adjustable wrench (25-30 cm). Keep wrench attached to valve.

- Prepare for frosting of the outside cylinder surface when releasing the last 1.5 to 2 kg of ProFume.
- Close valve completely when fumigant introduction is finished or cylinder is "empty."

Fumigant Introduction Hose & Fittings

- Use hose with minimum burst pressure of 3450 kPa (500 psi) compatible with liquid sulfuryl fluoride. Polyethylene or polypropylene hoses have proven satisfactory.
- Use care not to kink or crush the hose. Reinforced hose helps prevent collapse.

Personal Safety

- Always wear eye protection when introducing ProFume or repairing leaks on introduction manifolds or hoses. (Chapter 2)
- Proper respiratory protection (SCBA) must be on hand in case of required emergency entry into structure (Chapter 2).
- Make a security check for personnel, structure preparation and potentially involved non-targets. Apply proper lock-outs and tagging (Chapter 5).

Material Safety

- Use proper fumigant introduction techniques to prevent corrosion or water stains on interior materials.
- Provide protection for nearby plants.
- Use circuit breakers or fuses for fans.
- Place fans so they cannot cause damage to equipment.

PROFUME INTRODUCTION SUMMARY

The following factors need to be used in making judgments for ProFume introduction and distribution:

1. The structure
 - a. Size and volume
 - b. Space layout: open or compartmentalized; single or multi-story, etc.
 - c. Type of seal — structure and materials
 - d. HLT-sealing
 - e. Working temperature
 - f. Relative humidity (interior)
 - g. Equipment and Materials present
 - h. Others

2. Pest Complex

- a. Species
- b. Lifestage

3. Fumigation Atmosphere

- a. Temperature
- b. Humidity
- c. Air Circulation Pattern

4. ProFume Dosage

- a. Dosage for target pests
- b. Amount (lb or kg) ProFume for fumigation

5. Fans

- a. Capacity
- b. Number
- c. Air stream direction
- d. On/Off switches
- e. Safety circuits/breakers
- f. Aeration needs

6. Fumigant introduction sites and hoses

- a. Number and location of fumigant release locations
- b. ≥ 500 PSI burst strength
- c. Size (ID) of hose
- d. Length of hose
- e. Placement and direction of outlet

7. Fumigant introduction

- a. Duration of introduction
- b. Release method— all at once or periodic "bursts"

Fumigant Introduction Checklist

- Responsibilities of fumigators onsite
- Number and location of fumigant release points (document on graph)
- Fan capacity (cubic feet/minute)
- Hose diameter
- Hose length
- Calculate actual and permitted introduction rates. Ensure actual rate does not exceed permitted rate.
- Protective sheeting under fumigant release points and hose (as needed)
- Amount of ProFume to be released
- Time of introduction
- Planned duration of introduction
- Fumigant Top-up options

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MONITORING PROFUME GAS FUMIGANT7

Measurement of the accumulated dosage (g-h/m³ or oz-h/MCF) of a fumigant becomes increasingly valuable as the structure size, complexity, and the repercussions of poor pest control increase. The objective of monitoring fumigant concentration are:

1. To allow the ProFume* Fumiguide* to determine the optimal amount of ProFume to be introduced for controlling the target pests under the actual fumigation conditions
2. To allow the ProFume Fumiguide to calculate CT (dosage) achieved to ensure a successful fumigation
3. To allow the ProFume Fumiguide to calculate the actual HLT vs. just estimating the HLT
4. To develop records and experience to be able to use enhanced Precision Fumigation™ techniques in following fumigations

Monitoring discussed within this chapter refers to measuring accumulated dosage and does not refer to required monitoring for worker and bystander exposure.

Refer to label for all requirements for monitoring for human exposure.

Monitoring fumigant concentration can provide important information to the fumigator regarding the placement of fumigant introduction sites that will assist in the efficiency and success of future fumigations. Thus, in addition to helping maximize efficiency of a large fumigation, monitoring fumigant concentration can serve as a learning experience for the fumigator. For instance, if equilibrium is not achieved quickly, the fumigator can consider placing additional introduction sites or fans in the next fumigation.

Specific guidelines for monitoring the typical fumigation:

ProFume* gas fumigant should be circulated so as to reach equilibrium rapidly, ideally within an hour of introduction. The time for HLT

determination starts only after equilibrium of ProFume has been established.

1. Monitor ProFume in spaces most representative of the atmosphere in which insects will be located within the structure. In larger jobs, more sampling points may be necessary.

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2. In structures with partitions or poor air circulation, samples should be taken from the separate sections, such as: each floor of multiple story structures or each room in a partitioned building.
3. Measurements should be dependable and accurate, especially when low concentrations are involved, (see following sections on instrumentation).
4. The time required between measurements to determine the HLT will depend on the estimated HLT or past history of the structure. Usually two to four hours will be sufficient, but in the case of very large structures or excellent half-loss times, more time may be required.

Monitoring allows the correct amount of ProFume to be introduced and calculates dosage corrections necessary to ensure a successful fumigation.

EQUIPMENT

ProFume Fumiguide Program

The ProFume Fumiguide is used for all fumigations. See directions for details and specific use.

Monitoring Hoses

Arrangements should be made to place sampling hoses in the structure prior to fumigant introduction. Semi-rigid vinyl hoses (3-6 mm or 1/8"-1/2" ID) should be placed so as to sample representative concentrations with a Fumiscope or other appropriate equipment. Monitoring hoses larger than 6 mm ID may take a longer time to pull the sample from the fumigated

space to the monitoring device because of the larger volume of air needed to be moved.

Ideally, monitoring lines should be placed on all levels of the fumigated structure. If the structure is compartmentalized into separate rooms or other sub-units, be sure to place lines in areas representative of the different units. For more detailed information on monitoring hose use and placement, see Chapter 5.

Fumiscope

The Fumiscope is designed to measure the actual concentration of ProFume within the fumigation site to determine accumulated dosage. *The Fumiscope is not sensitive enough to use as a clearing device after the exposure period.* The Fumiscope also is used in conjunction with the ProFume Fumiguide program for determining actual half-loss times.

Fumiscope units are portable and weigh approximately 3.5 kg (8 lbs). The Fumiscope uses a mechanism to compare the thermal conductivity of a mixture of ProFume and dry air to that of dry ambient air. This difference is converted into an electric current, which is displayed as ounces per 1,000 cubic feet.

The sample is drawn (by electric pump) through the drying tube, the flow rate meter, and subsequently through the thermal conductivity cell by an electric pump.

The **Model D** Fumiscope has a digital readout and indicates 0-1,000 gm/m³ or ounces per 1,000 cubic feet. It is normally operated on 110 volt AC, but can be adapted to operate on 220 volts AC or from a 12-volt auto battery.

Older analog models (**EV** or **E-200**) are still found in the field. The model EV has a range of 0-50 ounces per 1,000 cubic feet. The model E-200 has a range of 0-100 ounces per 1,000 cubic feet.

Fumiscopes can be purchased through your distributor or from the manufacturer.

Fumiscopes Manufactured by:
Key Chemical and Equipment Co., Inc.
13195 49th Street N., Unit A
Clearwater, FL 34622
Phone: (813) 572-1159
Fax: (813) 572-4595

Operating Procedure (for units using Drierite)

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1. Fill drying tube with Drierite (4-8 mesh). Tip: Be sure cotton is in place in bottom of tube to prevent dust from being drawn into the pump and cell.
 2. Turn on pump and check for leaks by blocking inlet and noting if flow rate drops to "zero." Do the same by blocking the outlet.
 3. After warm-up (approximately 10-15 minutes depending on the humidity), adjust the flow rate to approximately 1 cubic feet per hour (CFH) and "zero" the instrument.
 4. Attach sampling hose (usually 6 mm tubing) and readjust the flow rate if necessary to the same rate in Step 3.
 5. Wait at least 3 minutes for a monitoring line of 100 feet or less for the sample to reach the Fumiscope and the reading to stabilize before recording the concentration.
 6. Disconnect the tubing and adjust the flow rate to the original setting and check to be sure the unit returns to "zero" - if not, reset it to "zero." Zero drift may occur during the first few minutes of operation.
 7. Change Drierite when approximately 3/4 of the material has changed from blue to pink. (Spent Drierite may be regenerated by placing in a shallow pan and heating in an oven to 150-200 C for 20-30 minutes then returning it to the bottle while still slightly warm.)

Monitoring Line Purge Pump

Because most fumigations will result in the use of multiple monitoring lines that are several hundred feet long, the use of a vacuum purge pump is recommended. Because the pump within the Fumiscope is not high volume, getting accurate samples from locations several hundred feet away in a timely manner can be a problem.

The use of a vacuum pump ensures timely, accurate samples from all areas within the structure. The use of this system greatly reduces the time needed to monitor all locations within the structure.

Fumiscope Calibration Procedure

Small sample cylinders containing known concentrations of ProFume are available for calibration purposes. Specially designed plastic sample bags are used to transfer and inject the gas/air mixture to the Fumiscope. The instrument can then be adjusted to accurately measure the known concentration. This method is ideally suited for quick, easy and reliable

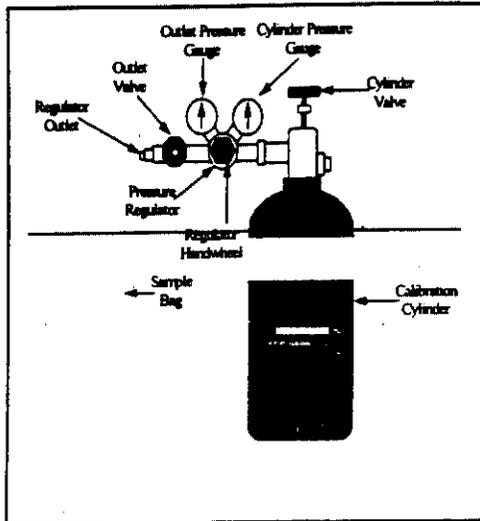
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calibration of the Fumiscope, and confirmation of accuracy in the field.

**Sample cylinders and bags are
available from:
Scott-Marrin, Inc.
6531 Box Springs Blvd.
Riverside, CA 92507-0725
Phone: (909) 653-6780**

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Calibrating the Fumiscope



The procedure for testing the calibration of the Fumiscope is as follows:

1. Warm up and "zero" Fumiscope.
2. Attach regulator to calibration cylinder and tighten with a wrench (note - left-hand thread).
3. Close outlet valve and back out regulator knob (turn to left).
4. Open cylinder valve approximately 1/2 turn.
5. Turn regulator valve clockwise until outlet pressure gauge reads 20-35 kPa (3-5 psi).
6. Attach sample bag to regulator outlet and slowly open outlet valve to fill bag approx. 90% full. Do not overfill as bag will burst.
7. Disconnect sample bag from regulator and connect to Fumiscope inlet.
8. Read Fumiscope meter for concentration of calibration standard. If the concentration on the meter is more than 5-percent different from the actual concentration, remove the bag, re-zero the Fumiscope and repeat measurements.

If the calibration check indicates a need for adjustment, remove the four phillips screws in the faceplate of the Fumiscope.

1. Wait 2-3 minutes and then adjust the meter to the gas concentration with the appropriate "pot" (blue disks).
2. Remove the bag and allow the meter to return to zero. If it does not return to zero, re-zero it and re-calibrate.

Model E-V and E-200 have two adjustment "pots" along the top of the circuit board. The disk on the left (when facing front of panel) adjusts the scale for ProFume. These two pots are interacting. The methyl bromide (MeBr) scale must be adjusted first if the instrument is to be calibrated for both gases. If a calibration is desired for ProFume only, the MeBr pot should not be touched and only the pot for ProFume is adjusted. Some also have a zero adjust lower on the board (adjust this first if it needs adjustment).

Model D has three pots on the top edge of the board. The outer pot is the zero adjust, the center is for ProFume, and the inner is for MeBr. The MeBr scale must be adjusted first if the instrument is to be calibrated for both gases. Some instruments have another zero adjust lower on the board near the pump (adjust this first if the zero needs adjustment).

An alternate procedure can be used to calibrate the Fumiscope. This procedure is based on comparing the concentration readings of the instrument to be calibrated with a standard instrument, and adjusting the one to be calibrated to indicate exactly the same concentration as the standard.

Factors Affecting Measurement

1. Warm-up - Allow the instrument to warm up until the readout stabilizes (usually 10-15 minutes - depending on the humidity).
2. Zero - Frequently re-align meter to zero.
3. Flow rate - Keep flow rate at 1 cubic foot/hour. Check flow rate for each sample.
4. To save time, charge sampling hoses with a hand squeeze bulb or vacuum pump before connecting them to Fumiscope.
5. Monitoring line - For accurate readings do not draw samples through fumigant introduction hose, which could cause erroneously high readings.
6. Other gases - Fumiscope will detect other gases and vapors, including paints, varnishes, propane and natural gas, sewer gases and auto exhaust.
7. Temperature - Avoid rapid changes in temperature. Avoid moving the instrument from shade to sun or from a hot car to cool shade.
8. Moisture - Water can cause the TC cell to rust. Check sampling tube for condensation. Keep units with digital meters in air-conditioned environments

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when not in use to prevent moisture from getting into the meter. Use fresh and adequate drying medium, such as Drierite.

- 9. Interference - Flickering fluorescent light ballasts will interfere with Fumiscope measurements. Use extension cords with grounds.
- 10. Static electricity - In analog meters, replace broken glass on meter with glass, not plastic, to avoid effects of static electricity.
- 11. Dust from Drierite - Dust can damage the pump and TC cell. Regularly replace cotton in bottom of drying tube. Clean inside of drying tube with glass window cleaner when dusty.

For Fumiscope Repair Procedure, contact the manufacturer (see Page 8-2).

MONITORING SCENARIOS

Monitoring should be conducted in a manner so that the optimal amount of ProFume* required is introduced based on the measured half-loss time to ensure the targeted dosage (CT) is achieved.

A typical scenario of key steps in the precision fumigation process is outlined below:

- 1. Input all information and variables into the ProFume Fumiguide.
- 2. From information provided by the ProFume Fumiguide, safely introduce part (i.e., one-half) of the calculated amount of ProFume gas fumigant into the fumigation space.
- 3. After a period of about one-hour, begin monitoring to determine when maximum concentration occurs. This is normally the time actual exposure time is started to be accumulated.
- 4. Continue to monitor at practical time intervals (initially 2-4 hours, longer thereafter) to determine the actual half-loss time over the exposure period for the structure or sub-areas.
- 5. Using the information calculated by the ProFume Fumiguide, either introduce additional ProFume to achieve sufficient ounce-hours in the time remaining for the fumigation and/or extend exposure time and add appropriate amount of fumigant. Attempt to add fumigant early in the exposure period to get maximum efficiency in CT accumulation.

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AERATION, CLEARING, AND REENTRY 8

Two persons trained in the use of ProFume, at least one being an applicator licensed/certified by the state, must be present on site during the initiation of aeration procedure.

One of the outstanding features of ProFume* gas fumigant for structural fumigation is its capacity to rapidly diffuse into the sites of the pests. Then, when the confinement seals are removed, aeration is also rapid.

Just as fans are useful in achieving equilibrium of fumigants, they are excellent aids in attaining rapid aeration and are essential where cross ventilation is poor.

When first preparing the fumigation, plan ahead for the aeration period and take steps to aid aeration by strategic placement of fans and by placing seams away from outdoor plants. Open operable internal doors, access panels, and storage bins to facilitate aeration.

After fumigation, it is essential no occupant re-enter the structure, warehouse, chamber, connected structures, or other fumigation sites until the fumigant has been aerated and the site has been fully tested and cleared for reentry.

AERATION – Best Practices.....

Successful, timely, and safe aerations following fumigations must be planned. The following five best practices always should be planned into the fumigation prior to fumigant introduction:

Minimize concentrations at end of exposure period: The lower the concentration of fumigant at the end of the exposure period, the easier and more timely the aeration process will be. By using Precision Fumigation™ techniques, the fumigator can minimize the amount of fumigant introduced; maximize its efficiency, maximizing the accumulated dosage (CT).

Aerate at the highest point practical: By aerating at the highest point on the structure, the highest concentrations of fumigant are directed away from workers and bystanders and are allowed to quickly dilute to levels below 1 ppm.

*Trademark of Dow AgroSciences LLC
ProFume is a Restricted Use Pesticide.

Direct aeration gases upward: Aeration in an upward manner also directs fumigant away from workers and bystanders and by using additional fans, acts to further help dilute the fumigant to safe levels.

In many cases, a permanent exhaust system that forcefully directs the air column upward or emits it through a stack would aid in the efficiency and safety of the aeration process.

Control the exhaust rate: The exhaust rate during the aeration process needs to be controlled to ensure large volumes of fumigant laden air have time to disperse and do not exceed 1 ppm. Many mills, food processing facilities, and storage facilities have air handling systems that can easily achieve a total air exchange within the facility in a very short period of time.

However, if large volumes of air are exhausted from the facility too quickly, levels of sulfurly fluoride may exceed the exposure level of 1 ppm. Prior to using quick aeration procedures, fumigators need to take into account the proximity to bystanders, location of other structures, wind speed and direction.

Monitor to ensure worker and bystander exposure levels are not exceeded: Monitoring with calibrated, approved, low concentration devices such as the Interscan or Miran should occur to confirm worker, bystander, or fenceline concentrations are not exceeded. Monitoring should be conducted frequently enough to ensure exposure levels are not exceeded during the aeration process.

FACTORS INFLUENCING AERATION TIME

Four factors affect the time needed for aeration:

1. Rate of Air Exchange
2. Fumigant Concentration
3. Sorbtion/Desorbtion and Diffusion Rate
4. Temperature

Rate of Air Exchange

The most important factor in aeration is the rate of air exchange in a structure. The air exchange rate will be influenced by openings in the external walls (windows, vents, door, etc.), wind velocity, size and arrangement of the structure. The most effective, practical method to increase the rate of aeration is to increase cross ventilation by opening doors and windows. Fans are also useful for this purpose, as a means of establishing

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a directed airflow through the structure in which fresh air is introduced and air inside the structure is exhausted/ventilated as efficiently as possible.

Terminal Fumigant Concentration

The amount of fumigant left in a structure at the end of the fumigation period can vary greatly. All other factors being equal, the greater the terminal concentration, the longer the time required to complete aeration. Thus good planning and monitoring to ensure only the necessary amount of ProFume is introduced, can decrease the aeration period.

Load Factor — Sorption, Desorption and Diffusion

The "load factor" can be expressed as the amount of materials fumigated that will adsorb or absorb the fumigant. ProFume has relatively low sorptive characteristics, meaning it has a low potential to stick to or react with fumigated materials.

The sorption that does occur, however, can affect aeration in some situations. Desorbing fumigant can slow the time to reach safe reentry levels of 1 ppm or less. In food processing facilities, the greatest amount of ProFume to be desorbed is associated with the commodities.

The sorption/desorption phenomenon is a function of fumigant concentration and temperature — the higher the concentration throughout the fumigation, the greater the driving force for sorption and, therefore, the higher the quantity to be desorbed. As with sorption, desorption initially occurs very rapidly. Most of the fumigant will desorb during the initial part of the aeration period in response to the immediate lowered concentration inside the structure when seal is broken.

Temperature

Temperature has a direct effect on the clearance rate of a fumigant. The higher the temperature, the faster the rate of gas diffusion and desorption.

SAFETY CONSIDERATIONS AT AERATION

Two persons trained in the use of ProFume must be present at the time of the initiation of aeration. The "opening" of a fumigation should be carried out to minimize ProFume exposures for the opening crew and bystanders.

USE-SPECIFIC AERATION INITIATION PROCEDURES

Space Aeration

Aerate the enclosure or structure using passive or active ventilation methods. To ensure workers and bystanders are not exposed to concentrations that exceed exposure standards for reentry, control the ventilation process, monitor concentrations of ProFume around the fumigated enclosure or structure, or prohibit entry into the area.

Use fans and aeration exhaust stacks to ventilate the bulk of the fumigant from the structure's roof eave or higher.

Bulk Commodity Aeration

Aerate the storage facility containing the food commodity to 1 ppm or less before shipping the commodity over public roads, highways or waterways. The time required to aerate the storage facility to 1 ppm or less is dependent on commodity type, packaging, and ventilation. Forced air circulation will decrease the time required to reach less than 1 ppm.

Actively aerate food commodity for a minimum of 24 hours prior to offering to consumers.

Aerate the storage facility using active ventilation methods. To ensure workers and bystanders are not exposed to concentrations that exceed exposure levels for reentry, control the ventilation process using the "Best Practices" procedures within the Chapter, monitor concentrations around the fumigated storage facility or prohibit entry into the area.

The area or site must be monitored to ensure that liberation of fumigant from the treated commodity does not result in the development of unacceptable levels of ProFume. Do not allow reentry into treated areas by any person before this time without proper respiratory protection.

Vehicle (Trailers, Containers, Railcars, etc.) Aeration

In-transit aeration of any vehicle is prohibited. Containers, trucks, and other transport vehicles loaded with bulk commodities should be actively aerated following general aeration instructions in this chapter and "Commodity Aeration" instructions above.

Aerate the vehicle using active ventilation methods. To ensure workers and bystanders are not exposed to concentrations that exceed

exposure levels for reentry, control the ventilation process using the "Best Practices" procedures within the Chapter, monitor concentrations around the fumigated storage facility or prohibit entry into the area.

Surface Ship Aeration

Only those persons involved in the fumigation may be on board during fumigation and aeration. Approved respiratory protection must be worn until concentration of ProFume is confirmed with an approved monitoring device not to exceed 1 ppm.

In-transit aeration of ships is not permitted. Ships must be aerated and cleared for reentry prior to being reoccupied.

Follow all general instructions as described in this chapter, and if food commodities are being aerated, follow instructions for "Bulk Commodity Aeration" above and in Chapter 10.

Aerate the ship using active ventilation methods, such as fans and aeration exhaust ducting to ventilate the bulk of the fumigant from the ship.

To ensure workers and bystanders are not exposed to concentrations that exceed exposure levels for reentry, control the ventilation process using the "Best Practices" procedures in this Chapter, monitor concentrations of ProFume around the fumigated ship, and/or prohibit entry into the area.

CLEARANCE AND REENTRY

General Procedures

Two persons trained in the use of ProFume, at least one being an applicator licensed/certified by the state, must be present on site during the initiation of aeration procedure.

No one shall be in fumigated areas if the level of ProFume is above 1 ppm unless wearing a NIOSH or MSHA approved positive pressure self-contained breathing apparatus (SCBA, not SCUBA) or combination air supplied/SCBA respirator, such as manufactured by Ranger, Survivair, Scott, or MSA. Note: When in the fumigated area during the aeration procedure, approved respiratory protection must be worn until concentration of ProFume is confirmed not to exceed 1 ppm with an approved monitoring device.

Only an approved detection device of sufficient sensitivity, such as the INTERSCAN gas analyzer

[Model GF 1900] or MIRAN vapor analyzer [SapphIRe], can be used to confirm a concentration of ProFume of 1 ppm or less. The Interscan gas analyzer Model GF 1900 must be calibrated within one month prior to use as a detection device. All other approved detection devices must be calibrated according to manufacturer recommendations. The concentration of ProFume must be monitored in breathing zones. The structure or space being fumigated must remain posted for fumigation until cleared for reentry.

Measure the concentration of ProFume in the breathing zones of the structure or enclosure. When the concentration is measured to be 1 ppm, the structure or space being fumigated is cleared for reentry.

Reoccupancy

Do not allow reoccupancy of any fumigated site until the aeration and clearing process is complete according to label directions and sulfuryl fluoride levels do not exceed 1 ppm as determined by the use of a detection device with sufficient sensitivity.

Following the aeration period, the fumigator must test the breathing spaces in the space or structure to make certain that the concentration of ProFume* gas fumigant is 1 ppm or less before allowing re-occupation of the structure.

**Follow all federal, state,
and local requirements for
reoccupancy.**

Handling Unaerated Commodities.....

Transfer and processing of a treated commodity prior to complete aeration is permissible, however, transfer of unaerated containers or truck trailers over public roads is prohibited. Also, railcars cannot be moved off site until aerated.

While handling unaerated commodities, people must not be exposed to ProFume in excess of permitted exposure levels.

Transfer of incompletely aerated commodity via bulk handling equipment such as augers, drag conveyors and conveyor belts to a new site is permissible; however, the new storage must have warning signs if it contains more than 1 ppm ProFume. Workers who handle incompletely aerated listed commodity must be informed and appropriate measures must be

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taken (i.e., ventilation or respiratory protection) to prevent exposures from exceeding the exposure limit.

CLEARANCE TESTING EQUIPMENT

Interscan Gas Analyzer

Model GF1900 is a continuous, direct-reading instrument designed to monitor low concentrations of sulfuryl fluoride for clearing for re-entry and leak detection. **(Caution: Exposure to levels above 50 ppm can shorten the life of the sensor and/or furnace or cause the unit to fail).** An integral pump draws the air sample through a pyrolyzer (furnace) where the sulfuryl fluoride is converted to sulfur dioxide (SO₂) which then passes through an SO₂ sensor. The sensor output is registered on a direct reading dial as ppm of sulfuryl fluoride. The unit is lightweight and battery or AC powered for easy portability.

Specifications

Measuring Range: 0-50 ppm sulfuryl fluoride

Accuracy: ±2% of full scale

Warm-up Time: Approx. 10 minutes

Weight: 8¾ lb. (4.0 kg)

Power: 24 volt DC. Two 12-volt, rechargeable batteries in a leather case or AC Power Supply with 15 meter cable on output side.

Operation Time: The battery pack can operate the instrument for up to 70 minutes before recharging (recharge overnight).

Manufactured By:

Interscan Corporation
21700 Nordhoff St.
P.O. Box 2496 Chatsworth, CA 91311
(818) 882-2331 or (800) 458-6153

Analyzers can be purchased through your ProFume distributor.

Operation

1. Turn the function knob to the "off" position and connect a power supply or battery pack. Be certain to screw the connector all the way down.
2. Turn the function knob to the "on" position. The "on" light should appear and the pump will start.
3. If the analyzer is being powered by an AC unit, disregard the Lo Bat. light, which in some analyzers stays on, while in others, flickers on and off. If using a battery pack as a power supply, turn the function knob to the Bat. Test position. The needle should move to the right of the Lo Bat. position on the meter (40 ppm). If this is not the case, or if the Lo Bat. light is on, do not attempt to use. The battery needs charging.
4. If power supply is OK, turn the function knob to the "on" position and allow the unit to warm up. After the "ready" light comes on, adjust the meter to 20 ppm in ambient air using the zero knob. Observe the needle for about two minutes and look for any drifting of the pointer. If it has drifted more than three ppm to either side, repeat the procedure until the needle has stabilized. In some cases, the unit will have to purge between 30 and 60 minutes before it stabilizes.
5. Adjust the meter to read "zero" using the zero knob.
6. When using the battery pack, the Lo Bat. indicator will light when there is about 10 minutes of operating time left. After the light is on, turn the control knob to Bat. Test to see if the meter is on or to the left of the "bat" line. If the meter is to the right, turn back to "on" and continue. Check battery condition every few minutes. When the meter shows "Lo Bat" turn the knob to off and discontinue use.
7. Recharge batteries overnight.

Calibration Procedure

Small sample cylinders containing known concentrations of ProFume are available for calibration purposes. Specially designed plastic sample bags are used to introduce the gas/air mixture to the Interscan. The instrument can then be adjusted to accurately measure the known concentration. This method is ideally suited for quick, easy and reliable calibration of

the Interscan, as well as confirmation of accuracy in the field.

Sample cylinders and bags are available from:

Scott-Marrin, Inc.
6531 Box Springs Blvd.
Riverside, CA 92507-0725
Phone: (909) 653-6780

1. Warm up and "zero" analyzer.
2. Attach regulator to calibration cylinder and tighten with a wrench, (note - left hand thread).
3. Close outlet valve and back out regulator handwheel (turn to left).
4. Open cylinder valve approximately 1/2 turn.
5. Turn regulator valve clockwise until outlet pressure gauge reads 20-35 kPa (3-5 psi).
6. Close cylinder valve and open regulator valve to bleed regulator.
7. Attach sample bag to regulator outlet and slowly open outlet valve to fill bag approx. 90 percent full (do not overfill as bag will burst).
8. Disconnect sample bag from regulator and connect to analyzer.
9. Wait 2-3 minutes and then adjust the meter to the gas concentration with the SPAN adjust.
10. Remove the bag and allow the meter to return to zero. If it does not return to zero, re-zero it and re-calibrate.

Pyrolyzer (Furnace)

- Average lifespan - 3-4 years, depending upon the frequency and conditions of use.
- Reasons for malfunction - the pyrolyzer contains a porcelain furnace that can crack with age or mishandling. It is most susceptible to damage when it is hot. Avoid dropping the Interscan and transport/store them in shock-resistant containers.

- Diagnosing malfunctions - A pyrolyzer that will not heat up may be cracked or damaged. Furnaces can also be checked by using a voltmeter or testing for air leaks. Leaks are checked by opening the unit, turning the unit on, and briefly blocking the air intake on the SO₂ sensor. If the pump stops, there are no leaks.

Sulfur Dioxide (SO₂) Sensor

- Average lifespan - 3-4 years (whether used or not).
- Diagnosing malfunctions - A slow response time, erratic readings, or inability to calibrate the Interscan indicates the sensor may need replacement. Dysfunctional sensors can also leak electrolyte solution.

Battery Pack

- Reasons for malfunction - Excessive discharging of batteries after the "Low Battery" light is on.
- Battery charger - Turn battery charger off before connecting or disconnecting the batteries from the charger to avoid potential damage to the charger circuit board. A delay in the illumination of the charge light (for up to 5 minutes) once batteries are connected may be due to excessive discharging of the batteries during use.

Power Supply

- Reasons for malfunction - The cord connecting the AC power supply to the Interscan can become worn (turn brown or become frayed) through use and require replacement. Fumigators have incorrectly installed new cords, resulting in the destruction of the circuit board of the Interscan. The color-coding for the wiring of the power supply is the reverse of that for the battery pack, and the positive and negative ports of the canon plug are not identified.

Repair Instructions

Return the analyzer to the manufacturer, or:

Key Chemical and Equipment Co. Inc.
13195 49th Street N., Unit A
Clearwater, FL 34622
Phone: (813) 572-1159
Fax: (813) 572-4595

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Miran Gas Analyzer

The **Miran 101** is an older model designed to measure a single gas or vapor.

The **Miran 203** is a single beam infrared gas analyzer with interchangeable filters and two fixed pathlengths. Factory calibrated gas calibration sets, which can be interchanged in about one minute, allow you to monitor other gases.

The **Miran SapphIRe** is a newer model infrared gas analyzer that allows monitoring of other multiple gases.

Units are portable and designed to operate on 120-volt AC or on 7.2-volt rechargeable batteries. They are suitable for measuring low levels when clearing for re-entry and for leak detection.

Specifications

Weight:	Model 101 – 8 kg (18 lbs) Model 203 – 9 kg (20 lbs) SapphIRe – 9 kg (20 lbs)
Range:	Dual scale 0-15 ppm and 0-150 ppm
Operating Time:	Four hours on batteries (rechargeable overnight)
Accuracy:	± 5% of reading

Manufactured by:

Thermo Environmental Instruments.
8 West Forge Parkway
Franklin, MA 02038
Phone: (508) 520-0430

Operation

1. Turn on analyzer and allow to warm up for approximately 30 minutes.
2. "Zero" analyzer and take readings.

Calibration

The analyzers are factory calibrated and usually do not require frequent re-calibration. They should be checked either by the electronic method or by the closed loop method described below and sent to Foxboro or their representative when re-calibration is indicated.

Performance Verification Procedure for Miran 101 and 203 Analyzers

1. Turn on analyzer and allow it to warm up for 15 minutes.
2. Zero instrument and attach Tygon tubing loop.
3. Connect needle valve and tubing to ProFume cylinder.
4. Place end of 4.7 mm" Tygon tubing in container of water.
5. Turn on cylinder valve and use needle valve to adjust the flow of ProFume so there is a slow stream of bubbles in the water. This step should be done under an exhaust hood or outdoors downwind of the Miran.
6. Using a gas tight syringe, withdraw ProFume (13 microliters (µl) = 5 ppm[†]) from the tubing on the ProFume cylinder and inject it into the tubing loop on the Miran.
7. Repeat Step 6 twice and record results after each injection.

[†] Volume of 101 and 203 cell is 2.5 liters.
Volume of 24" of 1/2" tubing is 0.08 liters.
µl of gas injected ÷ 2.6L (cell + tubing) = ppm. Therefore, 13 ÷ 2.6 = 5 ppm.

Miran SapphIRe Analyzer Performance Verification Procedure

1. Turn on the machine and let warm up for 30 minutes.
2. From main menu, select 4 = Config/Setup. From the setup menu select 1 = Calibration. From the calibration menu select 3 = Performance Verification.
3. Grasp the capillary tubing end of the sampling line and slowly push it into the nozzle opening on the gas tank.
4. Zero analyzer and confirm stable zero.
5. Attach tubing sleeve to inlet tube of analyzer. Activate trigger valve and watch gas readings climb.
6. After 3-4 minutes readings should stabilize. Record readings.
7. Remove the tubing and reattach the zero filter.
8. Restart pump by selecting Option 2 from the control menu. Continue until reading is substantially zero.
9. Remove the capillary tubing from the tank trigger nozzle and check results against challenge gas concentration.

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Repair Procedure

Contact ThermoEnvironmental Instruments or their representative.

Other Units

As new technology is developed, new devices may be developed to detect ProFume. Contact your nearest representative from Dow AgroSciences for the latest information on detection devices.

Note: Prior to using these instruments to clear a structure for reoccupancy, meters must be "zeroed." This should be done according to the manufacturer's directions, away from the fumigation site and in an atmosphere that contains no ProFume. Manufacturer's instructions also include information regarding appropriate and necessary calibration and maintenance. Manufacturer's recommendations must be followed to ensure proper operation of these instruments.

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CHAMBER and STACK FUMIGATIONS 9

Introduction

Maximum pest control results with a minimum amount of fumigant can be achieved by chamber fumigation. Fumigation in either vacuum or atmospheric chambers cuts fumigant costs, since it eliminates the necessity to disperse the fumigant in large empty areas of storage buildings, and fumigant leakage can be limited.

ProFume* gas fumigant has excellent penetrating power and also aerates rapidly when the exposure time is completed, thus eliminating long waiting periods before fumigated materials

may be safely handled. It is also non-flammable, odorless and colorless, making it an ideal fumigant for chambers.

Precise control over the fumigation process can be accomplished in chambers that are specially constructed for this purpose. Regardless of the chamber type, it is highly recommended that the first fumigations of a chamber with a specific product be monitored to determine leakage rate (HLT) and gas distribution results specific to this setup. With this knowledge and Precision Fumigation principles, subsequent fumigations can be optimized.

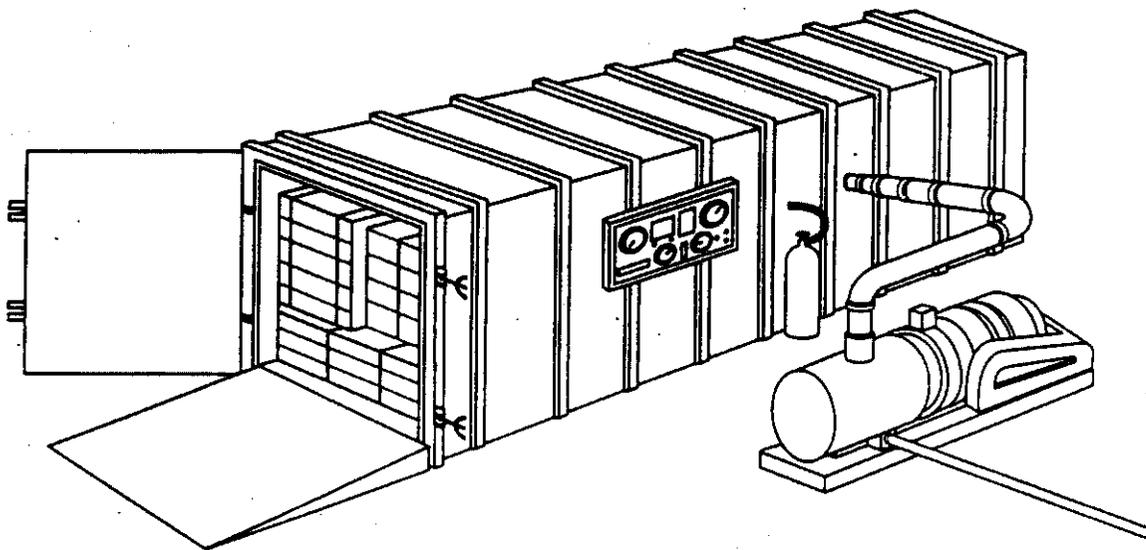


Figure 10a
Drawing of
Vacuum Chamber

*Trademark of Dow AgroSciences LLC
ProFume is a federally Restricted Use Pesticide.

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PREPARATION FOR CHAMBER FUMIGATION

Safety precautions and ProFume fumigation procedures vary by whether the chamber or stack is outside or within another structure.

Before any materials are fumigated, it is appropriate to:

1. Determine the correct dosage (concentration x time = ounce-hours) to control the designated pest under the specific treatment conditions (see Chapter 6).
2. Confirm that the chamber and its accessory equipment perform as intended.
3. Determine that ProFume will be confined within the chamber by making a test run and monitoring for leaks with appropriate equipment (see Chapter 8). Pressure testing can also indicate the gas confinement capabilities of the chamber.
4. Have on hand proper respiratory protection equipment (SCBA) and personnel trained in how to properly use it (see Chapter 2).
5. Train personnel in the proper handling of the ProFume cylinders (see Chapter 2).
6. Educate personnel in first aid procedures to be followed should an accident occur and personnel be exposed to ProFume. (see Chapter 3).
7. Notify other appropriate individuals that ProFume fumigations will be taking place: Company employees other than those performing the fumigations such as security patrols, janitors, etc.; also police and fire department personnel and others required by local, state and federal laws.

Understand and follow all label requirements and manual instructions specific to the location of the chamber or stack.

Instructions for Chamber or Stack Fumigations

Instructions which apply to both chambers and stacks located within enclosed structures or outside are presented below. Instructions specific to the type of fumigation being conducted are presented within the sections describing each fumigation type.

It is advisable to position the chamber away from work areas. The ideal situation is to locate the chamber outside or in a separate building, which is dedicated to fumigations.

Loading

Chambers and stacks should be loaded so that adequate air movement can occur around commodities to allow even distribution of the gas.

Thermometer

A thermometer should be installed to measure the temperature at the site of the pests to calculate dosage. Sufficient time should always be allowed for the chamber contents to warm up to the desired temperature before starting to fumigate. This ensures that the insect pests are active and will be exposed to the proper dosage.

Circulation Fan(s)

A shooting fan/circulation fan is recommended when introducing ProFume. A small circulating fan inside the chamber will provide a gentle movement of air adequate to achieve even gas distribution throughout the chamber.

However, if a large open space is not available, or if use of an introduction fan is dangerous or impractical, an introduction/circulation fan is not required. If a fan is not used, ensure introduction will not result in a fog-out within the fumigation chamber. Slow introduction rates (1-4 lbs per minute) are recommended to prevent excessive cooling of air near the introduction site. Do not apply liquid fumigant directly onto food commodities. Another recommendation is to increase the number of introduction sites.

Without circulation fans, reaching equilibrium will be delayed, or may not be achieved. Thus insect control may not be achieved throughout the chamber. As well, aeration will be slowed since ventilation will be minimal.

Testing Seal Effectiveness

Fittings for conducting pressure tests and for monitoring lines during fumigation should be incorporated in the chamber.

Chambers/Stacks Outside.....

Atmospheric Pressure Chambers

Design and Construction

A suitable atmospheric fumigation chamber consists of a gas-tight room with an appropriate door. An application system, exhaust blower and a small fan for even gas distribution are required.

If the chamber is to be used where low temperatures are encountered, it should be equipped with some means of heating to achieve at least 60°F (16°C) during fumigation. Heating systems should be turned off prior to ProFume introduction.

Primary consideration in the construction of the atmospheric chamber is to make it gas-tight. Sheet metal or other material impervious to sulfuryl fluoride is suggested. All joints must be sealed.

Chambers usually have two or more openings: the large loading door and the vents. Ideal construction has exhaust vent openings that are in stacks that vent the fumigation chamber away from the surrounding area. The entire edge of the door should have a rubber strip seal. All openings should have tight seals and closure devices that allow for proper security and lockout procedures.

Posting

The applicator must post all entrances and all sides of the chamber (if accessible) to be fumigated with warning signs. See the ProFume label for specific requirements.

Introducing Fumigant

Release ProFume from the cylinder placed outside the chamber through an introduction system (introduction lines, connectors, etc.) with a minimum 500 psi burst pressure rating.

A small fan should be used to distribute the gas uniformly within the chamber. Monitoring gas concentrations within the chamber can confirm the distribution of gas within the chamber.

Dosage Monitoring

Monitoring gas concentrations within the chamber during the exposure period with a Fumiscope (see Chapter 7) is recommended to confirm HLT, describe gas distribution throughout the chamber, and ensure the target dosage is achieved. Recommended monitoring site locations include one at high, medium, and low heights and in the front middle and back of the chamber.

Exhaust Fan(s)

The size of the exhaust blower will depend on the size of the fumigation chamber, the aeration time requirements and the type of material being fumigated. Generally a fan capable of changing the air in the chamber in five to 10 minutes is sufficient. Local representatives of the various blower manufacturers can be of assistance in determining the size required. The chamber exhaust must be via a stack, which carries unused ProFume outside the building and away from adjoining buildings or work areas. Consult your state agency for emission control requirements.

Aeration Procedures

Open the trap door to the exhaust vent, turn on the exhaust fan and open the front door an inch or two to permit the entrance of fresh air (if the door is hinged at the side, open the fresh air inlet provided). Aeration of ProFume is very rapid with good ventilation, but desorption can occur for a longer period of time.

Always check for the concentration of sulfuryl fluoride with a detector of sufficient sensitivity (see Chapter 9) before entering the chamber without proper respiratory protection (SCBA). Keep the exhaust fans running during the aeration period and also while unloading the chamber. Remove the warning signs when aeration has been completed and it has been determined that the area is safe to enter (see ProFume label on Aeration and Reentry).

Vacuum Chambers – Located Outside.....

Vacuum chambers require special designs, which take into account the vacuum pressure exerted on the materials of construction. For this reason, it is recommended that trained engineers be consulted before constructing a vacuum chamber. Follow all ProFume label directions and those given by the manufacturer or design engineer.

Vacuum fumigations often require a lower use rate than normal atmospheric fumigations. Do not exceed 200 oz-h/1000 cu ft.

Specially built steel chambers for vacuum fumigations provide the fastest and most effective fumigation. After the commodity is placed in the chamber, pumps evacuate air. ProFume is

introduced which rapidly penetrates all space previously occupied by air.

A lethal dosage of ProFume results when the proper concentration is maintained for the required fumigation period. With the sustained concentration (no leakage) and a vacuum of from 25-27 inches Hg, the time of exposure and the dosage may be reduced for some insects and life stages.

Posting

The applicator must post all entrances and all sides of the chamber (if accessible) to be fumigated with warning signs. See the ProFume label for specific requirements.

Drawing a Vacuum

A vacuum of 25-27 inches of mercury is commonly drawn for vacuum fumigations. Check to ensure that the vacuum is maintained according to plan. Unplanned vacuum release indicates leakage. Note that some vacuum fumigations are planned to allow release of the vacuum during exposure with the objective of improving penetration of the commodity as air enters the chamber.

Introducing Fumigant

Because of the special design of vacuum chambers, it is recommended that the manufacturer or design engineer's operation procedure be followed.

Release ProFume from the cylinder placed outside the chamber through an introduction system (introduction lines, connectors, etc.) with a minimum 500 psi burst pressure rating. (see Chapter 7).

A small fan can be used to distribute the gas uniformly in the chamber if the vacuum is to be maintained throughout the exposure period.

Dosage Monitoring

The Fumiscope cannot be used to measure ProFume during a vacuum fumigation unless the vacuum is released. If the vacuum is maintained, and thus no gas is leaking from chamber, the achieved dosage (CT) can be calculated by using the simple Concentration x Time formula.

Aeration Procedures

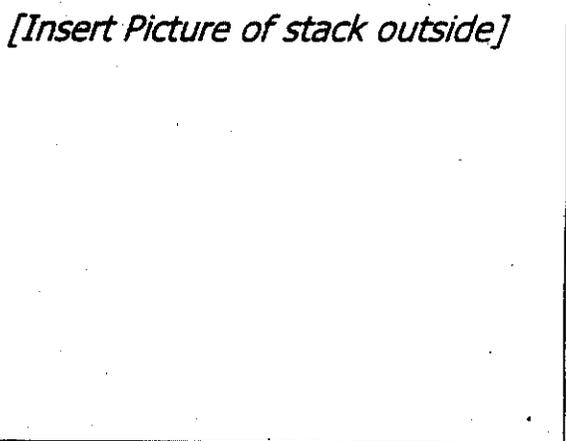
At the end of the exposure, release the vacuum ensuring any exhaust does not expose workers or bystanders above the permissible exposure limit. It is recommended to purge the chamber of air/fumigant two times by pulling a partial vacuum prior to checking the gas concentration for reentry

purposes. Aeration of ProFume is very rapid, but desorption can occur for a longer period of time.

Manage the aeration process (location, exhaust rate and direction) to ensure that workers and bystanders are not exposed to levels above 1 ppm.

Always check for the concentration of sulfuryl fluoride with a suitable detector (Section 9) before entering the chamber without proper respiratory protection (SCBA). Keep the exhaust fans running during the aeration period and also while unloading the chamber. Remove the warning signs when aeration has been completed and it has been determined that the area is safe to enter (see ProFume label on Aeration and Reentry).

Tarped-Stacks - Located Outside



Fumigations may be conducted in temporary chambers created using tarpaulins or other gas impermeable sheeting as the "walls" to hold in the fumigant (e.g. stacks of cocoa covered with tarps). These are sometimes called "Stack fumigations". The following instructions pertain to fumigation of tarped-stacks located outside other structures.

The items should be placed on an airtight foundation, such as another tarp or on concrete, and covered with a fumigation tarp to ensure a tight seal. The tarp over the items should be supported so as to create a gas expansion dome of approximately 2 feet above items and allow at least 1 foot of space around the sides for the gas to diffuse. The edge of the tarp on the foundation must be sealed either by weighting the edges with sand or water "snakes" or equivalent.

Tarp fumigations should be conducted out-of- doors or in a building that

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will not be occupied during fumigation and aeration periods.

Dosage is calculated using the ProFume Fumiguide (Chapter 6). Note that the HLT of Tarped-Stack fumigations are difficult to estimate, and therefore, monitoring with a Fumiscope is recommended to confirm the target dosage is achieved. Prior to releasing the fumigant, post warning signs on the tarp as specified in Chapter 5.

Posting

All entrances and all sides of the fumigated structure or space, including stacks and chambers and any connected area not monitored must have warning signs.

Dosage Monitoring

Monitoring gas concentrations within the tarped-stack during the exposure period with a Fumiscope (see Chapter 7) is recommended to confirm HLT, describe gas distribution throughout the stack, and ensure the target dosage is achieved. Recommended monitoring site locations include one at high, medium, and low heights and in the front middle and back of the stack.

Aeration

Best practices for aeration of Tarped-Stacks involves setting up a chimney system that will ventilate from the highest point of the stack in an upward direction at a rate that will not lead to workers or bystanders being exposed to levels greater than the PEL.

Opening the tarp cover at the seams is also functional for aeration of the stack. Ensure that workers and bystanders are not exposed above permissible exposure limits by using proper respiratory protection (SCBA) and monitoring/excluding practices.

Tarped Stacks – Within an Enclosed Structure.....

For all fumigations of NAP chambers or tarped-stacks located within an enclosed building or structure special fumigation instructions must be followed:

1) **Posting:** Post warning signs to all sides of the structure that encloses the stack. For a tarped-stack post all sides of the stack as well as all entrances and sides of the building.

2) **Occupancy:** All personnel not trained or involved in execution of the fumigation are not permitted within the structure enclosing the tarped stack during the fumigation.

3) **Securing the Enclosing Structure:** When the fumigation workers are not present within the enclosing structure, the enclosing structure must be secured from entry by anyone other than the licensed fumigator or persons under his/her direct supervision. See the ProFume label for "securing Structure Entrances" instructions.

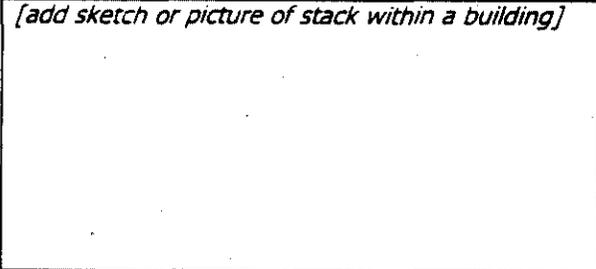
4) **Worker Exposure Monitoring:** Workers and bystanders should not be exposed above 1 ppm sulfuryl fluoride. When fumigation workers are present within the enclosing structure during the fumigation, frequently monitor with a detection device of sufficient sensitivity to measure at the 1 ppm level. Immediately vacate the area, or use proper respiratory protection (SCBA) if the concentration of SF exceeds 1 ppm. Utilize ventilation procedures to reduce SF below 1 ppm prior to allowing reentry without an SCBA.

5) **Introduction:** ProFume should be released from outside the building. If ProFume is released into the tarped-stack from within the enclosing structure, then the occupied area must be monitored to ensure the sulfuryl fluoride concentration does not exceed 1 ppm.

If any leak is encountered during application, immediately clear the area of all personnel not wearing a SCBA. Only persons who are wearing a SCBA are permitted in the area to address the leak. Only after the ProFume level has dropped below 1 ppm are unprotected personnel permitted to enter the area.

Aeration: Aeration should be designed to exhaust fumigant through the roof of the enclosing structure outward and upward to maximize potential for mixing with air (see Chapter 8). Manage the aeration process (location, exhaust rate and direction) to ensure that workers and bystanders are not exposed to levels above 1 ppm.

[add sketch or picture of stack within a building]



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Vacuum and NAP Chambers - Within an Enclosed Structure

Vacuum fumigations often require a lower use rate than normal atmospheric fumigations. Do not exceed 200 oz-h/1000 cu ft.

Vacuum fumigations can be conducted in vacuum chambers located within an enclosed structure without considering the entire structure as being under fumigation.

- 1) **Posting:** Post warning signs at all entrances to the vacuum chamber. Notify all personnel that fumigant release is about to commence.
- 2) **Introduction:** ProFume should be released from outside the building. If ProFume is released into the vacuum chamber from within the enclosing structure, then the occupied area must be monitored to ensure the sulfuryl fluoride concentration does not exceed 1 ppm.
- 3) **Worker Exposure Monitoring:** The area surrounding the vacuum chamber should be frequently monitored for sulfuryl fluoride concentrations to ensure that occupants and workers are not exposed above 1 ppm. Special care should be taken to monitor during introduction to ensure that the introduction lines and cylinder connections are not leaking.

If any leak is encountered during application, immediately clear the area of all personnel not wearing a SCBA. Only persons who are wearing a SCBA are permitted in the area to address the leak. Only after the ProFume level has dropped below 1 ppm are unprotected personnel permitted to enter the area.

4) **Aeration:** Aerate the vacuum chamber following instructions above for Vacuum chamber fumigations outside structures.

Before reentering the fumigation chamber, always determine the concentration of gas in the chamber using a sulfuryl fluoride device of sufficient sensitivity to measure at 1 ppm. Do *not* re-enter chamber without proper respiratory protection unless the sulfuryl fluoride concentration is 1 ppm or less.

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FUMIGATION OF BULK COMMODITIES..... 10

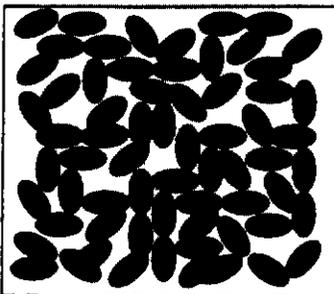
IMPORTANT CONSIDERATIONS.....

Fumigation of bulk commodities in storage presents some important differences from space fumigation. Be sure to follow all label instructions. Monitoring of fumigant concentrations during fumigations will ensure dosages (CT) were achieved for the targeted pests and provide valuable guidance on how to enhance subsequent fumigations.

SORPTION AND COMMODITY DISPLACEMENT.....

Interactions between commodities and fumigants are complex and are influenced by the commodity, its moisture content, temperature, amount of chamber loading, and the initial fumigant concentration.

One cannot just ignore the space taken up by the contents of a fumigated area and calculate the fumigant amount as if it were empty. This practice may introduce significant discrepancies between calculated target dosage and the actual dosage achieved due to varying sorption/reaction potentials of fumigants with commodities.



Interstitial spaces (in white) between kernels

The first factor to consider in achieving the correct dosage is taking into consideration the displacement of air in the structure by the commodity itself. The term "loading" or "load factor" refers to the bulk displacement of the air inside the structure or chamber occupied by the commodity itself. Most stored commodities contain a significant volume of air between the kernels. This volume of air (interstitial) may be 30-50% of the bulk displacement of the storage facility.

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Maximum pest control results with a minimum amount of fumigant can be achieved by fumigation of bulk commodities

Another factor affecting the amount of ProFume needed is the degree of fumigant sorption by the commodity. ProFume generally has a low commodity sorption rate. The rate of sorption varies by commodity. Generally, commodities with higher oil or have higher surface to volume ratios will have higher ProFume sorption rates.

The net effect of commodity displacement is that fumigant concentrations are higher than if the fumigated space was empty. The net effect of fumigant sorption into/onto commodities is that fumigant concentration drops, even in the absence of leakage.

Historically with other fumigants, sorption was assumed to balance out the effects of commodity displacement and fumigant dosages were calculated on the basis of the empty volume of the storage. Because of ProFume's low sorption potential, achieved dosages (accumulated CT's) may be higher than expected and could result in higher than expected fluoride residues. The following guidelines should be used to adjust the amount of fumigant or the exposure times:

1. Generally, initial target concentrations will need to be adjusted downwards to achieve, but not exceed, the target dosage. Because of the combined effects of air displacement and low sorption by commodities, less fumigant will be needed to achieve the target dosage, when compared to an empty storage structure.
2. Fumigators should monitor gas concentrations to determine the equilibrium concentration and calculate the actual leakage rate (HLT). Then, the ProFume* Fumiguide* will provide updated recommendations on fumigant amount and exposure time required to achieve the target dosage.

FUMIGANT INTRODUCTION...

In many commodity storage situations, the amount of open space for introducing ProFume

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is limited compared to the total volume of the structure. It may not be possible to use shooting fans and release methods that are recommended for space fumigations.

Because of limited free air volume and lower air movement, fumigators can best adjust by slowing the introduction rate. The introduction rate can be slowed by using smaller diameter shooting hoses and/or extending the hose length.

If the fumigant is released directly into the headspace of a storage structure, care should be taken to avoid contact of liquid fumigant and the commodity. Sufficient air circulation should be provided to prevent moisture condensation in the introduction area.

It is strongly recommended that recirculation systems (portable or built-in) be used to rapidly and evenly distribute ProFume throughout the space being treated. Existing aeration blowers that are vented to the outside should not be used.

Procedures for Fumigating Bulk Commodities.....

1. Follow instructions on the label and in this manual regarding sealing (Chapter 4), securing (Chapter 4), posting warning signs (Chapter 4), and aeration/clearing (Chapter 10).
2. Seal and secure the storage structure. Follow label instructions relative to "Connected Structures" and "Securing Structure Entrances".
3. Determine the ProFume target dosage and quantity of fumigant needed using the ProFume Fumiguide.
4. Make adjustments to the dosage based on the fumigant monitoring results and ProFume Fumiguide recommendations for achieving target dosages.
5. Determine where the fumigant will be released.
6. Best practice is to introduce fumigant directly into the air stream of a recirculation system. This may either be inside the storage structure or directly into the ducting of the system. If the fumigant is released into the recirculation system, it should be down stream of the fan itself.

7. In almost all cases fumigant introduction rates should be slower than for space fumigations of similar volumes to provide time for the fumigant to penetrate the grain mass and not establish high fumigant concentrations in the introduction space.

8. In the event that a recirculation system is not available, the fumigant should be released into the headspace above the commodity. Care should be taken to prevent contact of liquid fumigant with the commodity.

9. Air circulation should be started prior to fumigant introduction, and continued during introduction, to aid in ProFume penetration into the commodity mass. High concentrations in the introduction space can result in excessive fumigant loss via leakage before the fumigant penetrates evenly into commodity mass.

10. After introducing the initial amount of fumigant to reach the targeted dosage, gas concentrations should be monitored periodically and any adjustments in terms of amount of fumigant or exposure time should be made based on the ProFume Fumiguide status recommendations.

Bulk Commodity Aeration.....

1. Prior to the initiation of fumigation procedures, equipment should be put in place for a safe aeration.
2. The fumigant laden air should be vented from the highest practical point of the storage structure slow enough to not exceed exposure limits.
3. If available, aeration blowers can be used to rapidly exhaust remaining fumigant so long as these do not vent in areas where workers or bystanders might be affected.
4. SCBA equipment must be worn if workers must enter the fumigated space to initiate aeration or levels in the breathing zone exceed 1 ppm.
5. The storage facility should be finally aerated to 1 ppm or less.
6. The area or site must be monitored to ensure that liberation of fumigant from the treated commodity does not result in the development of unacceptable

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levels of ProFume. Do not allow reentry into treated areas by any person before this time without proper respiratory protection.

7. Actively aerate commodity a minimum of 24 hours prior to offering to consumers.

Handling Unaerated Commodities.....

Transfer and processing of a treated commodity prior to complete aeration is permissible, however, transfer of unaerated containers or truck trailers over public roads is prohibited. Also, railcars cannot be moved off site until aerated.

While handling unaerated commodities, people must not be exposed to ProFume in excess of exposure limits.

Transfer of incompletely aerated commodity via bulk handling equipment such as augers, drag conveyors and conveyor belts to a new site is permissible; however, the new storage must have warning signs until it is aerated to 1 ppm or less. Workers who handle incompletely aerated listed commodity must be informed and appropriate measures must be taken (i.e., ventilation and respiratory protection) to prevent exposures from exceeding the exposure limit.

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TROUBLESHOOTING 11

ProFume* gas fumigant in the gaseous phase is a very slightly reactive chemical compared to other fumigants such as methyl bromide, hydrocyanic acid (HCN), or acrylonitrile.

CYLINDERS

Valve Problems

ProFume cylinders are fitted with special valves that are appropriate for use with sulfuryl fluoride. These valves can be damaged if wrong size wrench is used. A 25-30 cm adjustable wrench should be used to open or close these valves.

Stuck Valve — Never use excessive force to open a stuck valve. If a valve will not open using normal force, return the cylinder to your ProFume distributor.

Leaking Valve — Make sure the valve is completely shut off, however, do not use excessive force. Reopening and then closing can usually properly seal the valve and stop the leak. If the valve continues to leak, often tightening the packing nut on the top of the valve to 25-30 foot pounds of torque with a adjustable wrench will stop the leak. (See ProFume Valve Stem Adjustment Procedures at the end of Section 2)

If the valve still leaks, move the cylinder to an isolated, secured area and allow the cylinder to continue to vent to the air. Be sure to keep people away from the area. When all the gas has escaped, replace the bonnet and identify faulty cylinders by painting the cylinder shoulders red, and tagging the cylinder describing the problem in detail. Return cylinders to your ProFume distributor so it may be sent to Dow AgroSciences LLC for repairs (see Section 2 for Cylinder Return Procedure).

Dip Tubes

A broken dip tube rarely is the reason liquid ProFume cannot be moved out of the cylinder when the valve is wide open. Sharp blows to the cylinder, rough handling, or dropping of the cylinder can break off the dip tube from the bottom of the valve (see Chapter 2). If the dip tube is broken, ProFume will be released from the cylinder, but at a much slower rate. Either introduce the ProFume slowly or replace the bonnet and call your distributor for instructions on cylinder return procedures (see Chapter 2 for Cylinder Return Procedures).

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Leaking Cylinders

Leaking may occur if cylinders receive rough handling. Abrasion on the side of the cylinder may produce pinholes in the metal.

Always identify faulty cylinders, valves, and dip tube by painting the cylinder shoulders red. Attach red tag describing the problem in detail. Return cylinders to your distributor.

CORROSION OF METALS

ProFume is not known to cause any corrosion when it is in the vapor (gaseous) phase under normal temperatures. Every batch of ProFume is tested for metal corrosion before being released for sale.

Metal surfaces of copper, silver, steel, stainless steel, brass, aluminum, etc., may, become corroded or rusted if ProFume is released *incorrectly*. If ProFume is introduced too rapidly, the temperature of the air will drop below the dew point resulting in the formation of condensation.

Condensation generally occurs in or near the area of ProFume introduction. Minute quantities of acids (by-products of the manufacturing process are soluble in water condensation, and can etch metal surfaces. The fumigant introduction rate should not exceed the fan capacity (one kg ProFume per 60 m³ /minute of fan capacity) to thoroughly mix the colder air where ProFume is introduced into the warmer air in the structure (see Chapters 4, 5 and 7).

Metal tarnishing/corrosion can also occur if heat sources are left on during fumigation. ProFume is decomposed by heat from flames such as pilot lights in furnaces, stoves, dryers, or refrigerators and such glowing heat sources as electric heaters. Heat sources above 400°C (752°F) decompose ProFume to corrosive materials (mainly HF, hydrofluoric acid). Therefore, it is imperative that pilot lights and other heat sources be eliminated or turned off during fumigations.

Damage to metals can also occur from the inclusion in the fumigated space of chlorine generators. These pieces of equipment should either be turned off or excluded from the fumigation.

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Damage to metals can usually be corrected by cleaning the metal items with a good metal cleanser or polish. The corrosion or rust is usually only on the surface.

GLASS ETCHING.....

ProFume in the gaseous phase is not known to cause etching of glass. HF (hydrofluoric acid), the decomposition product of ProFume (as described under the section on corrosion), may react with ceramic material such as window glass, china, glazed tile, etc., creating a condition referred to as "etching" or "frosting." Therefore, it is *imperative* that all heat sources and pilot lights be turned off during fumigation. Fog-outs can also cause etching of glass and ceramic tile. Each batch of ProFume is also tested for glass etching before it leaves the production plant.

RUN STAINS.....

ProFume in the gaseous phase is not known to cause staining of fabrics, walls, paintings, etc. Staining, however, can be caused by the presence of liquid water (dew or fog) caused by exceeding the capacity of the fan to mix cold air where ProFume gas is introduced with the air in the structure (see Section 7). A condition can occur when condensation forms on the interior and/or exterior surfaces of the structures and a "sticky" light to dark brown liquid (from grease, dirt, and smoke) runs down wall surfaces. This may have the appearance in color and consistency of cola. Spots also may form on the bottom side of horizontal surfaces. Most stains can be removed by washing.

Condensation forming and running down vertical surfaces can occur even without the introduction of ProFume. A structure that is air conditioned to a much lower temperature than the air temperature and then opened to introduce hot humid outside air will form condensation on cold surfaces such as heavy brass. This condition can be avoided by either warming the structure slowly prior to sealing or waiting until all seals are in place before opening windows and doors to avoid introducing outside air.

STAINING

ProFume in the vapor phase does not cause staining or discoloration of fabric or other materials normally found in a structure under fumigation. Fabric staining or color changes can occur when a high heat source (i.e., pilot light) converts sulfuryl fluoride to the acid, HF (hydrofluoric acid), sulfur dioxide and other corrosive materials. Many fabric dyes are acid or

base indicators and will change color in the presence of acids or bases.

For staining caused by frosting of the fumigant introduction hose, see Fumigant Introduction Hose Freezing, below.

FUMIGANT INTRODUCTION HOSE FREEZING

When ProFume is introduced according to label directions, the introduction hose will not freeze and the liquid will change to a gas at the end of the hose. The use of the proper size fumigant introduction hose is important (see Section 7). Initially, slowly open the valve a quarter to one half turn to begin the flow of liquid ProFume. Then open valve to one full turn or full flow through the hose. If the liquid changes to a gas within the hose, frost will collect along the length of the hose and water damage can occur to floors, furniture, etc., where the hose rests. Also, ProFume may change from a liquid to a gas in a hose with kinks. This can cause freeze damage from either frost accumulating on the outside of the hose, or the hose becoming brittle, breaking and splashing liquid ProFume on surfaces. Replace kinked or damaged hoses. Use mesh-reinforced, flexible hosing of proper specifications to avoid this problem.

During ProFume release from the cylinder, some chilling of the valves, cylinder, and fumigant introduction hoses can occur under normal circumstances. Valves can freeze if ProFume is allowed to change from a liquid to a gas within the valve area. Valve freezing is usually caused by using an improper fumigant introduction hose connector.

Carpeting and floors can be damaged if cylinders, fans and hoses are allowed to rest upon them. When this could pose a problem, plastic or other protective material should be placed under the fumigant introduction hoses and fans.

PLANT AND TURF DAMAGE.....

ProFume is quite toxic to most plants and they should be protected from the fumigant, however, plants should not be used as an indicator of the success or failure of a fumigation. Plants should be removed from inside the fumigation site (see Section 5). Structural foundation plantings of ornamental shrubs and trees can be protected to a certain degree from the gas by wetting the soil thereby sealing off the gas from the plant root system. Water is an excellent barrier and ProFume will not readily move through moist soil.

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Certain plants have been found to be more sensitive to ProFume than others. These include junipers, some dwarf palms, springer fern, orchids, and Lily grasses (*Liriope* spp. and *Ophiopogon* spp.), which are commonly used as border plantings. Special attention should be given to these plants during fumigation and the initiation of aeration to reduce the exposure to ProFume. Plants that have been moved should be placed in a similar environment to that where they were being grown which they are used to — same temperature, light, humidity, etc.

ODOR PROBLEMS

Odors can also be caused by the decomposition of dead animals. Occasionally animals such as rats or mice are trapped inside the fumigation site and killed during the fumigation. Many times they die in inaccessible areas within the structure and cannot be easily removed.

POOR CONTROL OF PESTS

Poor control of the target pest is caused by not generating the target CT (Concentration x Time) for the temperature to kill the pest. Accumulation of target CT does not begin until the fumigant is uniformly mixed throughout the site (reached equilibrium). Many factors may contribute to insufficient CT accumulation.

1. Confinement of fumigant, primarily ground seal or tarps, is worse than estimated.
2. Inaccurate monitoring device.
3. Too short an exposure period (insufficient CT).
4. Using the wrong dosage (insufficient Gram/H).
5. Not using adequate fans to distribute the gas properly within the site.
6. Not accurately determining the temperature of the pest site.
7. Error in calculating volume to be fumigated.
8. High winds which can cause excessive loss of gas.
9. Target pest excluded from exposure to fumigant by some gas inhibiting barrier.

PLASTICS

Liquid ProFume is a good solvent of some plastic materials. ProFume should not be introduced directly onto plastic surfaces such as windows, as liquid droplets may discolor or etch the material.

Plastic fittings (connections) are not recommended for use with ProFume. Certain nylon fittings have been damaged by the liquid dissolving the plasticizers in the plastic that resulted in the formation of a white powder in the hose. No information is available on other types of plastic connectors; therefore, only metal connections are recommended.

MISCELLANEOUS

White Powder Left as Residue: A white powder substance found on windows, tile, glass, lamps, etc. indicates that a source of heat (pilot lights, etc.) was left on during the fumigation.

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APPENDIX 12

**ENGLISH-METRIC
CONVERSION TABLES**

Temperature
 $(^{\circ}\text{C} \times 1.8) + 32 = ^{\circ}\text{F}$
 $(^{\circ}\text{F} - 32) \div 1.8 = ^{\circ}\text{C}$

$^{\circ}\text{F}$	$^{\circ}\text{C}$
104	40
102	39
100	38
98	37
96	36
94	35
92	34
90	33
88	32
86	31
84	30
82	29
80	28
78	27
76	26
74	25
72	24
70	23
68	22
66	21
64	20
62	19
60	18
58	17
56	16
54	15
52	14
50	13
48	12
46	11
44	10
42	9
40	8
38	7
36	6
34	5
32	4
	3
	2
	1
	0

Volume
 $1 \text{ ft}^3 = 0.0283 \text{ m}^3$
 $1 \text{ m}^3 = 35.31 \text{ ft}^3$

m^3	ft^3
1	35.3
10	353
25	706
50	1,765
75	2,647
100	3,530
200	7,060
300	10,590
400	14,120
500	17,650
600	21,180
700	24,710
800	28,240
900	31,770
1,000	35,300
1,500	52,950
2,000	70,600
3,000	105,900
4,000	141,200
5,000	176,500
6,000	211,800
7,000	247,100
8,000	282,400
9,000	317,700
10,000	353,000
20,000	706,000
30,000	1,057,000
40,000	1,412,000
50,000	1,765,000
100,000	3,530,000

Wind Speed
 $1.609 \text{ kph} = 1 \text{ mph}$
 $0.621 = 1 \text{ kph}$

kmph	mph
50	31
48	30
46	29
44	28
42	27
40	26
38	25
36	24
34	23
32	22
30	21
28	20
26	19
24	18
22	17
20	16
18	15
16	14
14	13
12	12
10	11
8	10
6	9
4	8
2	7
0	6
	5
	4
	3
	2
	1
	0

DOSAGE
 $\text{oz-hr}/1000\text{ft}^3$
 $\approx \text{gm-hr}/\text{m}^3$

PRESSURE
 $1 \text{ PSI} \approx 6.9 \text{ Kpa} \approx 0.689 \text{ bar}$
 $1 \text{ bar} \approx 100 \text{ Kpa} \approx 14.50 \text{ PSI}$

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GLOSSARY

TERMS USED IN FUMIGATION.....

ACTIVE INGREDIENT:

Components of a pesticide that control the target pest and is responsible for the pesticidal effect.

ACUTE INHALATION TOXICITY:

Immediate poisoning from a single elevated inhalation exposure to a substance; causes injury or death from a single exposure.

ACUTE ORAL TOXICITY:

Immediate poisoning from a single oral elevated ingestion exposure to a substance; causes injury or death from a single exposure.

ACUTE TOXICITY:

A rapid response, often within minutes or hours, to a single exposure or dose of a chemical.

ADSORPTION/ABSORPTION = SORPTION:

The action of a material in holding a gas or substance. The opposite of desorption.

AERATE:

Exchange fumigant-laden air with fresh air until the concentration of fumigant has reached the permitted entry level.

AERATION:

The final step of a fumigation that involves proper ventilation and clearance of ProFume from the structure.

AMERICAN CONFERENCE FOR GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH):

The professional organization of governmental industrial hygienists which establishes annual recommended guideline threshold limit values (TLVs) for lifetime noise, radiation and chemical occupational exposures for eight hours per day, 40 hours per week.

ANTIDOTE:

A remedy that counteracts the effects of a poison.

ARTHROPOD:

Any segmented invertebrate of the phylum Arthropoda, having jointed legs.

ATMOSPHERE:

A mass or body of gases that are present in a region or place.

AXIAL FLOW FAN:

A fan in which the air flows through the impeller and casing is primarily axial. The impeller is contained within a cylinder housing (AMCA Publication 211).

BOILING POINT (BP):

The temperature at which a liquid converts from liquid phase into a gas (the temperature at which the vapor pressure in a liquid equals the external pressure).

BONNET:

The cap that covers the valve and safety cap on the fumigant cylinder to protect the valving system from damage and prevent accidental release of the fumigant.

CARCINOGENICITY:

Possessing the power, ability or tendency to produce or incite cancer in a living tissue.

CELLULOSE:

A polysaccharide consisting of repeated glucose units, which is a major component of plant cell walls.

CENTRAL NERVOUS SYSTEM (CNS) DEPRESSION:

An alteration of level of consciousness that proceeds other changes in vital and neurologic signs.

CERTIFIED APPLICATOR:

Member of a fumigation crew who has received the proper training and is approved to release the fumigant.

CHLOROPICRIN:

Most commonly known as a 'tear gas,' is used as a warning agent in Vikane fumigations. However it is not to be used with ProFume as it does not have approved food tolerances.

CIRCULATION:

Mechanically stir or circulate the fumigation atmosphere.

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CLAMPS:

Devices used to attach tarps together and hold them in place during a fumigation.

CLEARING:

The procedure following the aeration period when the fumigator tests the breathing space in the structure with sensitive equipment to make certain the concentration of ProFume* gas fumigant is 1 ppm or less before allowing re-occupancy.

CONCENTRATION:

Amount of fumigant per unit area within the fumigated space during exposure period. Usually measured in ounces per 1,000 cubic feet or grams per cubic meter.

CONDENSATION:

The change of a vapor or gas into a liquid.

CUBIC FEET PER MINUTE (CFM):

Often used as a rating system for the amount of air a fan can move.

CYANOSIS:

Any bluish discoloration of the skin.

CYLINDER SLING:

A type of holster or suspension ring used to suspend a fumigant cylinder.

DESORPTION:

The liberation or removal of a fumigant substance from other substances.

DEW POINT:

The temperature at which water will condense from air (the temperature at which dew forms).

DEW POINT DEPRESSION:

The number of degrees the temperature must be lowered for dew (water condensation form air) to form.

DIP TUBE:

A PVC tube that extends from the bottom of the cylinder to the valve on the top that releases liquid ProFume.

DISPERSE:

Distribute the fumigant throughout the fumigation site.

DIFFUSION:

The spontaneous process whereby a fumigant moves from an area of high concentration toward an area of lower concentration.

DOSAGE:

The number of ounce-hours (gram-hours) accumulated during the exposure period. Target dosage is the ounce-hours targeted during the planning phase.

DOSE:

The amount of fumigant introduced into the fumigation space — oz/1000 cubic feet (gm/cubic meter). Often confused with dosage.

DRIERITE:

The hygroscopic material used in the Fumiscope™ unit to remove moisture from the air. Drierite in good condition is normally blue in color.

ENTRAINED AIR:

Air drawn in and transported.

EQUILIBRIUM:

The state when all the sulfuryl fluoride molecules are at equal concentrations from each other in a confined area.

EXPOSURE TIME:

The amount of time a fumigant is confined in a structure to kill the target pest.

°F/°C:

Working temperature. Usually the temperature of the cleft spots insect pests are located. Usually expressed in degrees Fahrenheit or Celsius. In the case of chamber fumigations, the internal temperature of the commodities to be fumigated (i.e., site of pest).

FACE SHIELD:

One of two pieces of safety equipment permitted to protect the eyes required when releasing the fumigant (see goggles).

FLASH POINT:

The temperature at which vapor explodes.

FLUOROSIS:

A mottling or blackening of the teeth caused by an overexposure to fluorine.

FOG:

Very fine droplets of liquid moisture in air.

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FOG-OUT:

The condensation of moisture inside a fumigated structure, which is caused by a large drop in air temperature. Methods to prevent a fog-out include: (1) using the proper inside diameter and length of the introduction hose, and (2) using appropriate fans with sufficient velocity to effectively mix the warmer air inside the structure with the colder ProFume gas.

FRASS:

Insect excrement that can sometimes be used to identify insect infestation.

FUMIGANT INTRODUCTION:

Release of the fumigant from its containers into the fumigation space.

FUMISCOPE:

A thermal conductivity analyzer used to monitor the concentration of sulfuryl fluoride during a fumigation. Measures in ounces per 1000 cubic feet or gm per cubic meter. The Fumiscope is not for monitoring for human exposure.

GAS:

Matter in vapor state. That fluid form of matter which is compressible with limits, and which owing to the relatively free movement of its molecules, diffuses readily in other like forms of matter and is capable of indefinite expansion in all directions.

GOGGLES:

One of two pieces of approved safety equipment to protect the eyes required when releasing the fumigant (see face shield).

GROUND SEAL:

The sealing of tarps to the ground to prevent fumigant loss during a fumigation.

HALF-LOSS TIME (HLT):

The relative measure of how well a structure holds fumigant. Actual time required to lose one-half of the fumigant concentration, measured in hours. The fumigant loss rate depends on the building construction, sealing practices, wind, and fumigant distribution influences. The *actual* HLT can be established only by measuring the fumigant concentration during the exposure period with a gas measuring instrument and using the ProFume Fumiguide* program.

HANGING BONNET:

A type of cap or ring used to suspend the fumigant cylinder.

HEAT OF VAPORIZATION:

The amount of heat necessary to change a liquid state to a gaseous state. This is usually measured in British Thermal Units (BTUs).

HEPATIC:

Pertaining to the liver.

HOURS EXPOSURE (HE):

The number of hours the site is exposed to the fumigant.

HYDROFLUORIC ACID:

A highly reactive chemical which can corrode or damage many household effects. ProFume can decompose into hydrofluoric acid and sulfur dioxide if exposed to high heat conditions present in gas, flames or glowing electric elements.

HYDROGEN FLUORIDE:

A colorless liquid made by the action of sulfuric acid on calcium fluoride. The compound is an extremely strong fluorinating agent, which attacks glass.

HYDROLYSIS:

A chemical reaction that causes chemical breakdown in the presence of water.

INSIDE DIAMETER (ID):

The measurement of the interior width of the fumigant introduction and monitoring hoses.

INERT INGREDIENT:

Other non-pesticidal or formulating ingredients in a pesticide formulation.

INTERSCAN GAS ANALYZER:

A portable analyzer designed to measure low concentrations of sulfuryl fluoride for worker and bystander exposure and final clearing. The Interscan provides immediate and continuous readings of gas concentrations from 1 to 50 ppm.

LACHRYMATION:

The secretion or discharge of tears from the eye.

LATENT HEAT OF VAPORIZATION:

The number of calories per mole of substance needed to change a liquid at its boiling point to a gas. For ProFume, this is 4,600 cal/mole. When liquid fumigants under pressure are

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released, available heat is "pulled" from the immediate surroundings as the liquid changes to a gas.

Possessing the power, ability or tendency to produce genetic changes or mutations.

LATENT MORTALITY:

The delayed kill of an organism receiving a toxic dose.

LEAK DETECTOR:

Device used to detect leaks in the structure or seal during a fumigation. An example would be a TIF 5750 or XP-1 detector models.

LOAD FACTOR:

The amount of material within the fumigated space. Sometimes fumigant is sorbed by materials and made unavailable for insect control.

MAXIMUM CONCENTRATION:

The greatest concentration of chemical that can or is permitted to exist as a gas in a given space. The higher the maximum concentration of the fumigant, the more that can be applied in a given space.

MCF/MCM:

1,000 cubic feet or 1,000 cubic .

MIRAN SapphIRE (mobile infrared analyzer):

A type of clearance device used to clear a structure for re-occupancy after a fumigation. Uses Infrared Technology to measure down to ppm.

MOLECULAR WEIGHT:

The sum of the weights of the constituent atoms of a molecule. For sulfuryl fluoride it is 102.07.

MONITORED FUMIGATION:

Repeated observations of a fumigation during the exposure period to determine the concentration of gas at a specific location, detect gas loss over time, ensure the appropriate amount of fumigant and the exposure time, and/or to reduce potential problems or expenses.

MINE SAFETY AND HEALTH ADMINISTRATION (MSHA):

This government agency is responsible for approving respiratory protection devices used in the workplace.

MUTAGENICITY:

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NATIONAL PEST MANAGEMENT ASSOCIATION (NPMA):

A membership organization which provides educational opportunities and materials for pest control operators throughout the United States.

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH):

The U.S. government agency responsible for research regarding occupational safety and health issues in the workplace. They also approve appropriate safety equipment, such as hard hats, respirators, eye protection, etc.

NON-FLAMMABLE:

Not flammable or readily ignitable

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA):

Federal agency that regulates worker health and safety procedures and practices.

ODOR POTENTIAL:

The possibility of malodor being generated due to the fumigant having been in contact with certain materials.

OUNCE-HOURS (OH) OR GRAM-HOURS:

Dosage = concentration X hours exposure.

OVICIDAL:

Possessing the ability to kill the egg stage of an insect.

PARTIAL PRESSURE (DALTON'S LAW):

In any mixture of gases the total pressure is equal to the sum of the partial pressures each gas would exert were it alone present in the volume occupied by the mixture. The total pressure P is equal to the sum of the partial pressures of the individual gases.

PARTS PER MILLION (PPM):

A measure of the concentration of a substance, e.g., 10 ppm = 10 drops of water in a million drops.

PERMISSIBLE EXPOSURE LIMIT (PEL):

The eight-hour time weighted average acceptable inhalation exposure limit for any regulated substance in the workplace. This exposure limit is enforced by OSHA and is the law.

PENETRATION:

The passage of fumigant into or through an object, such as flour, commodities, wood, tarps, soil, etc.

POSTEMBRYONIC:

The larval, pupal and adult stages of insects.

POUNDS PER SQUARE INCH ABSOLUTE (PSIA):

A measure of atmospheric pressure. PSIG is pounds per square inch as measured by gauge.

PULMONARY:

Pertaining to, or affecting, the lungs.

PULMONARY EDEMA:

The presence of abnormally large amounts of fluids in the intercellular spaces of the lungs.

REACTIVITY:

The ability of the fumigant to react with (combine with or change) other compounds in which it comes into contact.

RELATIVE HUMIDITY:

The ratio of the amount of water present in the air relative to the amount it could hold at 100% saturation; usually expressed in percent.

RELEASE OF FUMIGANT:

The actual introduction of fumigant into the fumigation space or site.

RENAL:

Relating to the kidneys.

REVOLUTIONS PER MINUTE (RPM):

A measure of fan speed.

RODENTS:

Any animal from the order Rodentia, such as mice and rats.

SAFETY CAP:

A covering that protects the cylinder valve from damage or accidental release of the fumigant.

SAND SNAKES:

Sand- or water-filled tubes made of material used to seal tarps to the ground to minimize release of the fumigant.

SCBA - POSITIVE PRESSURE:

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Self-contained breathing apparatus that maintains a slightly positive pressure of air inside the face piece at all times.

SECONDARY LOCKS:

Securing mechanisms used during fumigation to prevent inadvertent or illegal entry to a structure under fumigation.

SHORT-TERM EXPOSURE LIMIT (STEL):

The time-weighted average exposure limit for a particular compound, which should not be exceeded at any time during a work day, even if the eight hour time-weighted average is within the threshold limit value (TLV). Exposures to this level of a compound should not be longer than 15 minutes, and should not occur more than four times per day. There should be 60 minutes between exposures in this range.

SOLITARY INSECTS:

Category of insects that do not have all three characteristics of social insects.

SOLUBILITY:

The capability of being dissolved in a solvent such as water.

SORPTION:

The uptake of gaseous fumigant resulting from the attraction and retention by liquid and solid materials present. If great enough, there is a gradual reduction of fumigant available to kill the target pest. Sorption may also negatively affect the penetrability of the gas.

SPECIFIC GRAVITY:

The ratio of the weight of a body to that of an equal volume of some standard substance — water in the case of solids and liquids, air in the case of gases. The ratio of the mass of a liquid to the mass of an equal volume of water at 4°C, water = 1.

SQUIRREL CAGE FANS:

A fan in which the air flow through the impeller is primarily axial upon entering the impeller and is changed by the impeller blades to an essentially radial flow at the impeller discharge. The impeller is more generally contained in a volute-type housing (AMCA Publication 211).

SUBCHRONIC ORAL TOXICITY:

The oral toxicity of a material determined for an exposure period between an acute (24 hours) and chronic (weeks to months) in length.

SULFURYL FLUORIDE:

The active ingredient of ProFume, which is non-flammable, non-corrosive and does not cause undesirable odors, is a gas at temperatures above -55°C (-67°F).

TARPAULIN:

Semi-permeable membranes used during fumigation to confine the fumigant in a specific area during the exposure period.

TEMPERATURE (°C OR °F)

The pesticidal activity of a fumigant varies with temperature. The dosage requirements for ProFume are based on the mean temperature of the coldest potential pest infested site in the structure. This temperature is nearly always represented by that of the subarea soil or slab. A probe or surface thermometer can be used to measure temperature. It is very important to accumulate the proper ounce-hours for the temperature that exists.

TERATOGENIC:

The potential for an effect to cause congenital abnormality.

TERATOLOGY:

The division of embryology and pathology that deals with abnormal development and congenital malformations.

THRESHOLD LIMIT VALUE (TLV):

The time-weighted average concentration for a normal eight-hour day and 40-hour work week to which nearly all workers may be repeatedly exposed day-to-day without adverse effects.

VACUUM CHAMBER:

Specially built steel chamber used for fumigation. After the material to be fumigated is placed in the chamber, air is evacuated by pumps. The fumigant is then admitted and rapidly fills all the air space previously occupied by air.

VALVE STEM:

Opening at the top of the cylinder through which the fumigant is released.

VAPOR CORROSIVENESS:

The tendency of the gas to corrode materials. When properly introduced, ProFume is not corrosive.

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VAPOR DENSITY:

The weight ratio of a gas to air.

VAPOR PRESSURE:

The pressure exerted by a gas that is in equilibrium with its solid or liquid state. The higher the vapor pressure, the more easily and rapidly a fumigant will diffuse and penetrate to reach a gas-air equilibrium and the more rapidly it will aerate and desorb.

WARNING AGENT:

A type of 'tear gas' introduced into a structure prior to fumigation to assure the space to be fumigated is and remains free of people.

WATER SOLUBILITY:

The ability of the fumigant to dissolve in water. The less soluble in water, the less that compound is attracted to and adsorbed on the surface of materials. It is also important when considering penetration of the fumigant into soil moisture.

WATER VAPOR:

Water in the gaseous state