RESTRICTED USE PESTICIDE DUE TO INHALATION TOXICITY

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

00004162

Dow AgroSciences™

Vikane®

Specialty Gas Fumigant

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

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

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

Active Ingredient	
sulfuryl fluoride	99.8%
Inert Ingredients	0.2%
Total	100.00%

Keep Out of Reach of Children

DANGER
PELIGRO

POISON

Precaucion al usuario: Si usted no lee inglés, no use este producto hasta que la etiqueta le haya sido explicada ampliamente.

Precautionary Statements

Hazards to Humans and Domestic Animals

Extremely Hazardous Liquid And Vapor Under Pressure • Fatal If Inhaled • May Be Fatal If Swallowed • Liquid May Cause Freeze Burns of Exposed Skin

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

First Aid

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

First Aid (Cont.)

If inhaled: Get exposed person to fresh air. Keep warm and at rest. Make sure person can breathe freely. If breathing has stopped, give artificial respiration. Do not put anything in the mouth of an unconscious person. Call a poison control center or doctor for further treatment advice.
If liquid is on skin or on clothing: Immediately apply water to contaminated area of clothing before removing. Once area has thawed, remove contaminated clothing, shoes, and other items covering skin. Wash contaminated skin area thoroughly or shower. Call a poison control center or doctor for further treatment advice.
If liquid is in eyes: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

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

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

Refer to elsewhere on this label 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 this 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. 62719-4

EPA Est. 464-CA-1
900-012666 / 00276858

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

Net Contents 125 lb

Directions for Use

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

Storage and Handling

Store in dry, cool, well ventilated area under lock and key. Post as a pesticide storage area. If the storage area is in an occupied building, the storage area must have either 1) a forced air ventilation system that meets required local ordinances for the storage of hazardous materials and operates continuously; or 2) be equipped with a permanently mounted and properly maintained and functioning sulfuryl fluoride monitoring device designed to alert occupants of the building if sulfuryl fluoride in the air of the storage area is greater than 1 ppm. Store cylinders upright, secured to a rack or wall to prevent tipping. Do not contaminate water, food, or feed by storage.

Cylinders should not be subjected to rough handling or mechanical shock such as dropping, bumping, dragging, or sliding. Do not transport any cylinders in closed vehicles where they occupy the same common airspace as personnel. Transport securely only in an upright position.

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

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

Leak Procedures: Evacuate immediate area of leak. Use a NIOSH or MSHA approved positive pressure self-contained breathing apparatus (SCBA, not SCUBA) or combination air-supplied/SCBA respirator, such as manufactured by Ranger, Survivair, Scott, or MSA, for entry into affected areas to correct problem. Move leaking or damaged cylinder outdoors or to an isolated location, observing strict safety precautions. Work upwind if possible. Do not permit entry into leakage area by unprotected persons until concentration of fumigant in the breathing zone is determined to be 1 part per million (ppm) or less, as determined by a detection device with sufficient sensitivity such as an INTERSCAN, MIRAN [SapphIRe] or Spectros ExplorIR gas analyzers. For more detailed information on the source and use of air monitoring devices or respirators, consult the Vikane Gas Fumigant Structural Fumigation Manual.

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

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

General Information

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

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

When used for fumigation of enclosed spaces, such as houses and other structures, warehouses, vaults, chambers, trucks, vans, boxcars, ships, and other transport vehicles, 2 persons trained in the use of this product, at least one being an applicator who is licensed/certified by the state, must be present during introduction of fumigant, reentry prior to aeration, and during the initiation of the initial aeration procedure when exposure exceeds 1 ppm. **Two persons need not be present if monitoring is conducted remotely (outside the area being fumigated) and no one enters the fumigated structure.**

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

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

Remove food, feed, drugs, and medicinals from the structure before the fumigation if they cannot be adequately sealed to prevent exposure to Vikane. Chloropicrin must be used as described on the label to warn of an ongoing fumigation.

Preparation for Fumigation

Structural Fumigation

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

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

Open operable internal doors, internal openings to attics and sub areas, storage chests, cabinets, drawers, closets, and appliances (such as washers, dishwashers, dryers, microwave or conventional ovens, etc.). Using electric fan(s) will help provide for forced distribution and aeration of basements and other dead air spaces to facilitate rapid dispersion of gas. Refrigerator and freezer doors may be left open if the units are turned off or disconnected and all food items have been removed. If the applicator chooses to leave sealed food items in closed refrigerators and freezers during the fumigation, the appliances must be opened when clearing the structure until the concentration of Vikane in them is 1 ppm or less.

Multi-Unit Structures: When fumigating a single unit/room within a larger structure (such as townhouses, apartments, condominiums), all units of the entire structure must be prepared as a fumigated structure, and all applicable rules, regulations and label instructions apply, such as occupant notification, structure preparation, posting, securing, and aeration. An adult occupant of each currently-occupied unit must be provided with the Fact Sheet for Vikane. Ensure that all exterior entranceways and exterior doors providing access to individual units are secured with secondary locks (see Securing Structure Entrances) so that only the state licensed applicator in charge can gain access. Chloropicrin need only be used in the fumigated space where Vikane is introduced. During Step (3) of Aeration Procedure 1 or 2, check all units within the fumigated structure for concentrations of Vikane with an approved clearance device. If the concentration of Vikane is greater than 1 ppm in the breathing zone (i.e., areas within the structure where individuals typically stand, sit or lie down) in a unit, ventilate the unit with operable doors and windows open and continue to measure the concentration of Vikane until it is 1 ppm or less. Structure may be reoccupied when concentrations in the breathing zones in all units is 1 ppm or less.

Connected Structures: A connected structure is defined as any structure connected with the structure to be fumigated by construction elements (e.g., pipes, conduits, ducts, etc.) which may allow passage of fumigant between the structures. If state rules and regulations do not describe or permit a process to isolate and seal a connected structure to prevent passage of fumigant from the fumigated structure, then the connected structure must be vacated during the fumigation. When it is necessary to vacate any connected structure, that structure shall be considered as a fumigated structure and all applicable rules, regulations and label instructions apply, such as occupant notification, structure preparation, posting, securing, and aeration. Chloropicrin need only be used in structures where Vikane is introduced. Concentration levels of Vikane must be measured in the breathing zones (see Aeration and Reentry) in any connected space or structure to confirm concentrations are 1 ppm or less before structure can be reoccupied.

Tarpaulin Fumigation
Open operable windows as permitted by local and state regulations. When tarping, use a highly resistant material such as a vinyl coated nylon, or polyethylene sheeting of at least 4 mil thickness. Seal all seams. Seal the bottom edges of the cover to the ground using materials such as soil, sand, or weighted "snakes." To minimize escape of gas through the soil and to avoid injury to nearby plants, wet soil outward from foundation to the cover if not sufficiently moist to act as a barrier for the gas.

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

Chamber Fumigation
For chamber fumigation use a tightly-sealed chamber with adequate circulation.

Construction Materials, Furnishings (Household Effects), Vehicles, and Shipping Containers
Follow preparations as appropriate in above paragraphs for chamber, taped fumigation, or tarpaulin fumigation to assure good confinement of the gas for the recommended period of exposure.

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

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

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

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

Warning Agent
Chloropicrin is a warning agent introduced into the structure during fumigation. In order to avoid direct exposure to the fumigant being released, chloropicrin must be released within the structure at least 5 to 10 minutes prior to introduction of the fumigant. Place a handful of wicking agent, (e.g., cotton) in a chloropicrin evaporation container(s). Do not use chloropicrin evaporation containers or application equipment made of magnesium, aluminum, or their alloys as chloropicrin may be severely corrosive to such metals. To enhance the distribution of chloropicrin throughout the structure, place the chloropicrin evaporation container in the air stream of a fan. Pour chloropicrin over the wicking agent. When adding chloropicrin to evaporation containers, dispense no more than 3 fl oz per container. Use 1 fl oz/10,000 to 15,000 cubic feet (30 ml/283 to 425 cubic meters) of space to be fumigated or follow dosage rate calculated by the electronic Fumiguide™ system. Establish at least one chloropicrin introduction site for each 45,000 cubic feet of space to be fumigated. Removal of all chloropicrin evaporation containers from the fumigated space during the initial phase of aeration after tarp removal will aid in the dissipation of the warning agent from the structure.

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

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

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

Respiratory Protection
If the concentration of Vikane in the breathing zone of the fumigated area (as measured by a detector device with sufficient sensitivity such as an INTERSCAN, MIRAN [SapphIRe] or Spectros ExplorIR gas analyzers) does not exceed 1 ppm (4 mg/cubic meter), no respiratory protection is required. When this concentration is exceeded, all persons in the exposed area must wear a NIOSH or MSHA approved positive pressure self-contained breathing

apparatus (SCBA, not SCUBA) or combination air-supplied/SCBA respirator such as manufactured by Ranger, Survivair, Scott, or MSA. Before using any make or brand of SCBA, learn how to use it correctly. Determine that it has an adequate air supply for the job at hand, that it fits properly, providing an adequate seal around the face, and that it is in good working order. For more detailed information on the source and use of air monitoring devices and respirators, consult the Vikane Gas Fumigant Structural Fumigation Manual.

Prefumigation Check: Check for potential leaks.

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

Dosage and Exposure Time

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

Pest	Dosage Factor (as a multiple of drywood termite dosage)
rodents†	1/2X
carpet beetles†† and cockroaches††	1X
furniture carpet beetles†† and bedbugs	3X
old house borers and Formosan termites	4X
clothes moths	6X
powder post beetles and death watch beetles	10X

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

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

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

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

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

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

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

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

Introducing the Fumigant

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

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

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

Only a certified applicator may authorize removal of placards, and only when the concentration of Vikane in the breathing zones of the treated site is 1 ppm or less.

Aeration and Reentry

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

Only an approved detection device of sufficient sensitivity, such as the INTERSCAN, MIRAN [SapphIRe] or Spectros ExplorIR gas analyzer, can be used to confirm a concentration of Vikane of 1 ppm or less. The INTERSCAN must be calibrated according to manufacturer recommendations within one month prior to use as a clearance device. All other approved detection devices must be calibrated according to manufacturer recommendations. The concentration of Vikane must be monitored in breathing zones. Structure must remain posted for fumigation until cleared for reentry.

Open all operable attic doors and accesses and direct a fan into the attic. If the structure has an attached garage, the door between the garage and structure should be open. If the

structure has a central air handling system, the fan (or blower) should be activated for each unit if operational. As an alternative, a fan may be placed in front of a furnace inlet to blow air into central heating and cooling ducts.

Select the appropriate procedure based on the fumigation rate:

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

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

Aeration Procedure 1

These steps must be completed in sequence.

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

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

Step (3): After the minimum 6-hour waiting period, measure the concentration of Vikane in breathing zones of each room. If the concentration of Vikane is greater than 1 ppm, ventilate structure with operable doors and windows open and confirm concentrations are 1 ppm or less before the structure is reoccupied.

Aeration Procedure 2

These steps must be completed in sequence.

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

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

Step (3): After the minimum 8-hour waiting period, measure the concentrations of Vikane in breathing zones of each room. If the concentration of Vikane is greater than 1 ppm, ventilate structure with operable doors and windows open and confirm concentrations are 1 ppm or less before the structure is reoccupied.

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

Terms and Conditions of Use

If terms of the following Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies are not acceptable, return unopened package at once to the seller for a full refund of purchase price paid. Otherwise, use by the buyer or any other user constitutes acceptance of the terms under Warranty Disclaimer, Inherent Risks of Use and Limitation of Remedies.

Warranty Disclaimer

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

Inherent Risks of Use

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

Limitation of Remedies

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

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

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

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

EPA-Accepted 04/13/06

RESTRICTED USE PESTICIDE DUE TO INHALATION TOXICITY
For sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicator's certification.

Structural Fumigation Manual for

Vikane®

Specialty Gas Fumigant

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

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

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

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

Keep Out of Reach of Children

DANGER  POISON

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

PELIGRO

Si usted no lee inglés, no use este producto hasta que la etiqueta le haya sido explicada ampliamente.

First Aid

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

If inhaled: Get exposed person to fresh air. Keep warm and at rest. Make sure person can breathe freely. If breathing has stopped, give artificial respiration. Do not put anything in the mouth of an unconscious person. Call a poison control center or doctor for further treatment advice.
If liquid is on skin or on clothing: Immediately apply water to contaminated area of clothing before removing. Once area has thawed, remove contaminated clothing, shoes, and other items covering skin. Wash contaminated skin area thoroughly or shower. Call a poison control center or doctor for further treatment advice.

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

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

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

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. 62719-4

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

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STRUCTURAL FUMIGATION: FUMIGATING WITH VIKANE GAS FUMIGANT. . . . . .

INTRODUCTION

Vikane® specialty gas fumigant was specifically developed by The Dow Chemical Company in the 1950s to be used exclusively by professional fumigators to control wood-destroying insects in structures. A manual was first prepared in the 1960s to help pest control operators gain a better understanding of wood-destroying insects and the art of structural fumigation. Since that time, much has changed in the industry and efforts are made to keep the manual current.

While every structural fumigation is unique, there are basic principles and guidelines to follow that are common to all structural fumigations. The purpose of this technical manual is to supplement and support the label for Vikane and add to the understanding of these principles and practices. The objective of this manual is to reinforce the continued safe and effective use of this product.

As label instructions and industry practices may change, this manual is not intended to be a final authority on fumigation nor is it intended to replace label requirements or state and local regulations. This manual will be periodically revised to reflect additional modifications of the label, as well as knowledge obtained through research and experience.

WHY FUMIGATE?

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

In addition, visual inspection usually will not reveal the entire infestation and exact distribution of the population in homes and other buildings is usually difficult to determine. Damage and insect activity may be on the inside of walls, under insulation and in other areas that are inaccessible and go undetected by even the most experienced inspectors.

This can also be true with other pests, such as cockroaches. Population levels may become so severe that conventional methods are not effective or fast enough. Harborages become established in "protected" areas that are difficult, or even impossible, to effectively treat. Resistance has been known to develop in cases where continual pressure from the application of residuals and knockdown agents has existed and control is seemingly unattainable.

During a fumigation for any of these pests, Vikane effectively penetrates the entire structure and its contents to completely eliminate the existing population. The physical nature of fumigants is to occupy all the air spaces within the structure. Being a gas, the fumigant penetrates the pores of wooden members and reaches other inaccessible areas where liquids and aerosols cannot, and does so without the necessity of locating every site of infested wood or existing harborage.

A good inspection is still required and plays an important role in pest management to determine the actual pest involved, the severity of the infestation and the best control method. Fumigants have no residual activity, but when needed, fumigation is more effective and efficient than any other means of control.

The Structural Fumigation Manual for use with Vikane has been prepared as a part of the continuing Product Stewardship Program for Vikane provided by Dow AgroSciences LLC. The manual includes recommendations for using Vikane and describes the safe handling and storage of this product.

Each fumigator using Vikane 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 Vikane. However, because regulations and the enforcement of regulations can change in a rapid fashion, the fumigator will need to stay informed about state and local regulations in areas where they operate.

State and local government offices, the distributors of Vikane or the sales representative from Dow AgroSciences in your area should be able to help identify the agencies that have a responsibility for regulating structural fumigation in your area.

In emergency situations, help may be obtained by calling Dow AgroSciences during normal business hours at 1-800-352-6776, Monday through Friday between 8:00 a.m. and 4:30 p.m. EST, or (517) 636-4400 after hours and on weekends.

Notice
The information, specifications, procedures, methods and recommendations herein are presented in good faith, are believed to be accurate and reliable, but may well be incomplete and/or not applicable to all conditions or situations that may exist or occur. No representation, guarantee or warranty is made as to the accuracy, reliability or completeness of said information, specifications, procedures, methods and recommendations or that application or use of any of the same will avoid hazards, accidents, losses, damage or injury of any kind to persons or property or that the same will not infringe patents of Dow AgroSciences or others, or give desired results. Readers are cautioned to satisfy themselves as to the suitability of said information, specifications, procedures, methods and recommendations for the purposes intended prior to use.

BE GOOD PRODUCT STEWARDS

All handlers and applicators using Vikane should be good product stewards by following the label and manual directions and all applicable federal, state and local regulations.

PRODUCT STEWARDSHIP – WHAT IS IT?

Dow AgroSciences is committed to exercising responsible care for its products in manufacturing and distribution and later in the handling of its products by distributors, dealers and use by its customers.

This means assessing the environmental impact of the products and then taking appropriate steps to protect employee and public health and the environment as a whole. In addition to safe production, stewardship means we have a continuous concern for the proper use and ultimate disposal of our products.

Users of Vikane should have a similar concern. Remember, that's also good business.

LEGAL RAMIFICATIONS OF CONDUCTING FUMIGATIONS WITH VIKANE

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

all of which are beyond the control of Dow AgroSciences or the seller. All such risks shall be assumed by buyer.

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

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

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

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

GLOSSARY

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

PRODUCT INFORMATION 1

Vikane is a product manufactured and sold by Dow AgroSciences LLC for the control of certain pests.

THE LABEL

This product is registered by the Environmental Protection Agency, Registration Number 62719-4. The label for Vikane gas fumigant is a legal document. It is illegal to use the product in any manner inconsistent with the label. Labels are periodically revised and available through Dow AgroSciences or your authorized distributor of Vikane.

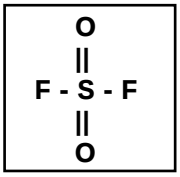
COMPOSITION

Vikane gas fumigant is an inorganic chemical and is composed of:

Active Ingredient
sulfuryl fluoride (by weight) 99.8%
Inert Ingredients..... 0.2%
Total 100.00%

PHYSICAL PROPERTIES

Structural formula: SO_2F_2



Color: None

Odor: None

Molecular Weight: 102.07 AMU

Specific Gravity: 1.35 at 20°C (68°F)

Vapor Density: 4.3 g/L at 20°C (68°F)

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

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

Gas Solubility at Pressure = 1 atm: 25°C (77°F) and in water 0.075% (750 ppm) by weight, only slightly soluble in organic solvents, vegetable oils and stoddard solvent.

Stability: Stable to heat normally encountered in structural and other 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 etch metal and glass.

Heat of Vaporization: 81.1 BTU/pound at –55°C (–67°F) or 4600 cal/mol. 1 lb of sulfuryl fluoride = 4.45 moles. 1 lb of Vikane will lower 1000 cu ft of dry air by 2.5°C (4.5°F).

Volume per Pound: 1 lb of gas occupies 3.8 cu ft at 25°C (77°F) and 760 mm Hg. 1 lb of gas per 1000 cu ft of unoccupied space equals approximately 3850 ppm at room temperature and pressure (25°C at 760 mm Hg).

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

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.

It can, however, react with strong bases such as some photo developing solutions.

IMPORTANT QUALITIES OF A GOOD STRUCTURAL FUMIGANT

In addition to being toxic to the target pest, there are many physical properties inherent to a fumigant.

Table 1a Characteristics of Structural Fumigants

	Physical Property	Desirable Characteristic	Vikane
1.	Toxicity to insects	high	high
2.	Sorption	low	low-moderate
	-wood and furnishings	low	low-moderate
	-soil	low	low
	-loss through tarps	low	low
	-penetration (diffusion)	high	high
3.	Desorption/Aeration	quick	quick
4.	Reactivity	none	relatively non-reactive as a gas
5.	Odor potential	none	none
6.	Boiling point	low	low (-67°F)
7.	Flash point	none	none
8.	Heat of vaporization	low	low (81.1 BTU/lb)
9.	Vapor pressure (77°F)	high	high (13,442 mm Hg)
10.	Water solubility	low	low (750 ppm)
11.	Vapor corrosiveness	none	none

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.

Desorption – The reverse process of sorption whereby gaseous fumigant escapes or diffuses from the material.

Reactivity – The ability of the fumigant to react with (combine with or change) other compounds in which it comes into contact.

Odor Potential – The possibility of malodor being generated due to the fumigant having been in contact with certain materials.

Boiling Point – The temperature at which the fumigant changes from a liquid to a gas. The lower the boiling point, the easier it is to apply the chemical at any given temperature without the need of heating.

Flash Point – The temperature at which the vapor explodes.

Latent Heat of Vaporization – The amount of heat required to convert the liquid fumigant to the gaseous state at a given temperature and pressure. When liquid fumigants under pressure are released, available heat is absorbed from the immediate surroundings as the liquid changes to a gas.

Vapor Pressure – The measure of the tendency for the fumigant to evaporate. 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.

Water Solubility – The ability of the fumigant to dissolve in water. This is important when considering penetration of the fumigant into soil.

Vapor Corrosiveness – The tendency of the gas to corrode materials. When properly introduced, Vikane is not corrosive.

TOXICITY DATA

Vikane (99.8% sulfuryl fluoride) is an odorless, toxic gas that can be handled safely. However, it is critical that individuals who are to use this product are thoroughly trained in its proper use.

Laboratory Animal Data

Acute Oral: LD_{50} – rat = 100 mg/kg. Human ingestion is highly unlikely since sulfuryl fluoride liquid turns to a gas at –67°F (–55°C). Food and medicinals are removed or placed in highly resistant containers prior to the fumigation to provide protection from gas exposure.

Subchronic Oral: Laboratory animals maintained for 66 days on feed directly fumigated at 2 lb/1000 cu ft experienced no adverse effects. Higher application rates (10 to 200 lb/1000 cu ft) for the same time period resulted in dose related decreases in body weight gains and fluorosis of the teeth.

Acute Inhalation: LC_{50} values have been estimated based on results from exposing laboratory rats to various concentrations for a fixed amount of time (3850 ppm = 16 oz/1000 cu ft): LC50 = 1122 ppm for 4 hours (males); LC_{50} = 991 ppm for 4 hours (females); LC_{50} = 3730 ppm for 1 hour (males); LC_{50} = 3021 ppm for 1 hour (females).

Convulsions, red staining around the eyes, nose and mouth, and cyanosis were the most notable observations for acutely exposed animals. The mortality curve for acute inhalation exposure is very steep, i.e., only a small margin exists between lethal and non-lethal exposures, as shown in the following results of other studies with rats:

Parts per Million (ppm)	Exposure Period	Lethality
15,000	12 min 6 min	96% 4%
8,000	30 min 12 min	100% 7%
4,000	60 min 30 min	97% 40%
2,000	2 hrs 1 hr	79% 4%

As can also be seen, the time/concentration relationship holds true, i.e., the higher the concentration, the shorter the exposure period required for lethality.

Subchronic Inhalation

Rate exposed for 6 hrs/day, 5 days/week for 9 weeks to 100 ppm Vikane did not show any adverse effects. Minimal kidney changes were observed in rats exposed to 300 ppm. Repeated exposures to 600 ppm were lethal to rats and produced kidney injury and inflammation of the nasal tissues and lungs.

Rabbits similarly exposed showed no effects from 100 ppm. The affected target organs in rabbits exposed to higher concentrations were the brain and respiratory system. Rabbits exposed to 600 ppm were slightly hyperactive, and convulsions were observed in one female.

In 13-week studies, rats exposed 6 hrs/day, 5 days/week to 30 ppm showed no adverse effects. A concentration of 100 ppm produced no effects other than mottled teeth. Rats exposed to 300 ppm had decreased body weights, mottled teeth and microscopic evidence of brain and kidney injury and inflammation of nasal tissues and lungs.

Rabbits exposed to 30 ppm for 6 hrs/day, 5 days/week for 13 weeks likewise showed no effects. At higher concentrations (100 ppm and 600/300 ppm), effects were noted. Those exposed to 600 ppm had their concentrations reduced to 300 ppm after nine exposures because two rabbits had convulsions following the ninth exposure of 600 ppm. The effects of the higher concentrations were decreased bodyweight gains and microscopic changes in brain and nasal tissues. These effects were dose related as the microscopic brain and nasal tissue changes were observed in most of the rabbits at 600/300 ppm but in only one male (nasal effects) and one female (brain lesions) exposed to 100 ppm for the length of the study.

Other Tests in Animals

Teratology

Vikane was not teratogenic (causing birth defects in offspring of exposed animals) in either rats or rabbits exposed to levels up to 225 ppm for 6 hours/day during the critical periods of major organogenisis.

Bred Fischer rats showed no evidence of maternal toxicity, embryolethality or fetotoxicity when exposed to 225 ppm for 6 hours/day on days 6 through 15 of gestation. Some signs of maternal toxicity (i.e., decrease body-weight gain, increase water consumption) was seen at 300 ppm, but no evidence of embryotoxicity was observed.

Maternal toxicity (i.e., loss of body weight) was observed in New Zealand white rabbits exposed to 225 ppm for 6 hours/day on days 6 through 18 of gestation. Decreased fetal body weight, indicative of fetotoxic effects, was also observed. No material or fetal toxicity was observed when exposed to 75 or 100 ppm during gestation.

Mutagenicity/Carcinogenicity

Vikane has been tested in a battery of mutagenicity tests that serve as a screen for identifying chemicals that affect genetic mechanisms. All test results indicate that Vikane is not mutagenic in standard testing. Vikane did not cause cancer in rats and mice exposed to Vikane in lifetime studies to assess whether or not the chemical has potential to cause cancer.

Reproduction & Offspring Development

The results of the studies described here indicate that Vikane is not likely to have any effect on reproduction or development of offspring. Groups of pregnant rats and rabbits were exposed to Vikane at three different concentrations: 25, 75 and 225 ppm for 6 hours/day during the majority of the gestation period. Although the highest level of 225 ppm was toxic to the maternal animals (as would be expected), there was no evidence that Vikane was teratogenic. The only effects on the fetus were reduced body weights in the rabbits at the highest level, probably associated with the maternal weight loss. In a reproduction study, male and female rats were exposed to concentrations of 5, 20 or 150 ppm throughout two generations. The highest level of 150 ppm was toxic to the parent animals. Rabbits exposed to 100 and 300 ppm of Vikane showed decreased body weights and microscopic changes in brain and nasal tissues. Parent animals exposed to 5 ppm had no evidence of effects. Decreased weights of the offspring were observed at 150 ppm that may have been secondary to decreased maternal growth. The only effect observed at 20 ppm was mild lung irritation in parental rats, with no evidence of toxicity in offspring. There were no effects on reproductive performance in any exposure group. These effects are similar to those seen in a 13-week study involving rabbits.

Potential Human Effects

Short-Term Inhalation Exposures

High concentrations of Vikane may cause respiratory irritation, pulmonary edema, nausea, abdominal pain, central nervous system depression, slowing of movements and speech, and numbness in the extremities.

Long-Term Inhalation Exposures

Fluorosis of the teeth may occur when humans are chronically exposed.

Workers who frequently come into contact with Vikane can have their urine checked for fluoride. It should be noted that high total fluorides in the urine could be due to chemicals other than sulfuryl fluoride. Today a person may be exposed to fluorides in drinking water, fluorinated toothpastes (which prevent tooth decay), and medicines in addition to that which we obtain from the food that we eat.

The OSHA permissible exposure limit (PEL) for sulfuryl fluoride is 5 ppm. The American Conference for Governmental Industrial Hygienists (ACGIH) has also established a threshold limit value (TLV) for sulfuryl fluoride of 5 ppm for 8 hours/day, 5 days/week for the life of a working individual. ACGIH recommends a short-term exposure limit (STEL) of 10 ppm.

Respiratory protection (positive-pressure Self-Contained Breathing Apparatus (SCBA, not SCUBA) is required when entering a fumigation site that exceeds 1 ppm or the concentration is unknown.

Evaluation of Worker Exposures During Structural Fumigations

A recent worker exposure study conducted by Dow AgroSciences evaluated both task-specific and full-shift exposures to Vikane during structural fumigations. This study monitored four fumigation crews and utilized a validated pump and tube collection method to accurately estimate the amount of sulfuryl fluoride present in the breathing zones of both fumigators and tent crew workers during the course of a normal five-day work week. Both the task-specific and full-shift margins of exposure calculated from this study showed that fumigators and tent crew workers exposed to Vikane during structural fumigations are not at risk from this exposure when label safety precautions are followed. This includes wearing a SCBA when exposure to Vikane exceeds 1 ppm or is unknown, such as when inside a structure during the initial hour of aeration. In addition, proper maintenance, training and use of the SCBAs should continue to be emphasized.

FUMIGATION SITES AND PESTS CONTROLLED

Vikane is registered to control undesirable pests in the following infested sites:
— structures
— fumigation chambers
— construction materials and furnishings (including household effects)
— vehicles, including rail cars and cargo containers, except aircraft and subsurface water vessels

For detailed information on the pests associated with these sites and the recommended practices for fumigating to control these pests, consult the following section and others dealing specifically with the fumigation sites as well as the product label.

Pests Controlled

Due to its toxic and penetrating qualities, Vikane is excellent for controlling a broad spectrum of pests, including insects, other arthropods and rodents, which are pests to humans. The pests for which Vikane is commonly used include drywood termites, Formosan subterranean termites, wood-boring beetles, fabric and museum pests, cockroaches and rodents.

Biological Activity of Vikane

The toxicity of fumigants, including sulfuryl fluoride, the active ingredient in Vikane, is determined largely by the uptake of fumigant by the target pest during the time of exposure. The post-embryonic stages of all arthropods tested are more susceptible to sulfuryl fluoride than the eggs. The toxicity of Vikane to the post-embryonic stages of different arthropods is dependent on the arthropod's intrinsic metabolism and respiration rates. As a rule of thumb, the faster the locomotion of the arthropod, the more susceptible it is to Vikane. Adult cockroaches, flies, fleas and ants are very susceptible to Vikane, with 95-99% mortality occurring at less than half the drywood termite dosage (Table 1c). By comparison, adult ticks and spiders require two-fold the drywood termite dosage for 99% mortality.

Table 1b shows the dosage required to control various pest populations.

From 2- to 34-fold the drywood termite dosage of Vikane is required to kill the eggs of arthropods tested (Table 1c). Research has indicated that the poor ovicidal activity of Vikane is primarily due to its lack of penetration through, and binding to, the eggshell and membranes. Where complete ovicidal activity is required, the rates to be used are listed in Table 1b.

The practical implications of poor ovicidal activity of Vikane depend on the target pest. For social insects, such as termites and ants, control of the egg stage is not necessary when workers are eradicated. The larvae of social insects hatching from eggs will not survive without the care of workers. For termites and ants, fumigant dosages lethal for workers will also kill winged reproductives, called swarmers.

Vikane is superbly suited for the control of drywood termite colonies, which are located above ground in structural wood.

The post-embryonic forms of subterranean termites and carpenter ants are susceptible to similar dosages of Vikane. However, their nests containing reproductives and brood are usually hidden outside of the fumigation zone, thus allowing the colony to survive and re-invade the structure. This is why fumigation should be conducted for Formosan subterranean termites and carpenter ants only when the colony is above ground and in the structure to be fumigated, and is inaccessible for localized treatment. For example, Formosan subterranean termites often make aerial nests and galleries that allow colonies to exist without ground contact. Fumigation with Vikane is sometimes necessary.

For many solitary (non-social) insects, a higher dosage of Vikane is required to kill the egg stage. For some insects, such as dermestid beetles and some cockroach species, the maximum application rate for Vikane, 10-fold the drywood termite dosage, is not sufficient to kill the egg stage. For these insects, the label for Vikane recommends two fumigations. The second fumigation is conducted after eggs surviving the first fumigation have hatched, and before these insects reach adulthood.

The German cockroach is an exception to other solitary insects because the embryos in the egg case are dependent on the female for survival. Unlike other structure-infesting cockroaches, the German cockroach female carries her egg case for about 30 days, when deposits it one or two days before the eggs are ready to hatch. Embryos desiccate if the female dies prematurely. Therefore, most embryos in the egg case of the German roach are controlled by Vikane at the drywood termite dosage.

By comparison, American, brown-banded and Oriental cockroach females deposit their egg cases after carrying them for only one to two days. Killing the adult does not have any effect on the survival of the eggs. Higher dosages are required for penetration through the thick, protective covering to kill the developing embryos.

Unlike insects, rodents are warm-blooded animals and do not require increased dosages at lower temperatures. To determine the proper dose for rodent control, use 80°F as the calculating temperature. The dose rate will be one-half of the rate for drywood termite control. However, regardless of the ambient temperature, the fumigator should use sufficient gas to accumulate at least 36 ounce-hours of exposure for a successful rodent fumigation.

Table 1b

Pest	**Dosage Factor** (as a multiple of drywood termite dosage)
rodents[1]	1/2X
Carpet beetles[2] and cockroaches[2]	1X
furniture carpet beetles[2] and bedbugs	3X
old house borers and Formosan termites	4X
clothes moths	6X
powder post beetles and death watch beetles	10X

[1]To determine the proper dose for rodent control, use 80°F as the calculating temperature. Unlike insects, rodents are warm blooded and do not require increased dosages at lower temperatures.
[2]More than one fumigation may be needed to control the infestation after egg hatch.

Latent Mortality

Sometimes live insects may be found immediately after a fumigation. Under optimum or favorable conditions, the target pest will be dead or obviously dying by the end of the fumigation period. Researchers have observed a delay in mortality of three to five days for termite species exposed to Vikane. Researchers have waited as long as two weeks to determine mortality of arthropods following exposure to Vikane (Table 1c). Latent mortality in insects occurs for exposures very near mortality threshold levels. Generally, within a species, the latent mortality period for the egg stage is longer and more variable compared to other life stages.

Signs of activity or live non-target organisms found within the structure after fumigation does not mean the fumigation failed because:
– Lethal dose 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 dose and will eventually die (latent mortality).
– The non-target organism may have entered the structure during the aeration period.
– Newly hatched larvae of the non-target organism may appear from eggs not killed by the fumigant.
– Frass pellets or powder may continue to fall out of damaged wood for weeks or months following the fumigation.

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

Table 1c Lethal Accumulated Dosages (LAD_{99}) (oz-h/1000 cu ft) of Sulfuryl Fluoride for Various Arthropod Species

Species		Hours of exposure	Temp (°F)	Life stage of arthropod			
Scientific name	Common name			Adult	Egg	Larva/ nymph	Pupa
Ticks and spiders							
Rhipicephalus sanguineus	Brown dog tick	16	72	186[a] (2)[b]	–	–	–
		8	81	108	–	–	–
Lactrodectus hesperus	Black widow spider	20	81	82 (4)	300[a]	–	–
Loxosceles reclusa	Brown recluse spider	20	81	77 (7)	–	–	–
Cockroaches							
Periplaneta americana	American cockroach	16	80	9[c] (7)	413[c] (14)	–	–
		8	81	–	>402[d] (14)	–	–
Blattella germanica	German cockroach	16	80	19[c] (3)	–	–	–
		4	70	16 (2)	64[c] (13)	–	–
		8	81	–	–	17[c] (9)	–
Supella longipalpa	Brown-banded cockroach	16	80	64[a] (14)	>256[d] (14)	64[a] (14)	–
Termites							
Neotermes jouteli	–	22	81	36 (5)	–	–	–
Zootermopsis angusticollis	Western dampwood termite	22	81	35 (5)	–	–	–
Kalotermes approximatus	–	22	81	44 (5)	–	–	–
Cryptotermes cavifrons	–	22	81	37 (5)	–	–	–
		4-20	81	48[a] (3)	–	–	–
Incisitermes snyderi	–	22	81	46 (5)	–	–	–
Incisitermes schwarzi	–	4-20	81	48[a] (3)	–	–	–
Incisitermes minor	Western drywood termite	22	81	51 (5)	–	–	–
		24	80	47 (5-14)	–	–	–
Reticulitermes flavipes	Eastern subterranean termite	22	81	20 (5)	–	–	–
Reticulitermes tibialis	–	22	81	30 (5)	–	–	–
Coptotermes formosanus	Formosan subterranean termite	22	81	39 (5)	–	–	–
		4-20	81	48[a] (3)	–	–	–
		24	86	132[a] (0)	–	–	–
Prorhinotermes simplex	–	22	81	42 (5)	–	–	–
Bed bugs							
Cimex lectularius	Bed bug	16	80	64[a] (14)	64[a] (14)	64[a] (14)	–
Dermestid beetles							
Attagenus unicolor	Black carpet beetle	16	80	–	1213[c]	38[c] (14)	–
		22	80	44 (4)	1694 (18)	68 (2)	–
Anthrenus flavipes	Furniture carpet beetle	22	80	78 (6)	854 (18)	156 (8)	–
Dermestes maculatus	Hide beetle	22	80	29 (3)	769 (5)	28 (6)	–
Trogoderma granarium	Khapra beetle	8	70	–	>499[d]	80[c]	128[c]
Wood-boring beetles							
Lasioderma sericorne	Cigarette beetle	16	80	15[c (14)]	–	–	–
		22	80	35 (3)	712 (10)	56 (3)	–
Lyctus planicollis	Southern lyctus beetle	16	79	–	512[c]	–	–
Lyctus brunneus	–	6.5	72	–	289[e,g]	–	–
Euvrilletta peltata	–	18	72	–	470[e,h]	–	–
Hemicoelus gibbicollis	–	20	72	–	>500[h]	87[e]	–
Grain beetles							
Tribolium confusum	Confused flour beetle	5	77	55 (7)	–	–	–
		16	80	55[c] (14)	1125[c] (14)	–	–
		24	80	–	1517[c]	–	–
Sitophilus granarius	Granary weevil	5	77	18 (7)	–	–	–
		16	80	15[c] (14)	794[c] (14)	14[c] (14)	14[c] (14)
Rhyzopertha dominica	Lesser grain borer	16	80	10[c] (14)	219[c] (14)	–	21[c] (14)
Oryzaephilus surinamensis	Saw-toothed grain beetle	16	80	14[c] (7)	–	–	–
Tenebroides mauritanicus	Cadelle	5	77	–	–	82 (7)	–
Moths							
Ephestia elutella	Tobacco moth	16	80	–	768[a] (14)	64[a] (14)	–
Sitotroga cerealella	Angoumois grain moth	16	80	21[c] (3)	87[c] (14)	24[c] (14)	–
Anagasta kuehniella	Mediterranean flour moth	16	80	34[c] (3)	–	42[c] (14)	–
Spodoptera eridania	Southern armyworm	16	80	–	363[c]	–	–
Tineola bisselliella	Webbing clothes moth	10	80	–	280[a] (14)	70[c] (14)	–
Flies and fleas							
Musca domestica	House fly	16	80	15[c] (0)	–	–	22[c]
Ctenocephalides felis	Cat flea	20	72	–	–	–	24[c]
Ants							
Camponotus floridanus	Carpenter ant	8	81	18 (5)	–	–	–
Camponotus modoc	Carpenter ant	8	61	48 (8)	–	–	–
Camponotus vicinus	Carpenter ant	8	61	35 (8)	–	–	–

[a] *Lowest LAD (oz-h/1,000 ft^3 is equivalent to mg-h/h and g-h/m^3) tested resulting in 100% mortality of life stage.*
[b] *Number in parentheses is days after fumigation at which mortality was assessed.*
[c] LAD_{95}
[d] *Highest concentration tested; emergence from some eggs/egg cases observed.*
[e] LAD_{90}
[f] *Ninth-generation selection of survivors from exposure to sulfuryl fluoride.*
[g] *>2-day-old eggs.*
[h] *>4-day-old eggs.*

Source: E.M. Thomas and Scheffrahn, R.H. (1994) **"Control of Pests by Fumigation with Vikane Gas Fumigant."** DOWN TO EARTH™ 49 (2).

SAFETY PRECAUTIONS.....2

Vikane is toxic to most living organisms including humans. It is colorless, odorless, packaged as a gas under pressure and has no warning properties. Therefore, it should only be used by professional applicators who understand these properties.

WORKER SAFETY

Worker safety at the job site is regulated by OSHA. OSHA mandates that the employer must have written safety procedures including standard operating procedures and emergency procedures. The employer must document training and ongoing surveillance of employee compliance with safety procedures. OSHA may give special attention to areas such as the use of ladders, working on roofs, lifting heavy objects such as tarps, sand snakes and cylinders, and SCBA use and maintenance.

The label for Vikane requires the personal protective equipment described below.

Eye Protection

A full face shield or splash-resistant goggles must be worn for eye protection during introduction of the fumigant. This is to prevent possible eye damage from liquid contact if a hose or valve fails. Liquid Vikane can freeze the eye. Eye protection will also help prevent physical injury as there is also the potential hazard of the hose disconnecting.

Protective Clothing

No specialized protective clothing is required. Skin contact with gaseous Vikane is not considered a problem; however, contact with liquid Vikane can cause freeze damage. Do not wear gloves or rubber boots because this type of protective clothing can confine the liquid on the skin. Do not reuse clothing or shoes that have become contaminated with liquid Vikane until thoroughly aerated and cleaned.

Respiratory Protection

Respiratory protection must be worn when the concentration of sulfuryl fluoride in the breathing zone of the fumigated area exceeds 1 ppm. The respiratory protection must be 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. Check the telephone directory for information on suppliers.

Consult OHSA for current standards concerning SCBA use and maintenance.

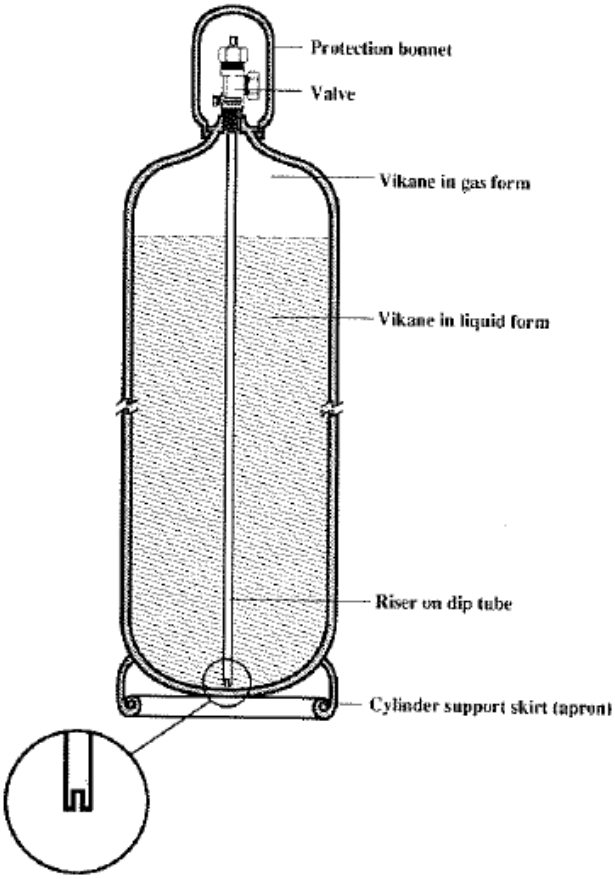
CYLINDER SAFETY

General Cylinder Information

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

Vikane is sold as a compressed 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 damaged, the cylinder should be immediately returned to the distributor.

Figure 2a



Only sulfuryl fluoride and no other gas such as CO_2 is used to pressurize the cylinder. Each full cylinder contains 125 lb of product normally under about 200 to 300 psi. See Table 2a below for a range of pressures for various temperatures.

Table 2a Cylinder Pressure of Vikane at Various Temperatures

Temperature		Pressure	Temperature		Pressure
°F	°C	(PSIA)[1]	°F	°C	(PSIA)[1]
0	-17.8	71	80	26.7	264
10	-12.2	86	90	32.2	303
20	-6.7	103	100	37.8	346
30	-1.1	123	110	48.3	393
40	4.4	145	120	48.9	445
50	10.0	170	130	54.4	503
60	15.6	198	140	60.0	566
70	21.1	229	150	65.6	636

[1]Pounds per Square Inch Absolute

These cylinders are equipped with a 1.030" righthand thread, 14 thread per inch, straight thread fitting. This is comparable to a 3/4" pipefitting (pipefitting is not the same as a hose fitting). Vikane is present in each cylinder both as a gas and liquid. Except when releasing the last three to five pounds, the product comes out of the tank through the riser or dip tube as a liquid. The last few pounds used from the cylinder, however, will be a gas or a combination of gas and liquid; therefore the gas will often take longer to move through the hose (see Figure 2a for cylinder diagram).

Cylinder Storage

Store cylinders of Vikane in a dry, cool, well-ventilated area under lock and key. Outside storage protected from the elements is preferred. When cylinders are stored in an occupied building, the storage area must have either 1) a forced air ventilation system that meets required local ordinances for the storage of hazardous materials and operates continuously; or 2) be equipped with a permanently mounted and properly maintained and functioning sulfuryl fluoride monitoring device designed to alert occupants of the building if sulfuryl fluoride in the air of the storage area is greater than 1 ppm.

All cylinders (full, partially full, or empty) should be stored in an upright, vertical position with valve protection bonnet and safety cap securely in place. Cylinders should be secured to a rack or wall to prevent tipping. Various state and local authorities may regulate the storage of products like Vikane. Be certain to check with the appropriate authorities in your area. Contact your state and local authorities for additional guidelines.

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

Cylinder Transport

Cylinders should not be subjected to rough handling or mechanical shock such as dropping, bumping, dragging or sliding. Always transport cylinders (full or empty) secured in an upright position with valve protection bonnet and safety cap in place. Never transport unsecured cylinders or those laying flat. It is recommended to transport cylinders in locations on vehicles where they would be protected from pact from potential collisions, such as read-end collisions, with other vehicles.

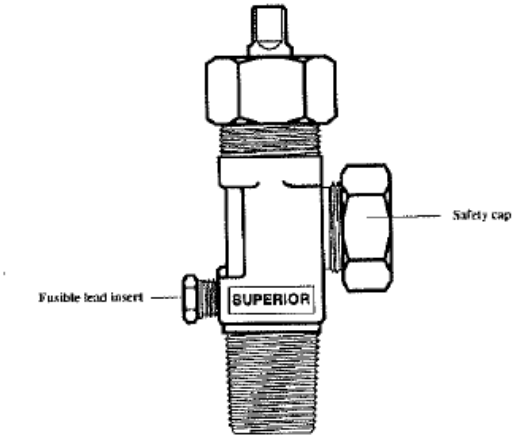
Because of the toxicity of Vikane, cylinders are not to be transported in the same airspace or breathing zone as the driver or other occupants of vehicles, such as in unpartitioned trucks or vans. All Department of Transportation (DOT) regulations must be followed. If you have questions, contact your local DOT.

Air Transportation

Cylinders of Vikane should not be transported by aircraft under any circumstances.

Valving

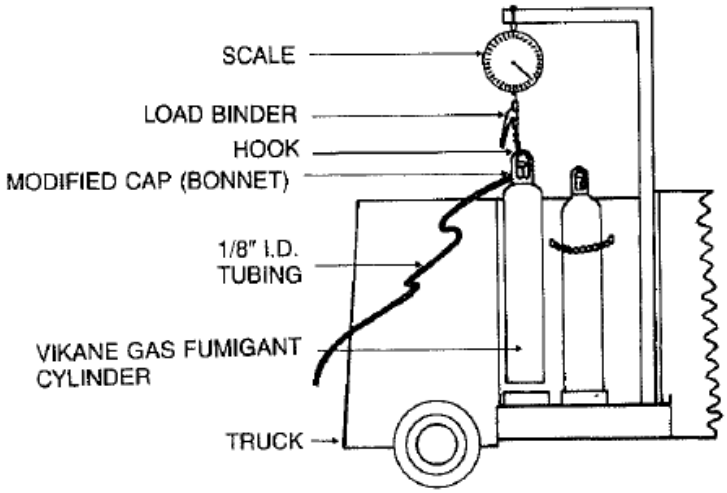
Special valves (see below) are used for Vikane; each is equipped with a safety cap and a covering . called a "bonnet." The safety cap and bonnet should be securely in place at all times except when gas is to be released from the cylinder to protect the valving system from being damaged and/or prevent accidental release of the fumigant.



Cylinder Valve

Never hang cylinders by the valves during weighing. Use a proper sling or modified bonnet specifically designed for this purpose. Modified bonnets have openings on two or more sides through which a hook strap or cable can be inserted to support the cylinder during weighing (Figure 2b).

Figure 2b
Fumigation Truck with Side Mount During Operation



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 valve protection bonnet before returning to the distributor for Vikane and subsequent shipper. Only Dow AgroSciences is authorized to refill cylinders. Do not use cylinders for any other purpose.

Cylinder Label Protection

Protect cylinder labels from being damaged to ensure label text can be read. Protection measures may include care when handling cylinders to prevent knocking or scraping of the labels and use of plastic-coated or covered chains when secured on distributor/PCO/fumigator vehicles.

Leaking Cylinders

If you believe a cylinder may be leaking fumigant, immediately evacuate the area of personnel. Do not permit entry into leakage area by unprotected persons until concentration of fumigant in the breathing zone is determined to be 1 ppm or less as determined by a detection device with sufficient sensitivity such as an INTERSCAN, MIRAN [SapphlRe] or Spectros ExplorlR gas analyzers.

For entry into affected areas when air concentrations of the fumigant exceed 1 ppm, use a positive pressure self-contained breathing apparatus (SCBA, not SCUBA) or combination air-supplied/SCBA respirator. Never use excessive force to open a stuck or improperly seated valve.

If the leak cannot be stopped, move the leaking or damaged cylinder outdoors or to an isolated location, observing strict safety precautions. Work upwind if possible. Once the cylinder is empty, contact your distributor of Vikane for proper return instructions.

Cylinder Return Procedure

One of the more common reasons for returning a cylinder is the perception that the last 3 to 5 lb of gas in the cylinder cannot be released. The final 3 to 5 lb of Vikane in a cylinder generally is in a gaseous state and requires more time than liquid fumigant to pass 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 distributor of Vikane. The distributor will need information about the cylinder (cylinder number, etc.) so they can complete a Defective Cylinder Report form and fax it to the Customer Information Center at Dow AgroSciences.
3. To assist in identifying defective cylinders when returned, the distributor will spray paint the top and shoulder of the cylinder with red paint and attach a completed red tag to the protection bonnet.

As such, Dow AgroSciences asks that PCO/fumigators refrain from marking functional cylinders with paint, as this could cause confusion when painted dysfunctional cylinders are returned for repair.

CYLINDER SAFETY – DO'S AND DON'TS

- Keep the safety cap and bonnet on cylinders except when introducing the fumigant.
- Store and transport cylinders in a secure upright position.
- Do not drop cylinders.
- Do not strike or heat the valve.
- Make sure fittings are tight before introducing the fumigant; non-corrosive metal fittings are recommended.
- Wear splash-resistant safety goggles or full face shield while releasing the fumigant.
- Never suspend or lift cylinders by the valve – suspend with a modified bonnet or cylinder sling.
- Use a proper fitting wrench when releasing the fumigant for good leverage and tight seal. Keep attached to the valve stem while releasing the fumigant.
- Have operable respiratory equipment (positive-pressure SCBA, not SCUBA) readily available.
- Contact your distributor of Vikane for specific instructions on identifying and returning cylinders that are defective.
- In case of an emergency, call (800) 992-5994.

VIKANE VALVE STEM ADJUSTMENTS IN THE FIELD

Introduction

When cylinders are filled at the plant, a soap solution is applied to the valve stem (the shaft below the handle) and valve threads at the top of the cylinder. The cylinder is not released if there are any leaks. Each time the valve is opened and closed, the stem works against the packing causing the packing to flow away from the 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 for "Leak Procedures." This may include, but is not limited to, immediate evacuation followed by reentry 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 Vikane 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 Vikane from around the valve stem in the field.

Warning: Follow cautions in Hazards and PPE section above prior to this procedure.

Step	Action
1	If product loss is detected, immediately close the valve. This will stop Vikane 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 25 to 30 foot pounds of torque, which is easily reached with a 10 or 12" crescent wrench.
3	Open the valve. If product loss is still present, 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.

FIRST AID/POISONING SYMPTOMS.....3

Symptoms and/or death in humans as a result of exposure to Vikane via inhalation will depend on the concentration and the length of exposure experienced.

POISONING SYMPTOMS

Vikane is colorless, odorless and, at low concentrations, non-irritating to mucous membranes. Vikane gives no warning of its presence. It is obvious from animal experiments that Vikane is toxic. It must be handled carefully in regard to the potential hazards it presents. Disregarding the lethal potential of Vikane can result in serious illness, even death.

The earliest sign of overexposure to Vikane is central nervous system (CNS) depression. Although dose-response data are not available for effects in humans exposed to Vikane, acute inhalation studies have been conducted on laboratory animals. No signs of CNS depression were observed in rats exposed to 450 ppm for 4 hours, while rats exposed to 750 ppm were lethargic after that time. Exposure to progressively higher concentrations would be expected to result in convulsions, tremors and/or strychnine-like muscular rigidity. Rats exposed to 1000 ppm began to show CNS depression 15 minutes after initiation of exposure, and slight eye irritation was evident after 2 hours. By 3 1/2 hours, the animals were moribund and/or convulsive, and some died shortly after termination of the 4-hour exposure. Rats exposed to 1425 ppm were sedated in 20 minutes, prostrate in 40 minutes, convulsive after 1 to 2 hours and dead in 4 hours.

Humans exposed to high concentrations of Vikane 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.

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. It is highly recommended 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.

FIRST AID TREATMENT

If on skin – If Vikane in liquid form is projected onto a small area of the skin, allow the material to escape completely. This chemical is highly volatile and will dissipate rapidly. Damage to the skin, if any, may result from liquid freezing the tissue as the liquid evaporates. Immediately apply water to contaminated area of clothing that gets wet before removing. Once area has thawed, remove contaminated clothing, shoes and other items covering the 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.

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

IN CASE OF EMERGENCY
CALL 1-800-992-5994

INFORMATION FOR PHYSICIANS

Vikane is a gas which has no warning properties such as odor or eye irritation. (However, chloropicrin is used as a warning agent and is a known lachrymator.) The prediction of possible effects in human beings is based in part on observations made on laboratory animals. Depending on length of exposure, it is predicted that persons exposed to Vikane will probably show little evidence of intoxication at first unless the concentration was moderate to high (>500 ppm). Early symptoms of exposure to Vikane are respiratory irritation and central nervous system depression. Excitation may follow. Slowed movement, reduced awareness, and slow or garbled speech may be noted. prolonged exposure can produce lung irritation, pulmonary edema, nausea, and abdominal pain. Repeated exposure to high concentrations can result in significant lung and kidney damage. Single exposures at high concentrations have resulted in death.

It is essential to keep the individual exposed to Vikane 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 one fatality attributed to Vikane was pulmonary edema with death attributed to cardio-respiratory failure. Convulsions may ensue with respiratory arrest being a terminal event. Assisted respiration may be necessary. **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 1-800-992-5994

URINE ANALYSIS FOR FLUORIDES

Urine samples from persons with potential overexposure to Vikane may be analyzed for total fluorides. However, the interpretation of these levels requires a baseline (pre-exposure level) to determine if the increased fluorides are actually due to exposure to Vikane. People are exposed to many sources of fluorides every day – water supply fluorination, toothpaste, medicines, as well as those occurring naturally in the food we eat.

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, sleevetype. Mixer, magnetic with a TFE fluorocarboncoated 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 1000 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 1000 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 0.01 mg F/mL). Store in chemical-resistant glass of 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:

   5.0 mL Standard yields 0.50 mg/liter
   20.0 mL Standard yields 2.0 mg/liter
   50.0 mL Standard yields 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 Semilogarthmic 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 in 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. Reference

   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.

   For further information, call 800-352-6776 (during normal business hours) or in an emergency (after hours) call 800-992-5994.

BASICS OF STRUCTURAL FUMIGATION.....4

Mankind has, no doubt, competed with insects for its food, clothing, health, shelter and artifacts since his earliest existence. The battle continues. The contest for food production and preservation is largely outside the scope of structural fumigation; however, the commensal cockroach and pantry pests are intimately associated with the kitchen and attending nutritional sources.

Whereas localized residual-type treatments are most often satisfactory methods of controlling exposed or accessible pests, the wood consuming insects such as the drywood termite and wood-boring beetles are seldom seen. They most often are deeply hidden within the wooden framework or other wooden components that are covered and, therefore, not easily accessible. Although Vikane will control other pests, the objective of most structural fumigations is to exterminate existing infestations of drywood termites of wood destroying beetles which are damaging wood. The complexity, extensive use of unprotected wood and escalating values of buildings make fumigation a highly useful method for protecting investments.

Fumigants such as smoke and sulfur fumes are probably among mankind's oldest pesticides; they were used as food preservatives as well as "space fumigants." Modern structural fumigation was developed by adopting the existing stored grain fumigants, hydrogen cyanide (HCN) and methyl bromide. HCN proved to be too combustible for this purpose. Methyl bromide has displayed excellent utility as a structural fumigant; however, it has a limitation because it can react with sulfur-containing materials to create persistent sulfide ("skunky") odors. For this reason, Vikane was developed specifically for the role of structural fumigation. To fulfill this need, 13 criteria were considered important.

Criteria for the "Perfect Fumigant"

1. Effective control of target pests.
2. Low use hazard.
3. Non-corrosive.
4. Non-flammable – non-explosive.
5. Low reactivity.
6. Low odor threshold.
7. High vapor pressure.
8. Rapid penetration to site of pest.
9. Low sorption on wood and other materials normally used in building construction.
10. Low solubility in liquids – especially water.
11. Rapidly aerated.
12. Easily monitored.
13. Easy to store, transport and apply.

Vikane conforms well with these criteria and is a superior fumigant for control of drywood termites. Although it is a toxic gas, if correctly used, the hazards are low. Safe methods are a necessity.

Always follow federal, state and local regulations.

FACTS ABOUT STRUCTURAL PESTS

Termites

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

The structure-infesting drywood and subterranean termites in the United States feed on cellulose, but these termites cannot make use of this material for nutrients without the help of microorganisms in their

digestive tracts. Newly hatched termites feed on materials passed to them by the older termites, thus the necessary microorganisms are passed on to new generations. Newly hatched young cannot survive without nestmates to feed them.

The three important types of termites found in the United States – drywood, subterranean and dampwood – are most easily identified on the basis of their habits and where they live. Drywood termites are a problem chiefly in the warm, moist coastal regions. They live inside of wood and do not require contact with the soil. Subterranean termites, as their name implies, generally live underground, and, with rare exceptions, must maintain contact with the soil. The dampwood termite is a larger insect than either the drywood or the subterranean termite, but is of less economic importance than the other two. Dampwood termites typically infest posts, forest trash, dead trees and wooden structural members in soil or areas with sufficient exposure to water.

Wood Borers

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

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

Old house borers belong to the family Cerambycidae, which is called "long horn beetles" (*Hylotrupes* spp.). They mainly infest sapwood of pine and spruce, but occasionally have been seen in hemlock, Douglas fir and other true firs. They are usually seen near the surface of wood in the sapwood and generally do not infest the heartwood. These beetles have a wide geographic distribution. Development from egg to adult can require up to 10 years in temperate zones.

Fabric Pests

Clothes moths are widely distributed, persistent pests in structures. They are noted for the damage caused to woolens and are normally controlled by localized treatments. Where severe infestations occur, or local control measures are insufficient, Vikane at six times the drywood termite dosage will give control of all life stages.

The **black carpet beetle** is a common pest of carpets, woolen garments, skins, furs and museum specimens, including bones. Their life cycle is usually completed in 12 months. Because of the excessively high dosage requirements to control the eggs, the termite rate will control only the post-embryonic forms. Two fumigations are recommended to control all life stages. These should be spaced two to six weeks apart in order to control newly hatched beetles. Check with local experts to determine the duration of each stage in the life cycle.

Health-Related Pests

Cockroaches are highly successful life forms that have existed almost in their present forms for 100 million years or more. The living and feeding habits of mankind have made commensal living attractive to roaches.

The **German cockroach** is considered by many in the pest control profession to be the "Number One" domestic pest. All stages of this roach are controlled by Vikane at drywood termite dosages because the female carries the ootheca (egg case) during the incubation period and the embryos are dependent on the female for survival.

The females of the **brown-banded** and **Oriental cockroaches** deposit the ootheca shortly after it is formed. The embryos are not dependent on the female for survival. The ootheca is vulnerable to Vikane

only at high dosages; thus, only the nymphs and adults of these species are controlled at termite dosages.

Bed bugs are occasional parasites of humans. They are usually hidden in the seams and folds of mattresses. They are controlled at three times the drywood termite dosage.

Rats and **mice** (rodents) are always unwelcome guests in any structure. They are easily controlled with Vikane using one half the calculated drywood rate (1/2X). However, regardless of the ambient temperature, the fumigator should use sufficient gas to accumulate at least 36 ounce-hours of exposure for a successful fumigation.

PENETRATION AND CONFINEMENT OF VIKANE

The objective of a structural fumigation is to confine enough fumigant for sufficient time to control the pest. There are, however, interactions to consider regarding the confinement characteristics of Vikane and its ability to penetrate to the site or chambers of the drywood termite or other pest.

Drywood termites and wood-boring beetles may be deeply imbedded in wood where they seal themselves away from their external enemies and environmental conditions. Vikane, when properly used, reaches and kills these pests in spite of their cryptic habits.

Penetration of Wood

Gases penetrate through air spaces in wood and soil. Fumigants differ in their ability to penetrate wood. Their performance depends upon certain characteristics and conditions of the fumigant and of the wood to be fumigated.

Wood Characteristics

1. Tree species (chemical makeup)
2. Density
3. Porosity (number and arrangement of pores)
4. Moisture content
5. Sorption qualities (affinity for the fumigant)

According to the National Lumber Manufacturers' Association, the pores of structural woods such as fir are so minute that they can be detected only with the electron microscope. On the other hand, they are so numerous they provide a total surface area of more than 20,000 sq ft in one cubic inch of wood – and enormous surface for sorption of fumigants.

The penetration of Vikane through different one-inch thick wood plugs is described in Table 4a. The higher the gas concentration and dosage accumulated, the greater the penetration of Vikane through wood. Vikane rapidly moves through pores of wood, as demonstrated by the maximum dosage of Vikane accumulated in the end cut (Pine A) sample. Transverse wood cuts in which the wood pores are not exposed (e.g., Pine B) and latex painted wood reduced penetration of Vikane. Penetration by Vikane was most reduced in moisture-saturated wood (hydrated Pine B), and wood with minute pores, such as red oak and douglas fir.

Table 4a Sulfuryl Fluoride Concentrations Inside Wood-PVC Voids Exposed to 16 oz/1000 cu ft of fumigant for 20 Hours Inside a Chamber

Wood	Exposure Condition	Gas Concentration (oz/1000 cu ft)[a]	Dosage (oz-h/1000 cu ft)[b]
pine A	end grain	16.15 a	296
pine B		14.08 b	171
mahogany		8.72 cd	89.7
w. hemlock		6.97 d	6937
red oak		2.50 e	24.2
douglas fir		2.95 e	57.9
pine B	hydrated	3.12 e	29.8
pine B	paint 2x	6.84 d	74.8
mahogany	paint 2x	6.49 d	65.7
mahogany	paint 3x	3.61 e	36.0

[a]Means (n=4) in columns followed by the same letter are not significantly different at P=0.05, Student-Newman-Keuls test (6).
[b]Mean dosage (concentration x time). Maximum theoretical accumulated dosage inside PVC cups is 296 oz-hrs/1000 cu ft.
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.

Vikane will diffuse into insect galleries that are near the wood surface and through cracks, kick holes, emergence holes, and other insect damage in the wood. Therefore, in most structural timber, Vikane does not need to penetrate through one inch or more of intact wood to reach insect galleries. One exception can be log structures, in which the thickness of the unplaned wood, and higher wood moisture content, may require longer fumigation exposure periods.

The low affinity for wood also provides Vikane the further advantage of rapid desorption of the fumigant and quick aeration of a building when the seals are removed.

It may be difficult, however, for Vikane to penetrate wood that is wet because the air passages are blocked by the water and by the swelling it causes.

Painted surfaces or plastic covered panels are not readily penetrated by Vikane or other fumigants. These surfaces form a barrier much like a plastic tarp and should be considered in assessing the ability of Vikane to penetrate into wall voids or other covered spaces. These conditions must be taken into consideration when fumigating.

Confinement of Vikane by Tarps

The question naturally arises: "If Vikane 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.

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

Table 4b Percent Permeation Loss and Adsorption of 8 oz/1000 cu ft Sulfuryl Fluoride After 24 Hours From 11 oz Glass Bell Jar With Lid Made of Tarp Materials

Tarp Material	Percent Permeation Loss Sulfuryl Fluoride	Percent Adsorption[a] Sulfuryl Fluoride
used tarp	100.0	8.8
tarp A, 10.3 oz/sq yd	3.3	6.1
tarp B, 7.2 oz/sq yd	5.5	3.1
tarp C, 9.6 oz/sq yd	0.2	3.3
4-mil polyethylene	0.0	1.3

[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.

Loss to Soil

The loss of Vikane to the soil is dependent on soil type and moisture. The Fumiguide B and calculator take soil type into consideration when estimating the half loss time. Solid water reduces penetration of Vikane due to the low water solubility of Vikane.

THE FUMIGATION ATMOSPHERE

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

All matter as we know it exists in three phases – SOLID, LIQUID and GAS (VAPORS). The best known example is water, which appears as solid ice, liquid water and water vapor (gas).

The air atmosphere includes water in all three phases, i.e.:
1. Ice crystals, such as in high cirrus clouds or as snow, hail or sleet;
2. Water droplets as clouds, fog or rain;
3. Water vapor that we cannot see but can feel, such as humidity in dry air.

Air is largely composed of nitrogen (78%) and oxygen (21%) (Table 4c). Excluding water, all other gasses equal only about one percent. These include carbon dioxide, argon, neon, krypton and others in minute amounts. There are many contaminants in the atmosphere such as dust, volcanic ash, smog, etc., with which fumigations are not normally involved. These contribute only a very small fraction of one percent of the total air.

Table 4c Composition of Air[1]

Gas		%	
nitrogen		78.09	
oxygen		20.95	
water		variable	
carbon dioxide		0.03	
argon		0.93	
krypton		0.0001	
neon	inert	0.18	about
xenon	gases	0.000008	1%
helium		0.0005	

[1]Standard conditions.

The amount of water in the atmosphere is variable. The warmer the air, the more water air can hold. This feature is very important as it relates to the use of Vikane.

The vast majority of structural fumigations occur close to sea level. Thus, our calculations are based on atmospheric pressures of 760 millimeters of mercury (mm Hg) and 20°C (68°F), which are known as "Standard Conditions."

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. The weight of 1000 cu ft of air is shown in Table 4d.

Table 4d Weight of Air/Mcf[1]

°F	lb	=	°C	Kg
32	80		0	36.3
68	75		20	34
105	70		40	30.7

[1]Approximately for standard conditions of 760 mm Hg and 20°C.

This relative density of air becomes apparent when a refrigerator or freezer door is opened and the cold dense air flows out onto the floor. Conversely, a hot air balloon rises because the contained heated air is lighter than the surrounding air. Once these different parcels of air are thoroughly mixed with the surrounding air, however, they will not tend to separate or stratify. This is an important feature we must understand as it relates to use of fumigants.

The weight is also noticeable when air is moving (wind) or we are moving through it. The ability to quickly disperse a fumigant depends on the air movement we create with fans.

Water Vapor

The concentration of water vapor in the atmosphere will vary with temperature. The warmer the air, the more water vapor it can hold. The different amounts are shown in Table 4e.

Table 4e Water Vapor in Air at Saturation[1]

°F	Lb H_2O/Mcf
40	0.5
60	1.0
80	1.9
100	3.5

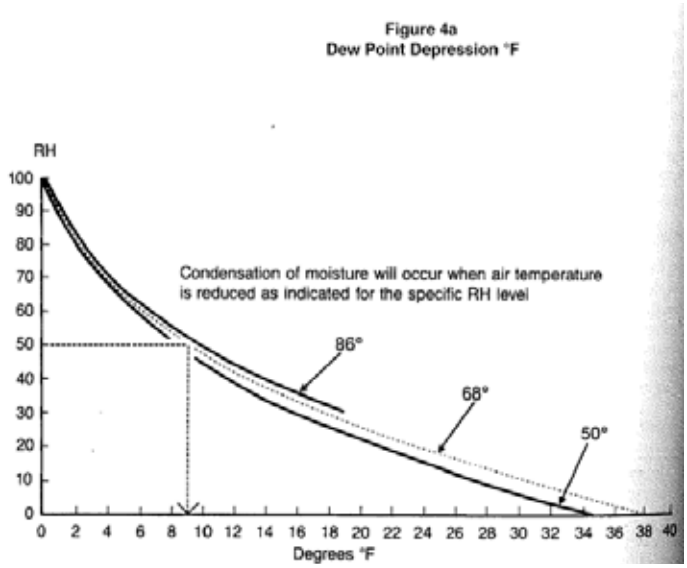
[1]Approximate at standard conditions.

The weight of water in 1000 cu ft of saturated air at 80°F is 1.9 lb. If this air is chilled to 60°F, it can hold only 1.0 lb. Thus, 0.9 lb 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 0.7 lb and could hold 1.4 lb at saturation, the relative humidity would be 50%. It can be measured by a psychrometer (dry and wet bulb thermometer) or a humidity gauge.

The **Dew Point** is the temperature at which water 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. This amount varies slightly for different air temperatures. The dew point and dew point depressions are shown for relative humidity levels when the ambient (existing) air temperature is 50°F, 68°F or 86°F (Figure 4a).



For practical purposes, the gasses of the air except for water are, and tend to remain, evenly distributed throughout the atmosphere. Water evaporates into and condenses out of the atmosphere, a function that is largely dependent upon temperature, concentration and vapor pressure. This process becomes a large part of the weather of the world. The use of Vikane in structural fumigation involves, and is influenced by, some of these basic principles as it interacts with the gasses of the air atmosphere.

Example: If the air temperature in a structure is 68°F and the relative humidity is 50 percent, how many degrees can the air temperature be lowered before condensation occurs?

Answer: See Figure 4a above. Condensation or possibly a "fog out" is likely to occur if the air temperature is lowered by approximately 9ºF or more.

Note: 1.0 lb of Vikane will lower the temperature of 1000 cu ft of air 2.5"C (4.5"F).

In practical use situations, the fumigator can use the information in Figure 4a to plan the job (fan size, fan location, fumigant introduction rate, etc.) so that gas is introduced into the structure in a manner that avoids "fog out" situations. See section on Change of State for additional information.

SEASONAL VARIATIONS-ECONOMICS

Temperature has a major influence on the dose/dosage requirements for successful fumigation with Vikane and certainly needs to be factored into these calculations. The economics of dosage are important, especially where seasonal variations are pronounced such as in California and to a lesser extent in Florida and Hawaii. The following example illustrates this need:

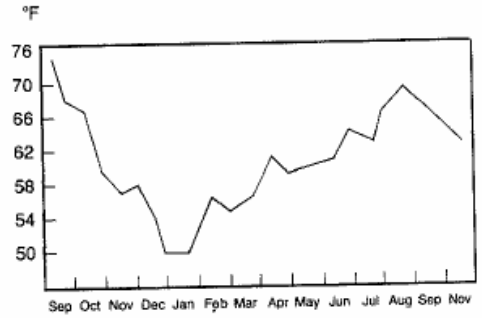
Table 4f Effect of Temperature on the Required Equilibrium Concentration of Vikane for a Measured 12 Hour HLT and 20 Hours Exposure

Temp. of slab or soil, °F[1]	55	60	65	70	75	80
Vikane, oz/1000 cu ft	16	12	9.5	8	7	6

[1]Temperature at coldest point of infestation.

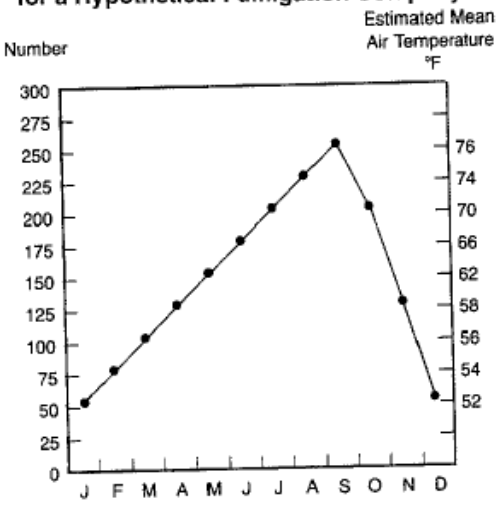
These dosage requirements can vary based on changing seasonal temperature conditions. For example, the sub-section soil temperatures were recorded over the course of a year in Garden Grove, in Southern California (Figure 4b).

Figure 4b
Soil Temperature in Sub-Section of House
Garden Grove, California
(The year was relatively cold for that locale)



In winter higher dosages are required. However, the following graph on seasonal frequency of fumigation illustrates that a larger majority of fumigations take place in the warmer periods when minimal dosages are adequate (Figure 4c). The fumigator should understand these variations and figure them into the economy of his practices.

Figure 4c
Estimated Relative Seasonal Fumigations
in Southern California
for a Hypothetical Fumigation Company



PREPARATION FOR FUMIGATION 5

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

The fumigator must comply with requirements of the fumigant label as well as to federal, state and local regulations. As an additional suggested guide, the fumigator has a compilation of GOOD PRACTICES published by the National Pest Management Association (NPMA). When in doubt, a fumigator should seek assistance from suppliers, regulators or other educational sources.

PROPERTY OWNER/CUSTOMER INFORMATION

Fact Sheet

Prior to the parties entering into a fumigation agreement, the Fact Sheet for Vikane must be provided to an adult occupant of the structure to be fumigated or of each currently occupied unit in multi-unit structures. This Fact Sheet is required by the label for Vikane and should not be confused with the customer checklist required by some state regulations.

Property Owner/Customer Checklist

The personnel of some fumigation companies carry out the entire task of preparation, whereas others will require that the home or building occupants assume the preparation duties, such as food and medicine protection, removal of plants, pets and waterproof mattresses (waterbeds can remain in place). The responsibility for the proper performance of a fumigation lies with the licensed fumigator regardless of who does the work.

Operable internal doors including cabinets, closets, appliances, etc., should be opened to aid in gas distribution and aeration.

The occupants or owners of buildings to be fumigated need to be informed of circumstances and conditions associated with a fumigation 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 (a sample checklist is at the end of this chapter). The customer may also be required to sign-off certain liabilities.

They need to know:

1. Their role in preparation for fumigation - what to protect, remove and prepare, etc.
2. The time to leave the structure and return for re-occupancy, as well as what the aeration process entails, so that there can be absolutely no entry into the structure until clearance is certified by the fumigator.
3. That often the fumigator requires that property owners surrender a key to the structure to be fumigated. Some states require property owners to provide exterior entrance keys to the fumigator prior to the fumigation. The fumigator should have access to all areas of the fumigation site during the entire period that the site is under his or her control.
4. Potential problems such as:
    a. Damage to plants too near the house for proper tarping or plants included within the fumigation space.
    b. Damage to highly sensitive plants.
    c. Damage to old or otherwise fragile roofs (especially tile), TV antennas, fences, etc.
    d. Excellent efficacy of the fumigation, but lack of residual effectiveness to control future infestations of pests.

Occasionally items of social value or of a peculiar nature may best be removed or protected because of the uniqueness of the risk; i.e., high-priced pictures, electronic equipment, chemical supplies, etc. Vikane is a high-purity material (99.8% or greater) and in the vapor (gas) phase has not been known to have caused adverse effects. Nonetheless, there are certain risks from misapplication by the fumigator resulting in liquid fumigant contacting surfaces and/or excessive moisture condensation. The risk of condensation increases under conditions of high relative humidity and where high dosages of Vikane are required. Proper fumigant release techniques to avoid misapplication and condensation are described on the label for Vikane. A good rule of thumb is "when in doubt, take it out." If the customer is unduly concerned about a particular item prior to the fumigation, removal of the item prior to fumigation is recommended.

MULTI-UNIT STRUCTURES

When fumigating a single unit/room within a larger structure (such as townhouses, apartments, condominiums), all units of the entire structure must be prepared as a fumigated structure, and all applicable rules, regulations and label instructions apply, such as occupant notification, structure preparation, posting, securing and aeration. An adult occupant of each currently occupied unit must be provided with the Fact Sheet for Vikane.

CONNECTED STRUCTURES

A connected structure is defined as any structure connected with the structure to be fumigated by construction elements (e.g., pipes, conduits, ducts, etc.) which may allow passage of fumigant between the structures. If state rules and regulations do not describe or permit a process to isolate and seal a connected structure to prevent passage of fumigant from the fumigated structure, then the connected structure must be vacated during the fumigation. When it is necessary to vacate any connected structure, that structure shall be considered as a fumigated structure and all applicable rules, regulations and label instructions apply, such as occupant notification, structure preparation, posting, securing, and aeration.

WHAT TO REMOVE OR PROTECT

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

To use the above-mentioned bags, place one inside another while empty. Double bagging helps assure effective protection. Place items to be protected inside the inner bag. Do not overfill – leave clearance (approximately eight inches) on top for adequate closure of the bags. Twist the top of the inner bag, fold once and secure the fold in place using fasteners such as a twist tie, tape, rubber bands or string. Repeat the closure of the outside bag in the same manner. Check the seal by pressing gently against the sides of the bag and listening for air leaks. No air should be able to escape.

FLAMES OR HEATING ELEMENTS

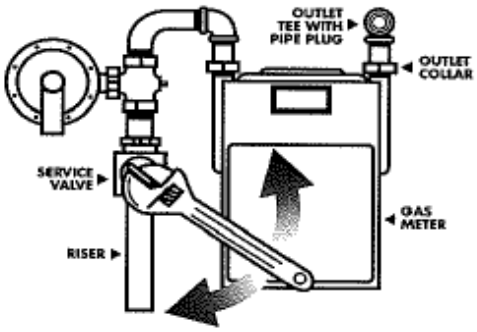
Vikane (sulfuryl fluoride) is a very stable compound that is relatively non-reactive and non-flammable. However, under high heat conditions present in gas flames or glowing electric elements, it can decompose into sulfur dioxide (SO_2), hydrofluoric acid (HF), and other decomposition products. HF readily dissolves in water to form hydrofluoric acid. This 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, gas refrigerators, ranges, ovens, broilers,

dryers, gas fireplaces, etc. Turn off or unplug all heaters, pianos, organs, 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 service (see Figure 5a). General guidelines are as follows:

1. Natural gas service should be shut off at the main service valve located on the riser of the gas meter. When a single gas meter serves more than one structure, gas service to all sources must be interrupted.
2. Use a 12-inch adjustable wrench to turn the service valve one-quarter turn. The gas supply is off when the service valve is perpendicular to the flow of the pipe (see Figure 5a).
3. After the valve is in the off position, brush or spray a soap solution (1 cap of leak soap compound per unit of water) onto the pipefittings. Bubbles will indicate leakage. If gas leakage cannot be corrected, leave the service valve off, discontinue fumigation preparations and notify the local gas company.
4. Bleed the gas line by removing the pipe plug from the outlet on the meter assembly and on any meter located on the manifold (see Figure 5a). This eliminates gas pressure within the meters and houselines. If no tee or pipe plug is available, loosen the outlet collar on the meter. If gas pressure continues to exist, reinstall plug or tighten outlet collar and notify the local gas company. Discontinue the fumigation preparations.
5. Reinstall pipe plug or tighten the outlet collar.
6. Visually inspect all possible sources of pilot lights including furnaces, hot water heaters, gas ranges, oven broilers, gas refrigerators, dryers, etc., to determine that all pilot lights are extinguished. Verify that no gas pressure exists by attempting to light one gas appliance inside the structure. Use a match extension tool when lighting appliance to prevent injury. If you detect natural gas during the inspection, discontinue any fumigation preparations, leave the service valve off and notify the gas company.
7. With multiple gas meter locations, close the service valve to each individual gas meter located on the manifold.
8. Never loosen, adjust, or otherwise affect the integrity of the gas distribution system except as instructed.
9. Whenever possible, do not enclose the gas riser within the tarp.

Figure 5a



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.

Damage to metals can also occur from the inclusion in the tent of the new type of swimming pool chlorinators that generate chlorine gas for chlorination. These pieces of equipment should either be turned off or excluded from the fumigation.

PROTECTING PLANTS AND SHRUBS

Sensitive plants growing near the fumigation job can be injured if they are exposed long enough to sufficient concentrations of Vikane. This situation can be caused by excessive leakage of fumigant from the soil-tarp seal without sufficient wind to disperse the fumigant. Also, Vikane can escape through dry soil at the ground seal. The soil at the foundation is usually the driest in the yard because of protection from the roof overhang. These conditions can be improved by first encouraging the homeowner to water the area next to the building on the day prior to the tenting. At that time they should also cut back plants to clear the area to place tents and ground snakes (at least 18”), and rake away the mulch or debris next to the foundation (at least 12”).

The fumigator should give special attention to the ground seal and can use a leak detector of sufficient sensitivity, such as a TIF 5750 leak detector manufactured by TIF Instruments, Inc., Miami, Florida, to identify leaks that may require correction (the TIF 5750 can detect Vikane to about 50 ppm). Sensitive plants could potentially be injured by Vikane during aeration when there is insufficient air movement to quickly dissipate the fumigant. The risks of plant injury would be increased when there are high concentrations of fumigant remaining at the end of the exposure period resulting from good confinement (often in slab type construction) and/or high dosages used. The fumigator should use the TRAP method of aeration (direct discharge) or plan to open seams initially in areas (driveway or patio) that will not allow exposure to plants. Junipers, monkey grass, springeri fern, lily grasses, and orchids appear to be especially sensitive to Vikane and their protection may require special attention.

There is a risk of injury to indoor or sheltered plants when they are removed to areas where they may be stressed due to unfavorable conditions. Plants should be moved to conditions similar to their usual growing habitat (e.g., light conditions, temperature, humidity, etc.).

Wetting the Soil

Some fumigators require that the occupants or owners wet the soil for the tarp seal, prior to the tarping time (generally the day before the fumigation). This procedure can often accomplish the necessary “sealing” of the soil and, if properly done, will not cause puddling or muddy conditions at tarping time. The sub-area of crawl space structures should not be watered or treated for subterranean termites immediately prior to a fumigation. If the sub-area is wet, it should be allowed to dry before fumigation. Enclosing the structure in a tarp can cause the moisture to be confined and accumulate within the structure during the fumigation period, leaving condensation and/or an odor problem.

GAS DISTRIBUTION/FANS

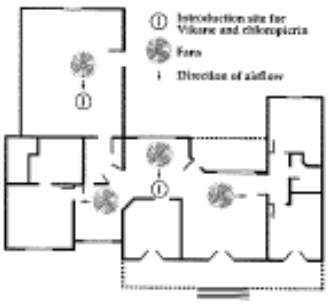
Distribution

Open operable internal doors, internal openings to attics and sub areas, storage chests, cabinets, drawers, closets, and appliances (such as washers, dishwashers, dryers, microwave or conventional ovens, etc.). This will aid in fumigant distribution and aeration. Using electric fan(s) will help provide for forced distribution and aeration of basements and other dead air spaces to facilitate rapid dispersion of gas. Refrigerator and freezer doors may be left open if the units are turned off or disconnected and all food items have been removed. (If the applicator chooses to leave sealed food items in closed refrigerators and freezers during the fumigation, the appliances must be opened when clearing the structure until the concentration of Vikane in them is 1 ppm or less.

It is recommended that Vikane be introduced into a structure in such a way that it reaches equilibrium rapidly (Figure 5b). The exposure period does not begin until equilibrium has been reached. Rapid mixing of fumigant with the atmosphere of the structure also helps prevent cooling air below the dew point, producing condensation. For best distribution, the introduction of Vikane should be directed into the air stream of the fan. The fan should be grounded and have a capacity of at least 1000 cfm for each pound of Vikane released per minute.

RIGHT WAY
Good Circulation

Figure 5b



Pay special attention to air circulation in cold weather. Low outside temperatures can induce moisture condensation on uninsulated surfaces such as exposed-beam ceilings, skylights or windowpanes. To help prevent condensation, fans should be used to maintain heat equilibrium throughout the structure during the exposure period. Furnaces and other sources of heat must always be turned off during fumigation.

Multiple Release Sites

The number of release sites of Vikane will be dictated by the size and configuration of the structure and the adequacy of the circulation. As a rule of thumb, there should be sufficient circulation to establish fumigant equilibrium within an hour. Experience with the product and with the measurements discussed elsewhere will help the fumigator judge the amount of circulation required.

Continuous Circulation

In addition to effective initial distribution of the fumigant, equilibrium of the gas is essential for making sure that the fumigant released into the structure will reach all areas in the structure where infestation may exist.

Although it has been demonstrated not to be necessary during the course of a normal fumigation with Vikane, a fan(s) can be used to maintain air/gas circulation. Care should be taken to ensure fans are in good operating condition and secure to avoid accidents if they are to remain on for the entire fumigation.

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 Vikane. Obviously, the air stream should not be directed against "leaky" tarps because excessive gas loss can occur. If the fumigation site is not equipped with electricity, generators should be provided to run the fans.

SEALING THE STRUCTURE

No two fumigation jobs are identical. The fumigator needs to make field judgments as to how best to seal a building. The fumigator must be guided by the principle of rapidly achieving and then maintaining equilibrium for a sufficient period to accumulate the ounce-hours needed to control the target pest.

The quality of the seal has a huge influence on the effectiveness of the fumigation. There are several approaches to the challenges of confining the fumigant.

Tarp

Most fumigators prefer to cover the structure with a tarpaulin that envelops all components susceptible to pest infestation. This method is effective on almost any size or type of structure (or site). The ability

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

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

1. Vinyl coated nylon
2. Neoprene coated nylon
3. PVC (polyvinyl chloride) coated nylon
4. Laminated (several layers) polyethylene
5. 4 to 6 mil polyethylene for "single use" tarps

Thickness
As a minimum, 4 to 6 mil (160 to 240 microns) thickness of the above materials is able to adequately confine Vikane. A tarp of 100 microns is equivalent to a 400-gauge material. One mil tarps (40 microns or about 150 gauge) of polyethylene normally used for soil fumigation are not of an adequate thickness to confine Vikane. Nor do they possess the strength and weight needed for the handling, wind resistance and abrasion encountered in structural fumigation.

Tarps should be kept in good repair since all fumigants escape readily through any opening, even the most minute, especially on windy days. Rotate your tarps on a regular basis to ensure poor tarps are discarded and new tarps are purchased. It is a good idea to mark new tarps with the purchase date. Patching rips or holes in the field should be kept at a minimum. Where tarps join, the edges should also be tightly rolled and appropriately clamped because loose folds waste fumigant. Obviously, more clamps will be needed on windy days.

Before tarping, open operable windows as permitted by local and state regulations to aid in the distribution of the fumigant between the tarps and the structure. Attic and sub-section vents should also be open during fumigation, as well as interior doors, cupboards, drawers, washers, dryers, storage chests, closets, and ovens. Refrigerator and freezer doors may be left open if the units are turned off or disconnected and all food items have been removed. (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 structure 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.

Uneven or rough-textured soil surface should be evened with soil or wet sand to improve tarp seal. Grass, mulch or rocky surfaces make poor seals.

If possible, soak the surface with water at the ground seal or, preferably, have the homeowner soak the soil in the morning prior to releasing the fumigant. To improve the seal, loose sand can be packed on the lower edge of the tarp. Ramping with sand or soil is also very effective for sealing around steps and ridges.

The faster the gas reaches equilibrium within the building, the less the loss rate at the ground seal. 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 due to wind movement.

Paper

Stucco or masonry block buildings may be sealed so as to include all of the wooden portions of sills and sashes in the fumigation job by taping laminated paper or plastic film over outside doorways, windows and vents. With this method, as with tape, partitions may interfere with fumigant distribution. When

either tape or paper is used for sealing, particularly if a sub-section is involved, a re-circulation fan is required, unless proper amounts of fumigant are introduced separately into each compartment to assure an adequate concentration of gas. Neither sealing method is recommended for houses in which any wooden section, including roofing, is exposed to the outside. Always monitor with a Fumiscope when using these methods.

Tape

Stucco or masonry block buildings can be sealed by taping the cracks at windows, door, and other small openings. Vents from the attic, basement or crawl space should be sealed at the edges. A disadvantage of this method is that fumigant distribution to the attic and sub-section may be poor due to partitioning of these areas from the living space. Some wooden members, such as sills and window sashes, may also be left unfumigated. This method is risky and caution is advised. Always monitor with a Fumiscope.

Preventing Condensation

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

1. Do not tarp or seal a structure when it is wet – let it dry. It is especially important to make sure that wooden shingles are dry before sealing.
2. Do not tarp a structure immediately after treating the sub-section soil with insecticides. Allow the soil treatment to dry.
3. Pay special attention to air circulation in cold weather. Low outside temperatures can induce moisture condensation on uninsulated surfaces such as exposed-beam ceilings, skylights or windowpanes. To help prevent condensation, fans should be used to maintain temperature equilibrium throughout the structure during exposure period.
4. Cold temperatures in warm weather may also warrant special attention. A structure that is air conditioned to a much lower temperature 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 either warming the structure slowly prior to tenting or waiting until all tents are in place before opening windows and doors to avoid introducing outside air.

SECURITY

Vikane is a toxic gas. During the entire process of exposure and aeration, the fumigated structure must be reasonably secure against inadvertent or illegal entry.

The label for Vikane requires that the structure be posted with specific warnings on all entrances during the exposure and aeration periods. Warning signs should 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 certified applicator may authorize removal of warning signs and only when the concentration of Vikane at the treated site is $\leq$1 ppm. The label states the signs must bear in English and Spanish:

- 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 of fumigation.
- Name of fumigant used.
- Name, business address, and a telephone number of the applicator. It is highly recommended that a 24-hour telephone number (including weekends) is written on the warning signs to allow for prompt communication with a fumigation company representative in case of emergency. Some states require this by law.

Also required by label is the proper use of the warning agent, chloropicrin. This is an essential part of security against improper entry.

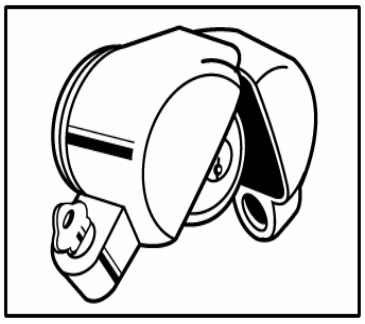
Tarped structures must have proper circulation and exposure to the fumigant. Windows that have locked screens are not considered normal entries and should be opened for the fumigation. However, the risk of illegal entry should be considered in the plans for securing valuables during the fumigation.

Securing Structure Entrances

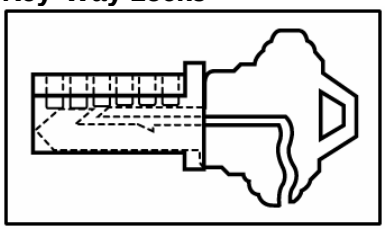
To secure the structure against unauthorized entry during the fumigation exposure period and Step 2 of Aeration Procedure 1 or 2, use a locking device or barricade on all exterior doors or doorways. A locking device or barricade must be demonstratively effective in preventing an exterior door or doorway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

Common secondary locking devices include:

Clam Shell Locks

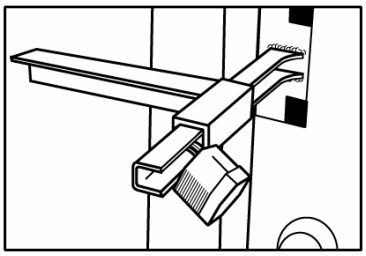


Key-Way Locks



Key-way 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



Chains can also be used on certain structures. Pins and staples in keyways are not recommended unless they are the only option and can only be removed with a special tool.

Existing locking devices, such as pins or bars for sliding glass doors, or interior bolts, can be used to secure entrances if the devices cannot be opened or removed from the exterior of the structure.

Guards may also be considered for some circumstances. Some states require guards to be posted at fumigated buildings.

Other security measures can include:
1. Barricades
2. Caution tape similar to that used on construction sites.
3. If a fence encircles the fumigated structure, posting no trespassing signs on gateways/entrances.
4. Notify local police to increase patrol.
5. Notify local neighbors and neighborhood watch groups.

The fumigator is responsible for all aspects of conducting a fumigation even though some duties are assigned to others. Proper preparations must be carried out before the actual fumigation can proceed. The fumigator should always use a checklist to help prevent exclusions, which can be either unsafe or economically embarrassing. The following list is an example but may not be complete:

FUMIGATOR'S CHECKLIST

The fumigator is responsible for all aspects of conducting a fumigation even though some duties are assigned to others. Proper preparations must be carried out before the actual fumigation can proceed.

The fumigator should always use a checklist to help prevent exclusions, which can be either unsafe or economically embarrassing. The following list is an example but may not be complete:

Preparation:

Confer with occupants/owners —

Protect or remove by (O) occupants or (F) fumigator (circle which):

O	F	People	O	F	Medicinals
O	F	Pets	O	F	Food
O	F	Plants	O	F	Personal items
O	F	Wet soil at seal	O	F	High value items
O	F	Waterproof mattress covers			

Identify Liabilities — *Potential Problems:*

o Roof	o High Value Items
o Antenna	o _____
o Surrounding Plants	o _____

Occupancy — *Single or Multi-Units:*

o Time Out: _____	o Contact: _____
o Time In: _____	o _____
o Keys _____	o _____

Authorities Notified:

o Fire	o Regulatory
o Police	o Guard
o Utility	o _____

Heat Sources Off:

o Pilot lights	o Electric heaters
o Stove	o Automatic equipment
o Space heaters	o Electric pianos/organs
o Water heater	o _____
o Gas refrigerators	o _____

Plan for Fumigant Introduction:

Fans (with fuses/ground wire):

o Capacity	o Power Source	o _____
o Number	o Cords	o _____
o Position	o Switches	o _____

Fumigant Introduction Hose:

o Site	o Entry	Size _____ ID
o Rate	o Security	
o Direction	o Special Needs	

Plan for Fumigant Exposure Period:

- o Monitoring hoses placed.
- o Open interior drawers, microwaves, ovens dishwashers, doors, cabinets, attic crawl, etc.
- o Verify food and medicinal preparation in accordance with the label directions.
- o Windows open with locked screens on tarp jobs.
- o Exterior doors secure *(Conform to codes).*
- o Tarps, Seals — *Proper and secure.*
- o Non-target areas secure.
  - o Exterior plants and pets.
  - o Neighbors.
  - o Spectators — *especially children.*
- o Warning signs attached.
- o Post and inform guard where required.
- o Cubage calculated (Mcf) _____
- o Dosage calculated (oz/Mcf): _____
  - o Soil or Slab °F _____
  - o HLT estimate _____
  - o Hours Exposure _____
  - o Wind Velocity _____
  - o Humidity _____
- o Cylinder of fumigant secured for measurements.
- o Safety equipment on hand *(SCBA and safety goggles, etc.).*
- o Crew Check — *Final clearance of building for personnel and equipment.*
- o Introduce Warning Agent — *Use 1 oz of chloropicrin/10-15 Mcf.*
- o Close and lock last entry.
- o Start fans.
- o Wait 5-10 minutes for chloropicrin distribution.
- o Introduce Vikane gas fumigant.
- o Check for leaks.

Opening, Aeration and Clearance:

Tape/Paper Fumigation:

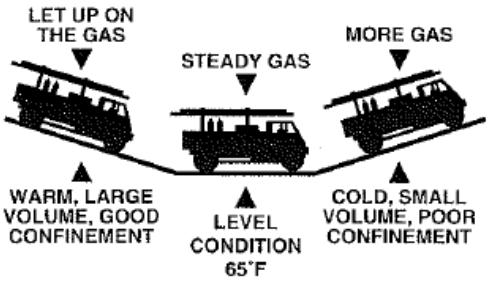
- o Open doors — Start fans.
- o Remove interior seals — Open windows (wear respiratory protection).

Tarp Fumigation:

- o Remove bottom seal.
- o Open tarps — Downwind side first, then upwind side.
- o Move warning signs from tarp to structure.
- o Start fans.

- o Reactivate utilities.
- o Test for clearance of Vikane gas fumigant with suitable instrument.
- o Remove warning signs when site is cleared for re-occupancy.
- o Post fumigation notices where required.
- o Return building keys to occupant/owner.

ESTABLISHING THE DOSAGE.....6



ESTABLISHING THE REQUIRED DOSAGE OF VIKANE

The structural fumigator is challenged with the task of erecting a temporary fumigation chamber each time he fumigates. Because of the multitude of variations, there are no two jobs identical, nor are any of them truly gas tight. The leakage rate, called half-loss time (HLT), is dependent on the sealing conditions as well as external factors such as the wind.

Half-loss time is the time required to lose one half of the fumigant concentration. The higher the HLT, the better the fumigant confinement. An estimated HLT is determined using the front side of Fumiguide B calculator. Actual HLT is determined by monitoring the fumigation.

In addition to the fumigant loss rate, the required dosage (concentration x time) of Vikane is determined by the temperature at the site of the pest and the susceptibility of the pest(s) to be controlled. Consequently, to specify a single dosage rate for all conditions would seldom be correct – usually it would be either excessive or insufficient.

Refer to the glossary for definitions of terms used in this chapter.

The length of the exposure period, or hours exposure (HE), is critical only as to the time needed to accumulate sufficient ounce-hours (OH) required for the temperature at the site of the pest.

HE is the number of hours the site is exposed to the fumigant. Exposure periods from 2 to 72 hours are proved by the Fumiguide Y, which coordinates the necessary adjustments to obtain proper dose for the job. The hours of exposure begin only after equilibrium has been reached.

Dosage calculators have been devised to arrive at a usable dosage.

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

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

3. Fumiguide Calculator is a hand-held microprocessor that performs the functions of both the Fumiguide B and Y Calculators and includes relative humidity as a calculating factor.

The required dosage needed to control the drywood termite has been established as the 1X rate for the Fumiguide calculators.

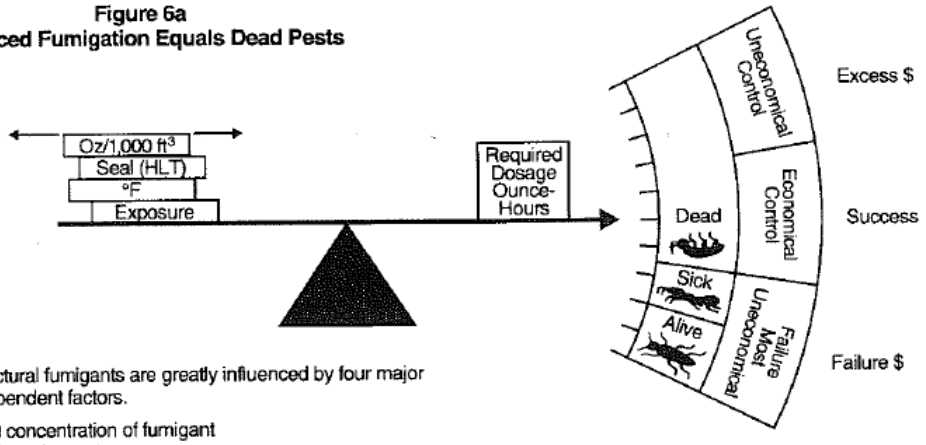
FACTORS AFFECTING DOSAGE

Balanced Fumigation – Establishing the Dosage

Dosage

In structural fumigation with Vikane, the dosage (OH) is equal to the concentration of Vikane (ounces) x time (hours). Therefore, the dosage required to kill drywood termites (1X rate) is accumulated over a period of time and is measured in OH; the number of ounces of fumigant multiplied by the exposure time in hours. The OH requirements are dependent on the temperature at the location of the pest. The fumigant dosage must be adjusted to this temperature to efficiently control the target pest (Figure 6a). As time passes, fumigant is lost from the structure and the rate of accumulation of OH decreases.

Figure 6a
Balanced Fumigation Equals Dead Pests



All structural fumigants are greatly influenced by four major interdependent factors.

1. Initial concentration of fumigant
2. Fumigant loss rate
3. Temperature at site of pest
4. Exposure period

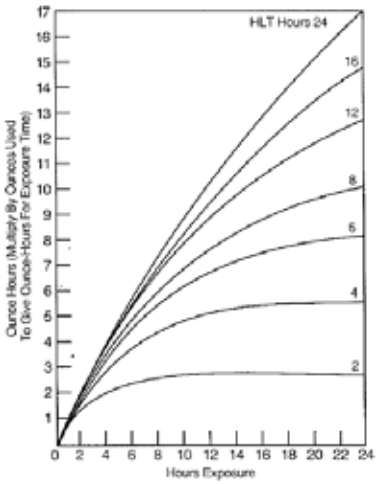
A change in any factor will require a compensating change in one or more of the others for equivalent performance, hence the term BALANCED FUMIGATION.

Accumulation of OH Related to HLT and Exposure Time

Several HLT curves displayed in Figure 6b show different rates of dosage accumulation related to exposure time. To furnish coordinates as unit OH, the curves are plotted for one ounce of fumigant. To determine the total OH accumulated, multiply the respective OH coordinate by the number of ounces of fumigant used.

Under conditions of rapid fumigant loss (short HLT) it is obvious that only the initial hours of exposure are of any significance for the accumulation of dosage.

Figure 6b
Accumulation of Fumigant Dosage (OH)
Related to Half-Loss Time (HLT)
When Initial Concentration is 1 oz/Mcf.



Fumigant Loss Rate Contributing Factors

There is no method at present for accurately predetermining the loss rate of fumigant from a structure. The conditions affecting the fumigant confinement will differ for each job. The results from numerous measurements for Vikane indicate the main influencing factors to be:

1. Condition of tarpaulin or cover.
2. Condition of seal (where tarp joins soil, steps, wires, fences, etc.).
3. Type of underseal (slab or soil).
4. Volume of structure (ratio of surface area to volume).
5. Wind velocity.

Tarp and seal condition have been assigned a series of values expressing the estimated conditions (Table 6a). These values are necessarily subjective, but have proven useful when associated with the practices and terminology of professional fumigators.

The loss rate factors can be worked out easily on the Fumiguide B Calculator or the Fumiguide Calculator to give the HLT estimation.

Table 6a HLT Estimation

Influence	Estimated	Factor	Start with the basic HLT of 12 hours, then multiply products by successive factors — Example
Tarp or Stucco Conditions	Excellent	1.0	0.9 x 12 = 10.8 hours
	Good	0.9*	
	Medium	0.8	
	Fair	0.7	
	Poor	0.6	
Seal Tarps Tape At Soil	Excellent	1.0	0.8 x 10.8 = 8.64 hours
	Good	0.9	
	Medium	0.8†	
	Fair	0.7	
	Poor	0.6	
Soil	Slab	3.0	1.0 x 8.64 = 8.64 hours
	Clay	2.0	
	Loam	1.0†	
	Sandy Loam	0.5	
	Sand	0.25	
Volume (1,000 ft²)	1	0.4	1.2 x 8.64 = 10.4 hours
	3	0.6	
	8	0.8	
	16	1.0	
	27	1.2†	
	45	1.4	
	65	1.6	
	90	1.8	
	125	2.0	
	400	3.0	
	1,000	4.0	

		Tarped	Sealed Masonry	
Wind (mph)	0	1.0	1.00	0.7 x 10.4 = 7.3 hours
	1-2	0.9	0.95	
	3-5	0.8	0.90	
	6-9	0.7*	0.85	
	10-14	0.6	0.80	
	15-20	0.5	0.75	
	20-	0.4	0.70	

The rate of fumigant loss is expressed as HLT, the time required for half the fumigant to be lost. An example is shown in Table 6b.

Table 6b Half-Loss Time of Six Hours

HLT	Elapsed Time (Hours)	Fumigant Conc. oz/1000 cu ft
(HLT = 6 hours)	0	16
one half of	6	8
remaining fumigant	12	4
is lost	18	2
every 6 hours	24	1

Examples of the required dosage of Vikane are shown in Table 6c for various loss rates of the fumigant for a temperature of 70ºF and a 20-hour exposure.

Table 6c Required Rate of Vikane for Drywood Termite Control at 70°F and 20 Hours of Exposure for Various Measured HLT

HLT	2	4	8	12	16	20	24
Vikane in oz/1000 cu ft	32	17	10	8	7	6.5	6

The experienced fumigator probably is familiar with the physical features of the terrain that will assist in making judgments of HLT calculations.

For a crawl space structure on sand the HLT estimation would be three hours, requiring 43 lb of Vikane. If, however, a shallow water table is known to exist, extend the volume to include the extra space and estimate the new HLT on the basis of perhaps a foam underseal. The new HLT would then be 12 hours, requiring only 13 lb of Vikane for the structure. If uncertain about how the terrain may affect the HLT, it is best to monitor with a Fumiscope.

Temperature at the Termite Site

The pesticidal activity of a fumigant varies with the temperature ("Precision Fumigation" by Doane Stewart, reference in bibliography); thus, the dosage requirements for a particular structure must be based on the mean temperature at the coldest site that could harbor the pest. Numerous temperature measurements have been made of various structural components and atmospheric conditions of homes under fumigation. These have shown that a thermometer reading of the concrete slab or the sub-section soil 2 to 3 inches below the surface will reliably represent the temperature of the coldest site that could harbor the target pest. The measurement can be made in the shade on the slab with a surface thermometer just before the fumigation.

As determined in other similar measurements, the warming influence caused by the weather is usually greatest in the attic and least in the soil; consequently, the temperatures of the mud sill and pier-post pad are usually the coldest and the most critical encountered in the entire structure.

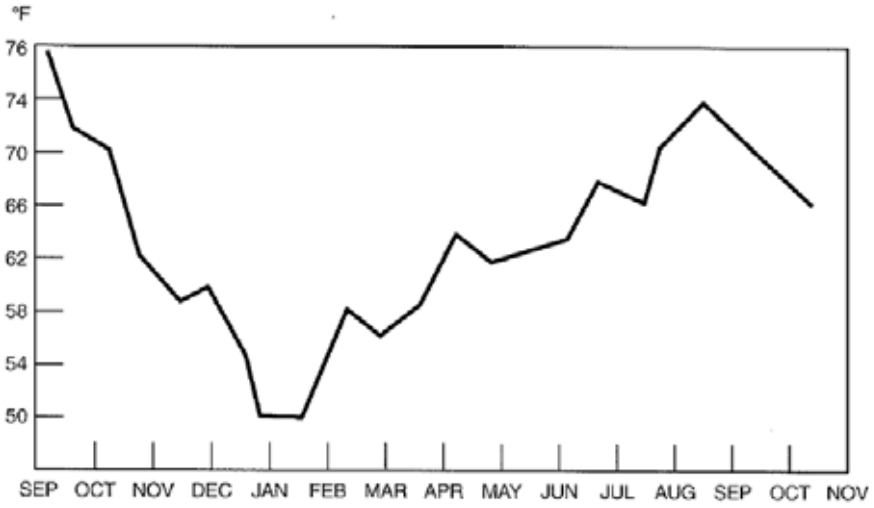
The range of temperature in Table 6d (55°F to 80°F = 13°C to 27°C) represents mean seasonal temperatures in Florida and Southern California, the areas of the continental United States where drywood termites are most prevalent.

Table 6d Required Equilibrium Concentration of Vikane for Drywood Termite Control for a Measured 12-Hour HLT and 20 Hours of Exposure

Temp. of slab or soil, °F	55	60	65	70	75	80
Vikane, oz/1000 cu ft	16	12	9.5	8	7	6

Temperatures measured over the course of a year in the sub-section of a house in Garden Grove, California, are plotted in Figure 6c.

Figure 6c
Soil Temperatures in Subsection of House
Garden Grove, California
(The year was relatively cold for that locale.)



Temperature Control

It is difficult to save a substantial amount of Vikane during winter fumigation by raising temperatures in the structure. There are no specific recommendations for heating the structure. However, if an elevated temperature is confirmed with a thermometer, it can be used in calculations with the Fumiguide System.

Fans, heater-fans and other electrical equipment should be grounded and have a good protective fusing system. The surface temperature of heating equipment should not exceed 752ºF.

In any event, the following conditions will have to be met:

1. Glowing heat surfaces or open flames must never been used during the fumigation period.
2. The temperature should still be measured at the coldest potential pest site, such as the pier pad, mud sill or north wall ("shaded"). The temperature of the soil at a depth of three inches is usually representative of the coldest areas.
3. The measured minimum temperature should be used for dosage calculations.

USE OF THE FUMIGUIDE SYSTEM

Using the Fumiguide B and Fumiguide Y Slide Rules and Fumiguide Calculator

Dow AgroSciences LLC has developed the Fumiguide Calculator for analyzing the factors that affect fumigant confinement and efficacy to calculate the required dosage of Vikane. The system encompasses the Fumiguide B and Fumiguide Y slide rules and the Fumiguide Calculator.

1. The Fumiguide B Calculator is designed to estimate confinement, measured as HLT, determine dosage for a non-monitored exposure period of 20 to 24 hours, and convert ounces/1000 cu ft to total pounds required.

2. The Fumiguide Y Calculator is designed to determine actual HLT based on measurements of concentration of Vikane during fumigation, determine dosage for a monitored exposure period of 2 to 72 hours, and ounce-hour requirements for drywood termites based on temperature.

3. The Fumiguide Calculator incorporates the calculations of the Fumiguide B, Fumiguide Y and Fumiguide S. The Fumiguide S calculated the rate (pounds/minute) of fumigant introduction based on fan capacity, measured in amps, and relative humidity. The Fumiguide Calculator determines the

dosage for monitored and non-monitored fumigations with exposure periods of 2 to 72 hours, converts ounces/1000 cu ft to total pounds required, and determines ounce-hour requirements and dosage for all target pests referenced on the label for Vikane. The calculator will also calculate the chloropicrin dosage. In addition, the calculator also can calculate additional pounds required for interrupted fumigations, such as when tarps blow open.

The Fumiguide system enables precision fumigation. The Fumiguide B Calculator is the basic tool used to estimate confinement and determine dosage for routine 20 to 24 hours non-monitored fumigations. The Fumiguide Y Calculator, used in conjunction with the Fumiguide B Calculator, affords the fumigator the flexibility of fumigating under a wide range of conditions, including exposure periods of 2 to 72 hours. The Fumiguide B Calculator is used in conjunction with the Fumiguide Y Calculator to estimate HLT and convert ounces/1000 cu ft to total pounds required.

When the Fumiguide Y Calculator is used to calculate dosage for non-monitored fumigations, the pounds of fumigant introduced must be increased by 33% since fumigant confinement has not been verified. If the success of the fumigation is financially critical, the Fumiguide Y Calculator or Fumiguide Calculator should be used in conjunction with Fumiscope readings to measure actual HLT to confirm oz/hr dosage accumulated. Since the Fumiguide Calculator incorporates the operations of the Fumiguide B Calculator and Fumiguide Y Calculator with additional functions, this calculator is the most versatile. Refer to the instruction booklets for the Fumiguide B Calculator, Fumiguide Y Calculator, and Fumiguide Calculator for directions on how to use them.

For repairs of the Fumiguide Calculator, contact:
HAMPTECH
c/o PMMI Electronics
1007 Spanish Moss Lane
Houston, Texas 77077 USA
doug.hampton@pmmi-electronics.com
281-293-8000 voice
281-293-8005 fax

Using the Fumiguide Y Calculator or Fumiguide Calculator When Monitoring

During the exposure period, the concentration of Vikane can be measured by a gas-measuring instrument. After the fumigant concentration has reached equilibrium, two measurements with an interval of time between will give the actual loss rate from which the HLT can be determined.

In case of an ounce-hour deficiency between the estimated and measured HLT, the required amount of additional fumigant or exposure can be readily calculated using the Fumiguide Y Calculator or Fumiguide Calculator.

Economics of Fumiguide Y Calculator or Fumiguide Calculator

For very small buildings or on easily prepared jobs, the higher estimated dosages of Vikane (as indicated by Fumiguide B Calculator) may be sufficient. However, as financial consequences of saving large quantities of Vikane or re-fumigation increase, the techniques of Fumiguide Y Calculator and Fumiguide Calculator become more attractive. On routine small fumigations, periodic measurements for HLT could prove economically beneficial to the fumigator in maintaining proper equipment and sealing standards.

Make sure to accumulate the required ounce-hours for the temperature and target pest!

Suggested Steps of Operation

Use Log Work Sheet.

Preparation Prior to Fumigant Release:

1. Measure soil/slab temperature (°F) with a thermometer.
2. Measure volume of fumigation space (under tarps).
3. Estimate HLT on Fumiguide B Calculator.
4. Estimate HE on Fumiguide Y Calculator. Coordinate the HE with the estimated HLT in central window (side A).
5. On Fumiguide Y Calculator, in lower window, calculate dosage of Vikane (oz/Mcf) for temperature. Establish ounce-hours Vikane needed for temperature (soil or slab).
6. On Fumiguide B Calculator, convert ounces Vikane/Mcf to pounds needed for structure.

Note: Steps 4 to 6 can be calculated on the Fumiguide Calculator.

Introduce Warning Agent and Vikane

Use proper fans to achieve rapid equilibrium of the Vikane.

After Equilibrium of Vikane in Structure

1. Measure (with a gas measuring instrument such as a Fumiscope) concentration of Vikane (oz/Mcf).
2. After one or more hours, take a second measurement of concentration of Vikane.
3. Using the Fumiguide Y Calculator (side B) or Fumiguide Calculator, calculate the actual measured HLT.
4. If the measured HLT equals that estimated, the job should finish on time. If the measured HLT is longer than that estimated, the actual ounce-hours dose will be reached earlier than intended.

If the HLT is shorter than estimated (more rapid loss of fumigant), then more Vikane needs to be added to finish on time. Additional exposure time may be used if sufficient Vikane is present.

FIELD WORKSHEET
FOR
FUMIGUIDE* CALCULATOR

NAME_____ DATE_____

ADDRESS_____ TIME OF INTRODUCTION_____

PHONE NUMBER_____ PEST_____

DOSAGE FACTOR	_____	RELATIVE HUMIDITY (%)	_____
TARP CONDITION	_____	SHOOTING FAN AMPS	_____
SEAL CONDITION	_____	MONITOR JOB (YES/NO)	_____
WIND (MPH)	_____	ESTIMATED HLT	_____
VOLUME (MCF)	_____	DOSAGE (OZ/MCF)	_____
UNDERSEAL	_____	TOTAL POUNDS REQUIRED	_____
TEMPERATURE (F)	_____	OZ/HRS REQUIRED	_____
HOURS EXPOSURE	_____	MAX. SHOOTING RATE	_____
		CHLOROPICRIN	_____

MONITORING INFORMATION
OZ/MCF

Time	Location				Average
	1	2	3	4	

FIRST READING (EQUILIBRIUM)_____

SECOND READING_____

HOURS BETWEEN READINGS_____

ACTUAL HLT_____

CORRECTION INFORMATION_____

RELEASE OF WARNING AGENT 7

Vikane is odorless. A protective warning agent such as chloropicrin must therefore be released within the structure or site at least 5 to 10 minutes before the fumigation begins. This is an added precaution to assure that the space to be fumigated remains free of people. Chloropicrin is released before introducing Vikane to allow time for it to vaporize adequately and distribute throughout the space to be fumigated.

Introduction of Chloropicrin

Research indicates that when chloropicrin is applied according to label directions at each introduction site for Vikane, it will reach warning concentration by the time the fumigant is introduced and will maintain a warning concentration throughout a 22 to 24 hour fumigation period. According to the label, in order for chloropicrin to perform this valuable warning function, it must be applied:

- In a shallow container with fresh wicking material.
- In the air stream of a fan.
- At a rate of 1 oz/10,000 to 15,000 cu ft or follow dosage rate calculated by the electronic Fumiguide system.
- Do not fill any shallow container or chloropicrin pan with more than 3 fl oz of chloropicrin.

In addition, it is suggested that chloropicrin be introduced:

- At least on each floor of a multi-story structure.
- At each fumigant introduction site.
- The most effective placement of chloropicrin is about 1 foot behind the fan with the fan positioned at a 45° angle upwards.

Because chloropicrin can be temporarily absorbed onto furnishings, care must be taken in choosing sites for fumigant and warning agent introduction. Areas with many furnishings on which chloropicrin can absorb may be disqualified as introduction sites by a fumigator wishing to avoid problems with chloropicrin desorption.

Because of the characteristics described above, it is important not to over apply the chloropicrin in any area of the structure, such as the lowest floor. Reaching a high localized concentration of chloropicrin will only lead to aeration difficulties due to the absorption potential of chloropicrin. The fumigator's goal should be to rapidly attain distribution with the warning agent, just as with the fumigant.

Precautions and Pertinent Points for Using Chloropicrin Warning Agent

1. Chloropicrin serves as an excellent warning agent. It must not, however, be relied upon as a deterrent to entry during the entire exposure period if the confinement conditions are poor or if the exposure period exceeds 22 to 24 hours.
2. It is imperative that the amount of chloropicrin be accurately measured. Less than the required amount will not give sufficient warning; too much can be difficult to aerate.
3. Store and transport chloropicrin and measuring container in a gas-tight case outside of the driver's space. Refer to the local Department of Transportation for further instructions on transporting chloropicrin.
4. Chloropicrin must be thoroughly aired from a structure before re-occupancy. Very small amounts can be irritating (see Table 7a). It may be helpful to operate the structure's air handling systems prior to re-occupancy to aerate chloropicrin from the ducts.
5. Chloropicrin is persistent when adsorbed on wood or concrete. Never use in fumigant introduction hose for Vikane or pour on concrete or soil.
6. Chloropicrin is an organic molecule with a very high boiling point and low vapor pressure (see Table 7b) relative to Vikane. These characteristics contribute to its tendencies toward sorption and slow desorption, and require specific procedures for chloropicrin introduction.

Table 7a Human Response to Chloropicrin

Response	ppm	Minutes Exposure
lachymation threshold (tears)	0.3	continuous
eye closure	0.3 – 3.7	continuous
incapacitated	4.0	continuous
intolerable	7.5	10
injury to respiratory system	15	1
lethal to man	119	30

Table 7b Physical Properties of Chloropicrin and Vikane

Chloropicrin	Vikane
$CCl_3 NO_2$	SO_2F_2
trichloronitromethane	sulfuryl fluoride
threshold limit value: 0.1 ppm	threshold limit value: 1 ppm
short term exposure level: 0.3 ppm	short term exposure level: 10 ppm
boiling point: 112°C (233.6°F)	boiling point: -55.2°C (-67°F)
vapor pressure: 20 mm Hg at 20°C	vapor pressure: 13,442 mm Hg at 25°C

For each chloropicrin introduction site, the following sequence is recommended after preparing the structure for fumigation:

1. Accumulate the appropriate quantities of chloropicrin. To assist with accurate measuring of chloropicrin, measuring devices with resealable/reclosable caps are available (Cardinal Products, www.cardinalproproducts.com). An additional advantage of using these devices is that chloropicrin can be measured outside the structure so only the amount of chloropicrin needed during the fumigation is carried into the structure.
2. Ensure that wicking material, such as a handful of cotton, is present in each shallow container. Do not use a container made of magnesium, aluminum, or their alloys as chloropicrin may be severely corrosive to such metals.
3. Place the shallow container in front of or behind fan with adequate cfm rating to distribute the chloropicrin.
4. Pour chloropicrin over the absorbent material (the measuring container and cap may be left near the container and residues allowed to evaporate).
5. If protective respiratory equipment is not being used, leave the area immediately. When more than one introduction site is present, adequate respiratory protection should be used.
6. After application of chloropicrin, seal the last entrance.
7. Start the fan(s), if not already started.
8. Wait 5 to 10 minutes before introducing Vikane.

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

Measuring Chloropicrin Concentrations

Chloropicrin concentrations can be determined using Dräger sensor tubes designed for measuring carbon tetrachloride concentrations. According to the Dräger Tube 81 01 021 Carbon Tetrachlroide1/a label, these tubes have identical sensitivity to chloropicrin and carbon tetrachloride. Contact your distributor or Dräger representative for additional information.

Mode of Operation
Combined tube consists of a pre-tube and an indicating tube. For measurement, both tubes are connected by the rubber tubing supplied. The pre-tube contains a white oxidation layer, the indicating tube a light-grey layer and a white indicating layer.

When air or gas samples are sucked through the combined tube, the indicating layer changes color to yellow in the presence of carbon tetrachloride.

Ambient Conditions
- Temperature: 15°C to 30°C.
- Humidity: 3 to 15 mg/L (corresp. 50% r.h. at 30°C).
- Atmospheric pressure: for correction of the reading, multiply by factor F. F = 1013/actual atmospheric pressure (hPa)

Prerequisites
The tubes may only be used in conjunction with the following Dräger Pumps: Model 21/31, Accuro, Accuro 2000 or Quantimeter1000. Using other pumps may result in considerable measurement errors. Observe the instructions for use of the pump.

Before each series of measurement, check the pump for leaks with an unopened tube. The measured value is applicable only to the place and date of measurement.

Measurement and Evaluation
1. Break off the tips of both tubes in the tube opener.
2. Connect them using the rubber tubing supplied.
3. Insert the combined tubes tightly in the pump. Arrows point towards the pump. Measuring range: 1 to 15 ppm (5 strokes, scale n=5).
4. Suck air or gas sample through the tube. Measuring period is approximately six minutes.
5. Read the entire length of the yellow discoloration.
   --Multiply the value by factor F for correction of the atmospheric pressure. Enter the result in the measurement record. Relative standard deviation +15% to 20%.
   --Observe possible cross sensitivities.
   --Flush the pump with air after operation.

Disposal
Avoid skin contact with the tube filling. Contents are corrosive. Keep out of reach of unauthorized persons. For disposal, observe safety recommendation S 2-26-28.1-36/37-44. See label for directions. Note that chloropicrin detection tubes have a limited shelf life.

FUMIGANT/VIKANE INTRODUCTION 8

The proper introduction of Vikane (release from the cylinder) is essential to the success, safety and economy of a fumigation. It is imperative that the fumigator understand the principles involved as well as the conditions that exist for introducing the fumigant on each job – no two are alike.

Many of the problems listed in the "Troubleshooting" chapter are the result of the improper introduction of Vikane.

USING THE CYLINDER

Vikane is supplied in cylinders equipped with tubes that extend from the bottom of the tank to a valve on the top. To release the fumigant, this valve is opened to permit a free flow of the liquid, which vaporizes as it escapes from the release hose.

The last 3 to 5 lb of fumigant in the cylinder will turn to gas before moving through the hose and the rate of flow is thus markedly reduced. During this phase, the cylinder and hose will often become frosted or iced. Care should be taken to keep this melting frost from dripping onto household furnishings.

The valve should be turned fully open to fill the fumigant introduction hose with liquid Vikane. Initially, the valve should be opened slightly until flow has begun and then opened about one full turn, which should give full flow through the 1/8" fumigant introduction hose. When finished, close the valve tightly using a wrench with a handle of 10"-12" in length. A clearance detector or leak detector may be used to test for a tight seal at the connections.

WEIGHING THE FUMIGANT

Either platform or hanging scales can be used to weigh the cylinder containing Vikane during fumigant introduction. If hanging scales are used, then modified bonnets or cylinder slings should be used to hang the cylinder from the scale. The cylinder should never be suspended by the valve! Consult Dow AgroSciences or your distributor of Vikane for a source of supply.

Regardless of the type of scale used, it should be routinely calibrated to assure continued correct readings. Refer to the scale manufacturer for further details.

RELEASING VIKANE

Proper Release of Fumigant is Important

Worker Safety

When releasing Vikane from the cylinder, the operator must wear a full face shield or splash-resistant goggles. Since there is a potential for the fumigant introduction hose to detach from the cylinder, all onlookers should remain at a safe distance from the release site.

Preventing Property Damage

The minutely small quantity of impurities in Vikane are of no consequence when it is correctly introduced and maintained in the gas phase. These impurities can cause damage and accelerate corrosion if a fog-out occurs during fumigant introduction, resulting in condensation on susceptible objects; i.e., metals, tile, glass, fabrics, etc.

Reaching Equilibrium

When Vikane is released as a liquid from the fumigant introduction hose, it becomes very cold as it expands to form a gas and chills the surrounding air.

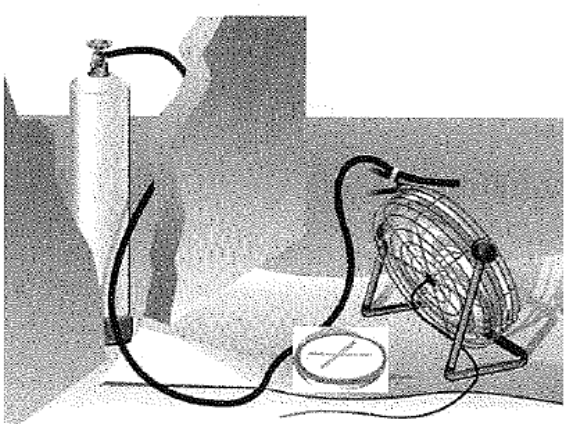
The chilling causes the formation of a cloud of condensed water (fog) that must be dissipated. The rate of dissipation depends upon the rate of release, atmospheric conditions, and the mixing rate (which is

determined by fan number, type and placement). Because it is chilled, this parcel of Vikane in air is much more dense than the surrounding air and will rapidly settle to the bottom of the fumigation space unless mechanically agitated.

All gases tend to move from an area of high concentration to low concentration and will, therefore, come to equilibrium in a confined space. Vikane will do the same when it is introduced into a fumigation space, regardless of the fact that molecules of Vikane are heavier than air molecules. In spite of the high vapor pressure of Vikane, the rate of passive diffusion may be too slow for this to occur within the practical time of a fumigation. Thus, good mechanical distribution (using fans) is essential. It is for the following reasons that substantial fans are needed when introducing Vikane, to prevent stratification, to aid proper dispersion, and to assist temperature distribution.

Summary
The event when introducing Vikane are shown in Figure 8a.

Figure 8a



Selection and Use of Equipment for Fumigant Introduction

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

Hoses
Release the fumigant through a suitable leakproof hose with a minimum burst pressure of 500 pounds per square inch (psi). In addition to safety considerations of burst pressure, flexibility, kink resistance and durability, the dimensions of the fumigant introduction hose can have a large influence on the efficacy and material safety of Vikane.

The introduction rate of Vikane is controlled largely by the inside diameter and the length (resistance) of the fumigant introduction hose. The effects of the inside diameter size on the flow rate of Vikane are shown in the Table 8a.

Table 8a The Effect of Inside Diameter Size on Flow Rate of Vikane Through a 25 ft Hose of Polyethylene (65°F)

Tube Inside Diameter (ID)	Pound Vikane per Minute
1/8	4
1/4	20
1/2	45

Table 8b shows the effect of hose length on the introduction rate for Vikane.

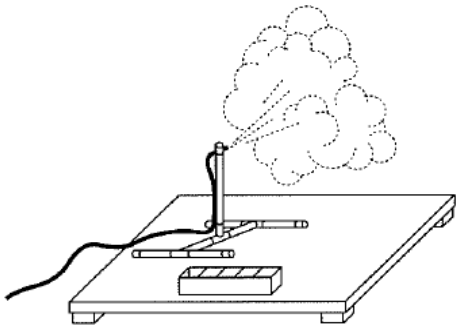
Table 8b Effect of Hose Length (1/8" ID) on Flow Rate

Hose Length (ft)	Pound Vikane per Minute
25	4.0
50	2.8
100	2.0[1]

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

Fumigant Introduction Stand
A raised fumigant introduction stand can be constructed of PVC pipe and the base weighted with rebar (see Figure 8b). Attaching the hose to customer furnishings is not recommended because these items may be damaged if contacted by tape or liquid Vikane.

Figure 8b



Another widely used solution is to securely tape the introduction hose to a tarp clamp, and then use the tarp clamp to attach the hose to the fan cage (see Figure 8a). The fan cage is angled upward at about 45° in this case. Additionally, success in fumigant introduction has been obtained by attaching the fumigant introduction hose to a coiled sand snake in front of an upangled fan at 45°.

It is recommended to always leave the introduction hose in place during the exposure period, rather than attempt to pull the hose out following introduction. Pulling the hose out can result in significant damage to furnishings or the structure.

Protective Sheeting
It is recommended that protective sheeting, such as polyethylene plastic, under the stand, hose and fan can be used to further protect floors and floor coverings during application. All of the fumigant introduction options outlined above offer the flexibility to incorporate protective sheeting in critical areas.

Chloropicrin Introduction
Chloropicrin should be introduced at each introduction site for Vikane. Chloropicrin must be used within the structure at least five to 10 minutes prior to the introduction of the fumigant. Place a handful of cotton in a shallow container and set the container in the air stream of a fan. Use 1 fl oz per 10,000 to 15,000 cu ft of space to be fumigated or follow dosage rate calculated by the electronic Fumiguide system.

Fumigant Introduction Site

The specific site of release of Vikane is very important to the success of the fumigation. Vikane should be introduced in a manner to achieve rapid equilibrium, avoid excessive loss due to stratification, and ensure safety to personnel and materials. Usually this can be accomplished by directing the flow into the air stream of a fan that has the capacity of 1000 cfm for every pound of Vikane introduced per minute.

Considerations for Site Selection

1. Largest space.
2. At least on location on each floor of a multistory structure.
3. Proximity of furnishings that might be damaged by introduction.
4. Since it is suggested that chloropicrin be applied at each introduction site for Vikane, consideration should be given to the furnishings in each site. If the furnishings in a given area are such that chloropicrin desorption may be a problem (overstuffed furniture, many boxes, pillows, excessive clutter, etc.) the fumigator may want to disqualify that area as a potential chloropicrin application site.
5. Number of sites: Research supports a fumigant introduction site for each 20 to -40 Mcf in a single-family dwelling.

Site selection should be made using common sense. Ask, "If Vikane was introduced in this location, how and when will it get to the most remote locations in the structure?" It may be necessary to use multiple introduction sites to rapidly attain equilibrium. As a rule, it is not necessary from an efficacy standpoint to introduce fumigant directly into the attic space. with proper site selection and fan placement, Vikane will reach equilibrium throughout the structure and will not stratify in the lower reaches of the building.

Purpose and Choice of Fans

There are three purposes for fans in a structural fumigation: fumigant introduction, circulation and aeration. Common high velocity axial fans used in the fumigation business are Patton, Lakewood and Dayton. These fans are usually the most practical and are the most often used due to their relatively low cost. Fans ensure that the fumigant equilibrium is achieved in a timely manner, and aid in the ventilation and aeration process. In all cases, the fan selection is important. Axial flow fans with the propeller-type blades are suggested because they move high volumes of air per minute.

When selecting a fan, check the manufacturer's specifications and ensure that the fan is OSHA approved, grounded, contains a thermal shut off switch, meets or exceeds the cfm needed, and has a shield for protection. Similar to other fumigation equipment items, fans will wear and need to be replaced. Never use an unsafe fan in a fumigation and remember to carry adapters with you to accommodate a 3-prong plug. If the fumigation site is not equipped with electricity, generators should be provided to run the fans.

Fan Capacity

The specifications for fans are numerous, e.g., number of blades, speed (rpm), watts, amps, shrouds, blade size and most importantly blade shape. These features affect the amount of air the fan can move, which is usually reported as cubic feet per minute (cfm). It is extremely important that you confirm the cfm rating of the fan by checking the manufacturer's rating. For example, an 18" 2.6 amp, 200-watt fan could have a different cfm rating based on the design of the blade (tear drop vs. flat). A 20" non-industrial fan will not move as much air as an 18" industrial fan due to the blade design. The cfm ratings are set by the manufacturer utilizing a gauge or meter in front of the circulating fan.

When introducing Vikane through a 1/8" ID hose, 25 feet long, the release rate will be roughly 4 lb/min. That rate of release of Vikane according to the label would require a 4000 cfm capacity fan.

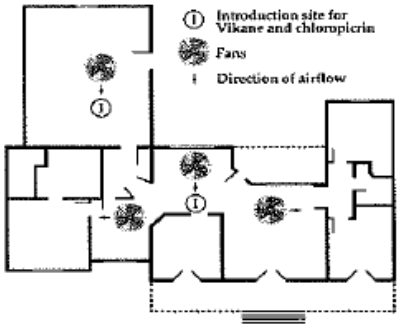
Tables 8a and 8b can be an aid in selecting the proper hose size and hose length for structural fumigation. Please note that there may be significant variation in cfm ratings among fan manufacturers and fan models. Be sure to contact the fan manufacturer for specifics.

Positioning Fans

There is no set pattern established for the positioning or the number of fans to use. A rule of thumb has been to use one for each 20 Mcf and at least one for each floor of the structure including sub-areas (basements) and open attics, if accessible. Fans should be placed so as to mix the fumigant and rapidly reach equilibrium. It is good fumigation practice to use more fans in structures that are divided into numerous smaller compartments or rooms.

Distribution and Aeration
It is recommended that Vikane be introduced into a structure in such a way that it reaches equilibrium rapidly since the exposure period does not begin until equilibrium has been reached (see Figure 8c). Remember, the number of fans will accumulate the calculated hours of exposure by reading equilibrium in the estimated time (usually one hour in an average house). The fumigant introduction fan(s) will mix the warm air of the structure with the cooled during introduction of Vikane and act as a "heat exchanger".

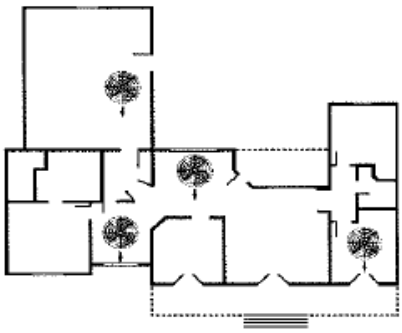
Figure 8c



For best distribution, the introduction of Vikane should be directed into the air stream of the fan. If you elect to shoot with the air stream, choose a large open space and tilt the fan to a 45° angle or greater. The fan should have a capacity of at least 1000 cfm for each pound of Vikane released per minute.

Fans are equally important during the aeration process of the fumigation. Depending on the size, compartmentalization, actual HLT, and terminal concentration, fan placement will be critical during active ventilation. Often, the fans will need to be repositioned for aeration. The best use of the aeration fan(s) is to position so airflow is moving in one direction. Position fans for fresh air intake in openings on one side of the structure and fans for exhausting fumigant in openings on the opposite side of the structure (see Figure 8d).

Figure 8d



Multiple Release Sites

The number of release sites of Vikane will be dictated by the size and configuration of the structure and the adequacy of the circulation. As a rule of thumb, there should be sufficient circulation to establish fumigant equilibrium within an hour. Experience with the product and with the measurement will help the fumigator judge the amount of circulation required.

Continuous Circulation
In addition to effective initial distribution of the fumigant, equilibrium of the gas is essential for making sure that the fumigant released into the structure will reach all areas in the structure where infestation may exist.

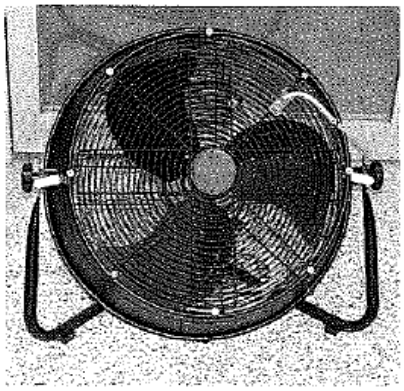
Care should be taken to ensure fans are in good operating condition and secure to avoid accidents if they are to remain on for the entire fumigation. After Vikane reaches equilibrium, introduction fans can be turned off remotely. Often, fans are left on during the fumigation to assist with ventilation of the fumigant during aeration.

All fumigations leak. The ground seal and tarp condition play a role in confinement. Unless there are abnormally large leaks, continuous circulation during the entire exposure period will not appreciably affect the loss rate for Vikane. Obviously, the air stream should not flow directly against "leaky" tarps because excessive gas loss can occur.

King of Fans

INDUSTRIAL HIGH VELOCITY TURBOFLOW FAN FOR INTRODUCTION OF VIKANE

Background
The King of Fans TurboFan was specially designed for fumigant introduction, circulation and aeration during structural fumigations. This TurboFlow fan was developed to meet industry needs for a more durable fan able to withstand tough conditions and demanding long-term use encountered in structural fumigations.


The TurboFlow Fan

The TurboFlow fan for Vikane utilizes two important physical attributes: 1) a unique shrouded fan housing and 2) a large commercial industrial sealed motor. These features maximize fumigant mixing by maintain and extending maximum high velocity air flow.

Best Practices
1. Make sure the fan is in good working order by plugging it into an outlet and turning the speed control switch to the high setting and letting it run for a few minutes.
2. Determine the best position and angle for the fan (usually about 45°) and carefully tighten the side knobs to secure the shroud at that angle. (Figure 1)
3. Carefully extend the tube holder until it is perpendicular to the fan face.
4. Holding the tube between your thumb and forefinger, measure the appropriate amount of introduction tubing needed so that approximately 1/2" to 3/4" of the hose will extend from the holder perpendicular to the face of the fan. (Figure 2)
5. After determining the length of introduction tubing needed, thread the tubing through the rim guide then proceed through the lower hole of the holder that best matches the tubing diameter. There are holes to match either 1/8" or 1/4" tubing (Figure 2)

6. Carefully loop the tubing back through the higher matching hole of the holder leaving a tube end of a 1/2" to 3/4". Leaving a 1/2" to 3/4" loop in the tube between steps 5 & 6 provides the best result. (Figure 2) MAKE SURE TUBE IS NOT KINKED!
7. Once the tubing is in place, easily adjust the tube and holder until the tube is projecting outward and is perpendicular to the fan face. (Figure 2)
8. For applications of Vikane, place the chloropicrin pan – 1' directly behind fan.

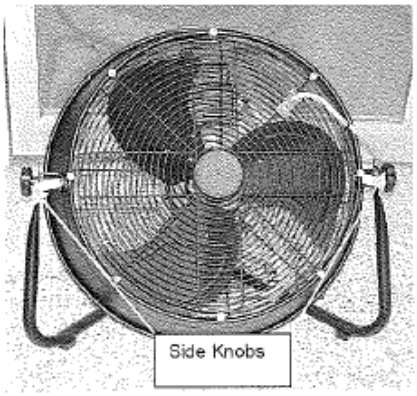


Figure 1

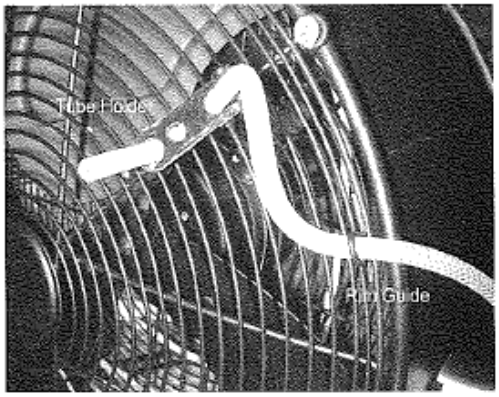


Figure 2

Model#	Description	Specifications	Lot Costs (as of February 2003)	
HVS-18A	18" TurboFlow Fan	6600CFM 1/3 HP Sealed Motor 2.7 Amp 3 Speed Settings SS Hardware Non-skid Pads	QTY 1-3 4-9 10-25 (Call King of Fans for current pricing.)	PRICE ~$ 69 ~$ 55 ~$ 50

Ordering Information
Orders and questions are processed through King of Fans at 1-800-330-2367. Your local fumigation/pest control product distributor of the TurboFlow fan may be able to handle orders or questions.
Contact:
King of Fans, Inc.
1921 N.W. 22 Street
Fort Lauderdale, Fl 33311
Krockenbach@kingoffans.com
(800) 330-3267 Toll Free
(954) 484-7602 Fax
Go to www.kingoffans.com for updates and additional ordering information.

Change of State

When water 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. A refrigerator or deep freeze works on the same principal; the evaporation of freon chills the cooling unit.

The following situations can be encountered when introducing Vikane. Included are suggestions on how to avoid them.

Frozen Valves and Hoses
When liquid Vikane is released from the confinement of the cylinder, it quickly expands into a gas because it boils at -55°C (-67°F). Like evaporating water, it absorbs heat from the surrounding material. The amount of heat needed from the air to evaporate 1 lb of Vikane is 20,460 calories. The loss of this amount of heat will chill 1000 cu ft of sea level air about 4.5°F for every pound of Vikane released.

If the valve is "just cracked" to reduce the rate of release, Vikane will expand from a liquid to a gas in the hose. When this happens, a chilling and consequent frosting of the outside of the valve and hose occurs. This is avoided by allowing full flow through the valve. The rate of flow of Vikane should be controlled by the ID and length of hose (see Tables 8a and 8b), and not be restricting flow through the valve.

Frozen Cylinders
If there is a break in the dip tube in the cylinder, Vikane in the gas phase will be discharged when the liquid level falls below that point. 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. Vikane will still be discharged, but at a slower rate because it is in the gaseous phase. Cylinders showing signs of a broken dip tube (a very rare occurrence) should be red tagged and returned to the distributor so that the problem can be corrected before refilling.

Liquid Vikane Spattering Out of Fumigant Introduction Hose
If Vikane is allowed to expand in the fumigant introduction hose, this chilling can be sufficient to prevent full vaporization of Vikane so that "super cold" liquid Vikane is splattered out of the hose. This can cause moisture stains, corrosion or other damage to objects it strikes.

Fog-Outs
Vikane will also take the heat needed for vaporization from nearby objects. If the drop in temperature of the object reaches the dew point of the surrounding air, 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 Vikane that the fog be controlled and dew formation be eliminated because liquid water absorbs the very small amount of impurities in Vikane and can result in accelerated corrosion or stains.

In addition, condensation forming on the photoelectric eye of a smoke detector can cause the smoke detector alarm to activate.

Releasing Vikane will cause some fog. A slow release and low humidity will cause less and a fast release and high humidity will cause more. After the fog forms, it in turn will evaporate at a rate that is dependent on the relative humidity and temperature of the fumigation atmosphere. Thus, 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 Vikane.

Fog-Out Prevention
There are several potential routes 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. Run air conditioner during wrapping of structure until the seal is complete. An air conditioner removes moisture from air as it passes through the unit. Do not open windows and tarp air conditioning compressor unit until the entire structure has been tarped. This will minimize condensation occurring when warm moisture-laden air contacts cooled interior surfaces.
3. Reduce the introduction rate with a smaller diameter hose, longer hose, or pulsed (interrupted) introduction.
4. Reduce the amount of Vikane introduced into one area by using multiple introduction sites. This would be most important for beetle and other in high-dosage fumigations.

5. Use multiple fans or larger fans to hasten the heat exchange.
6. Monitor the fumigation to reduce the overall fumigant requirements or extend the exposure period, if practical.
7. For difficult situations, 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 Fumiguide Calculator takes into consideration relative humidity and fan capacity in amps to recommend the fumigant introduction rate.

PRECAUTIONS WHEN INTRODUCING VIKANE

Safety

There are several safety concerns that arise when introducing Vikane.

Cylinder Safety
- Avoid "man-handling" the cylinder for weighing — use a hoist.
- 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 it and the fumigant introduction hose do not frost. Use proper size crescent wrench (10" to 12"). Keep attached to valve.
- Provide for frosting of the cylinder when releasing the last 3 to 5 lb of Vikane.
- Close valve securely when fumigant introduction has been completed or cylinder is "empty."

Fumigant Introduction Hose and Fittings
- Use hose with minimum burst pressure of 500 psi. Polyethylene or polypropylene hoses have proven satisfactory.
- Use care not to kink or crush the hose.

Personal Safety
- Wear eye protection when introducing Vikane in case of tube breakage.
- Have proper respirator protection (SCBA) on hand in case of required emergency entry into structure.
- Make security check for personnel and pets, and structure preparation.
- Use the proper safety equipment and procedures on the chloropicrin label when introducing the warning agent.

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 on fans.
- Place fans so they cannot cause damage to curtains, loose papers, pictures, lamps, etc. Personnel safety demands special attention as required when handling any toxic fumigant.

FUMIGANT INTRODUCTION SUMMARY

The method of introducing Vikane has a very important influence on the outcome of the fumigation. It has a significant impact on the efficacy as well as the profitability of the project. Outlined below are points that need to be considered when introducing Vikane.

1. The introduction methods used will agree with the need to develop a dose of sufficient ounce-hours for the working temperature to control the target pest throughout the structure.
2. Vikane should be introduced in a manner so as to be safe to personnel and property inside and outside of the fumigation space.
3. Equilibrium should be reached within an hour after Vikane is introduced in the building.

The following subjects need to be used in making judgments for introducing Vikane:

1. The structure
   a. Size

b. Configuration – open or compartmentalized; single or multi-story, etc.
c. Number and location of fumigant release locations
d. Type of seal – structure and soil
e. Pest (dosage requirements)
f. HLT
g. Working temperature
h. Relative humidity (interior)
i. Air conditioning
j. Others

2. Weather
   a. Temperature
   b. Humidity
   c. Wind

3. Vikane
   a. Dosage for required OH for pest
   b. Pounds Vikane for structure
   c. Pressure of release

4. Fans
   a. Capacity
   b. Number
   c. Air stream direction
   d. On/off
   e. Aeration needs

5. Fumigant introduction hose
   a. Size (ID) of hose
   b. Length of hose
   c. Placement and direction of outlet

6. Fumigant introduction
   a. Time of introduction
   b. Release – all at once or periodic "bursts"

Fumigant Introduction Checklist

- Number of fumigant release points (document on graph)
- Fan amps
- Hose diameter
- Hose length
- Protective sheeting under fumigant release points
- Pounds of Vikane released
- Time of introduction

ENTERING A STRUCTURE UNDER FUMIGATION

If emergency entry into a structure under fumigation with Vikane is required, the proper respiratory protection (SCBA) must be used.

FIRE FIGHTING

General Information

Vikane is not combustible. However, in temperatures exceeding approximately 400ºC (752ºF), Vikane will degrade to form hydrogen fluoride and sulfur dioxide. Theoretically, the number of ounces of

hydrogen fluoride per 1000 cu ft produced during a fire in a structure containing Vikane would equal 0.4x number of ounces of Vikane per 1000 cu ft [in temperatures exceeding approximately 400ºC, each mole (102 gm) of sulfuryl fluoride will degrade to form 2 moles (40 gm) of hydrogen fluoride]. Nonetheless, amounts of hydrogen fluoride actually produced during fires involving Vikane may be insignificant because Vikane rapidly diffuses from structures.

Warning Agent
Chloropicrin is used to aid in vacating a structure. Five to 10 minutes prior to introducing Vikane, chloropicrin is poured over cotton in a shallow container placed in the air stream of a fan. Chloropicrin is a non-combustible liquid and is not soluble in water. At temperatures exceeding 112°C (233°F), chloropicrin will degrade to form hydrochloric acid, phosgene, and oxides of nitrogen such as NO_2 and NO. The maximum concentration of chloropicrin used during fumigation with Vikane is 1 fl oz/10,000 cu ft, which equals 26 ppm. Due to the small amount of chloropicrin present during fumigations, the amount of decomposition products of chloropicrin formed during a fire would be insignificant.

Protective Clothing
Self-contained breathing apparatus and normal "turn-out" gear should be worn when fighting fires in structures under fumigation with Vikane.

Cylinders of Vikane
Vikane is packaged as a gas under pressure in cylinders; thus, cylinders contain both gas and liquid. Cylinders containing Vikane are designed not to explode in high temperatures. A fusible plug in the cylinder valve body melts at 158 to 165ºF releasing the contents of the cylinder.

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 SO_2 formed by decomposition of Vikane in the flame. Water also can be used to cool cylinders of Vikane and prevent discharge of the product caused by melted fusible plugs. Avoid runoff into waterways if possible. The toxicity of Vikane in water for fish is unknown.

Protective Clothing for Fires Involving Cylinders of Vikane
Self-contained breathing apparatus and encapsulating protective suits should be worn when fighting fires in atmospheres containing potentially high concentrations of Vikane. Protective suit material should be compatible with exposure to hydrofluoric acid.

MONITORING VIKANE 9

Measurement of the accumulated dose of a fumigant becomes increasingly valuable as the structure size, cost, and likelihood of refumigation increase. The goal in monitoring fumigant concentration is to measure the actual HLT (vs. estimating the HLT). This allows the operator to introduce less fumigant than that of a non-monitored fumigation, make dosage corrections, if necessary, and ensure a successful fumigation.

Monitoring fumigant concentration can provide important information to the fumigator regarding the placement of fumigant/warning agent 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 large or multi-unit structure to be fumigated.

SPECIFIC GUIDELINES FOR MONITORING THE TYPICAL RESIDENTIAL FUMIGATION

1. Monitor Vikane in spaces most representative of the atmosphere in the structure. In homes of average size, with good continuous air circulation a sampling of the large gas reservoir in the living space may be sufficient. In larger jobs, more sampling points may be necessary.
2. In structures with partitions or poor air circulation, samples should be taken from the separate sections, such as living space, sub-section, attic; each floor of multiple story structures; each unit in structures such as apartment buildings.
3. Vikane should be circulated so as to reach equilibrium rapidly, ideally within an hour of introduction.
4. Measurements should be as dependable and accurate, especially when low concentrations are involved, as in the case in large structures.
5. The time required between measurements to determine the HLT will depend on the estimated HLT. Usually two to four hours will be sufficient, but in the case of very large structures or excellent HLTs, more time may be required.

EQUIPMENT

Fumiguide Calculator

The Fumiguide Calculator can be used for both non-monitored and monitored fumigations. The Fumiguide Y may also be used for monitored fumigations.

Monitoring Hoses

For sampling Vikane concentrations, arrangements should be made to place sampling hoses in the structure before the fumigant is introduced. Clear vinyl hoses (1/4" to 3/8" ID is commonly used) should be placed so as to sample representative concentrations with a Fumiscope.

Monitoring lines should be placed on all levels of the fumigated structure, including attics and subflooring, if accessible. At least half of the lines should be placed in rooms/areas distant from the fumigant introduction point. If the structure is compartmentalized into separate towers, wings, or other sub-units, place lines in areas representative of different units.

The time for HLT determination starts only after equilibrium of Vikane usually one hour within completion of introduction) has been established. After that time it is usually desirable to draw samples from the main reservoir (living section) as well as the sub-area and attic crawl sections. If very good distribution methods are used, then a single sampling site can be considered.

Recommendations on monitoring hose placement and use are as follows:

1. When using more than one monitoring hose, label exterior end of hose with sample location before running the hose outside the structure.
2. When running the hose through an open window, secure the window so it will not accidentally close and constrict the monitoring hose during the fumigation. Secure interior doors so they do not close when fumigation fans are turned on or they may construct the monitoring hose as well as prevent rapid equilibrium.
3. Generally, sampling hoses are placed to sample at mid-level (three to four feet above the floor). The ends of the sampling hoses can be secured to stable objects in a manner such that the sampling hoses are not constricted and the objects will not be damaged.
4. After placement, monitoring hoses should be checked for airflow using the Fumiscope or a vacuum pump. Confirm that electricity is available to operate monitoring equipment during the fumigation.
5. Capping the ends of the monitoring hoses when not in use with tape or plugs will prevent moisture from collecting within the hose. When not using the hose, and before leaving the fumigation site, it is advisable to roll up the hose and place it in an inconspicuous area, such as under loose tarp ends or behind shrubs. This may help prevent unauthorized persons from tampering with the hoses.

Fumiscope

Fumigant concentration measurements are made by a thermal conductivity unit, the Fumiscope. The Fumiscope is designed to measure the actual concentration of Vikane within the fumigation site. It is not sensitive enough to use as a clearing device after the fumigation. The Fumiscope can be used in conjunction with the Fumiguide calculator(s) for determining actual HLTs.

The units are portable and weigh approximately 8 lb. The Fumiscope uses a cell to compare the thermal conductivity of a mixture of Vikane and dry air to that of dry ambient air. This difference is converted into an electric current, which is displayed as oz per 1000 cu ft on the meter. 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** has a digital readout and indicates 0 to 1000 oz per 1000 cu ft. 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 to 50 oz per 1000 cu ft. The model E-200 has a range of 0 to 100 oz per 1000 cu ft.

Units 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: (727) 572-1159
Fax: (727) 572-4595
e-mail: keychem@ij.net
website: www.Fumiscope.com

Operating Procedure

1. Fill drying tube with Drierite (4 to 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 to 15 minutes depending on the humidity), adjust the flow rate to approximately 1 cu ft per hour (CFH) and "zero" the instrument.
4. Attach sampling hose (usually 1/4" tubing) and readjust the flow rate if necessary to the same rate in Step 3.

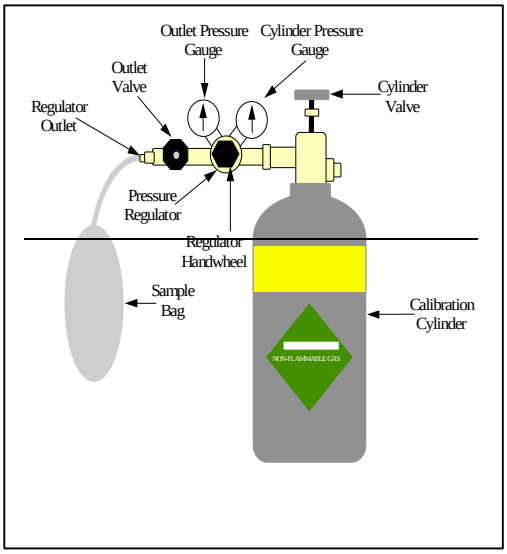
5. Wait at least 3 minutes for a monitoring line of 100 feet or less for the sample to reach the Fumiscope and the reading to stabilize before recording the concentration.
6. Disconnect the tubing and adjust the flow rate to the original setting and check to be sure the unit returns to "zero" - if not, 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 300 to 400 F for 20 to 30 minutes then return it to the bottle while still slightly warm.)

Calibration Procedure

Small sample cylinders containing known concentrations of Vikane 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 calibration of the Fumiscope 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
e-mail: sales@scottmarrin.com

Adjusting 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 handwheel (turn to left).
4. Open cylinder valve approximately 1/2 turn.
5. Turn regulator valve clockwise until outlet pressure gauge reads 3 to 5 psi.
6. Close cylinder valve and open regulator valve to bleed regulator.
7. Repeat steps 3 through 5.
8. Attach sample bag to regulator outlet and slowly open outlet valve to fill bag approx. 90% full. Do not overfill as bag will burst.
9. Disconnect sample bag from regulator and connect to Fumiscope inlet.

10. Read Fumiscope meter for concentration of calibration of Vikane. If the concentration on the meter is more than 5% different from the actual concentration, remove the bag, re-zero the Fumiscope and repeat the measurements.

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

1. Wait 2 to 3 minutes and then adjust the meter to the gas concentration with the appropriate "pot."
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" (blue disks) along the top of the circuit board. The disk on the left (when facing front of panel) adjusts the scale for Vikane. 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 Vikane only, the MeBr pot should not be touched and only the pot for Vikane 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 Vikane, 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 to 15 minutes depending on the humidity).
2. Zero - Frequently re-align meter to zero.
3. Flow rate - Keep flow rate at 1 cu ft/hour. Check 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 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.

Repair Procedure

Contact the manufacturer.

Fumiscope with Internal Drying System

September 2001 will include a new internal drying system. This new (patent pending) system makes the instrument much more accurate and convenient by eliminating the sample humidity fluctuation. This

new system allows Fumiscope operation for hours, even days, without the need to re-zero the unit due to changes in humidity. This new system can be retrofitted into older model D Fumiscopes.

The external glass drying tube and the use of Drierite have been eliminated. In place of the drying tube is a filter, which is attached to the inlet fitting of the instrument panel. The filter is designed to keep the new drying system from being damaged. The filter should last for years as long as the sample tubes are clean and moisture free. The filter should be changed if the flow meter can not be adjusted to read 1.0 CFH or moisture is present in the filter. The filter has no effect on drying or readings.

The sample line should be attached to the inlet side of the filter to obtain a reading after the instrument has been allowed to warm up (10 to 15 minutes) and the meter has zeroed.

Fumiscope with Calibration Access Ports

Model D Fumiscopes manufactured after September 2001 will also have three calibration access holes in the top of the case. This will allow for calibration without the need to disassemble the instrument.

The procedure for Fumiscope Model D Calibration with access ports is as follows:

1. To calibrate the new instrument, locate the three rubber plugs on the top, outside of the case. Gently remove the rubber plugs with a small screwdriver.
2. With the instrument powered ON and warmed up (10 to 15 minutes), place the panel zero adjust knob in the center of its span. Disregard the meter reading at this point.
3. With a small screwdriver at least 2.5" long, insert the screwdriver in the hole at the right side of the instrument.
4. Turn the adjuster to make the panel meter read zero.
5. Place the screwdriver in the center adjustment hole and place the front panel switch in the Vikane position.
6. Re-zero the meter using the front panel adjustment to read zero if necessary.
7. Place the gas sample on the inlet filter and observe the panel meter. When the meter reading does not change for 15 seconds, turn the screwdriver and adjust the meter to the correct reading.
8. Remove the gas sample and the unit should return to zero.
9. Replace the rubber plugs in the top of the case. This completes the calibration.

MONITORING A LARGE FUMIGATION

In general, monitoring lines should be placed on all levels of the fumigated structure, including attics and sub-areas if accessible. At least half the lines should be placed in rooms/areas distant from fumigant introduction points. If the structure is compartmentalized into separate towers, wings, or other sub-units, place lines in areas representative of different sub-units.

If time permits, monitoring can be conducted in a manner so that the exact amount of Vikane required is introduced based on the measured HLT. This type of precision fumigation is conducted by initially introducing part (i.e., one-half) of the calculated dosage of Vikane, monitoring to determine the actual HLT, and then introducing additional Vikane to achieve sufficient ounce-hours in the time remaining for the fumigation.

Construction of a manifold can significantly speed the process of taking concentration readings, as can the use of auxiliary air pumps to purge multiple monitoring lines.

MONITORING SCENARIOS

Following are descriptions of situations in which the Fumiguide Calculator and Fumiscope are used to monitor fumigant dosage and determine what, if any, action is required to ensure a successful fumigation.

Situation 1 Verify Required Ounce-Hours Achieved

In drywood termite fumigation, your conditions are as follows:

Dosage	1x
tarp	good
seal	medium
wind	5 mph
volume	30 Mcf
underseal	slab
temperature	70°F
hours exposure	20

Using a non-monitored dose calculation, you arrive at an estimated HLT of 24.8 hours and a dosage of 8.5 oz/Mcf, or a total or 15.9 lb. The required oz/hrs are 97.7 for that temperature.

A good use of monitoring in this situation would be to take an equilibrium concentration and one fumigant concentration measurement just prior to breaking the seal (a terminal concentration). In this way, you could be certain you accumulated adequate oz/hrs.

first reading	9 oz/Mcf
second reading	4 oz/Mcf
time between readings	19 hr
actual HLT	16.2 hr
action required	none-job finished

In this case you introduced the non-monitored dosage but entered the job in the Fumiguide Calculator as monitored. That way, you were able to enter the equilibrium and terminal fumigant concentrations and determine that although the HLT was shorter than estimated, the appropriate oz/hrs had been accumulated and the job was finished on schedule.

Situation 2 Additional Fumigant Required

In drywood termite fumigation, your conditions are as follows:

Dosage	1x
tarp	good
seal	medium
wind	5 mph
volume	30 Mcf
underseal	sand
temperature	70°F
hours exposure	20

This time, you introduced the monitored dosage, giving you an estimated HLT of 2.1 hours and the dosage of 32.5 oz/Mcf, or 61 lb. You measure the fumigant concentration at equilibrium (one hour after introduction) and again two hours later to measure actual HLT. You placed two monitoring hoses in two different areas of the structure to double-check that equilibrium was achieved and maintained.

first reading	40 oz/Mcf
second reading	12 oz/Mcf
time between readings	2 hr
actual HLT	1.2 hr
action required	add 32.1 lb

Your HLT in this case was significantly shorter than what was estimated, and the calculator responds by advising you to add fumigant in order to achieve control in the time allowed.

Situation 3a Function 2 Non-Monitored

An advanced function of the Fumiguide Calculator allows you to compensate in the case of a "blow-open" in which you have complete, or almost complete, loss of fumigant during the exposure period. This function asks you for the number of hours exposure before the blow-open, the number of exposure desired to finish the job, and, for monitored jobs, the concentration remaining in the structure at the time the situation has been corrected (i.e., the tarps closed and sealed).

Function 2 on the Fumiguide Calculator can be used for both monitored and non-monitored jobs. The first scenario involves a non-monitored job in which the conditions are as follows:

Dosage	1x
tarp	good
seal	medium
wind	10 mph
volume	30 Mcf
underseal	clay
temperature	70°F
hours exposure	20

In this case, the calculator provides an estimated HLT of 13.9 hours and a dosage of 10.3 oz/Mcf or 19.3 lb. Let's say, though, that your tarps blew open 6 hours into the exposure period. After re-sealing the tarps, you have 8 hours to finish the job. To use function 2 you must re-enter the job in the calculator. Immediately after the calculator responds with dosage information, press the FUNCT (function) button, followed by 2. When you enter the appropriate information, the calculator responds by advising you to add 21.9 lb of fumigant to complete the job within the next 8 hours.

Situation 3b Function 2 Monitored

In the previous example the calculator's response is based on the assumption that the estimated HLT was accurate. If you had monitored the job, you would have verified the HLT. In addition, following re-sealing the job, you would measure the remaining fumigant. After entering the first and second readings and determining the actual HLT of additional hours required and hours remaining, press FUNCT followed by 2 and enter the appropriate information.

first reading	11 oz/Mcf
second reading	10 oz/Mcf
time between readings	2 hr
actual HLT	14.5 hr
initial hours exposure	6
hours remaining	8
oz/Mcf remaining	2

The calculator responds that 7.6 lb of fumigant are needed to complete the job within the 8 hours remaining.

AERATION PERIOD 10

One of the outstanding features of Vikane for structural fumigation is its great ability 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 the fumigants, they are excellent aids in attaining rapid aeration and are essential where cross ventilation is poor, such as in basements.

When first preparing the fumigation, plan ahead for the aeration period and take steps to aid in aeration by strategic placement of fans and by placing seams away from outdoor plants. Opening operable internal doors, internal openings to attics and sub-areas, storage chests, cabinets, drawers, closets and appliances such as washing machines, dryers, dishwashers and ovens, and other enclosed areas is a label requirement designed to facilitate aeration. Refrigerator and freezer doors may be left open if the units are turned off, but if they remain closed for the fumigation, they will need to be opened during clearing.

FACTORS INFLUENCING AERATION TIME

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 time for the reduction in fumigant concentration to occur is designated HLT. 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 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. After the customary exposure periods of 20 to 24 hours for drywood termite fumigation, terminal concentration of 2 to 8 oz per 100 cu ft (500 to 2000 ppm) are most common; however, they may be as high as 32 oz per 1000 cu ft (8000 ppm) or higher when short exposures are used or when fumigating for beetles at elevated rates. All other factors being equal, the greater the terminal concentration, the longer the time required to complete aeration.

Temperature

Temperature will have a direct effect on the clearance rate of a fumigant because higher temperatures increase the rate of gas diffusion and desorption.

Load Factor — Sorption, Desorption and Diffusion

The "load factor" can be expressed as the amount of fumigant sorbed by the materials being fumigated and thus made unavailable to act as a fumigant. Vikane has relatively low sorbitive characteristics and fumigant "loss" due to sorption is not substantial enough to affect the success of the fumigation. The sorption that does occur, however, can affect aeration in some situations when desorbing since it is necessary to achieve and maintain air levels of $\leq$1 ppm. In residences, the greatest amount of Vikane to be desorbed is associated with synthetic materials such as polystyrene insulation and certain other synthetic polymer materials.

The low sorption and non-reactivity of Vikane with structural components and household items are extremely favorable properties for rapid aeration.

The sorption/desorption phenomenon is a function of fumigant concentration — 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 the tents are opened. Research has shown, however, that fumigant concentrations within a structure may rise due to desorption of the fumigant from the structure and its furnishings as well as diffuse from internal voids, such as wall voids. This process continues after the fumigant has been ventilated from the living areas of the structure.

The aeration procedures described on the label for Vikane prevent accumulation of more than 1 ppm of the fumigant after the structure has been created for re-entry.

AERATION PROCEDURES

Aeration procedures available to the fumigator may vary depending on the state. Refer to the label registered in the state or your representative from Dow AgroSciences LLC for further information.

Aeration Procedures 1 and 2 are as follows:

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

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

Aeration Procedure 1

These steps must be completed in sequence.

Step (1): Aerate structure with all operable windows and doors open, aided by the use of one or more fans, for a minimum of 1 hour. Total fan capacity, using one or more fans, shall be capable of displacing a total of 5000 cfm.

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

Step (3): After the minimum 6-hour waiting period, measure the concentration of Vikane in breathing zones of each room. If the concentration of Vikane is greater than 1 ppm, ventilate structure with operable doors and windows open and confirm concentrations are 1 ppm or less before the structure is reoccupied.

Aeration Procedure 2

These steps must be completed in sequence.

Step (1): Aerate structure with all operable windows and doors open, aided by the use of one or more fans, for a minimum of 1 hour. Total fan capacity, using one or more fans, shall be capable of displacing a total of 5000 cfm.

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

Step (3): After the minimum 8-hour waiting period, measure the concentrations of Vikane in breathing zones of each room. If the concentration of Vikane is greater than 1 ppm, ventilate structure with operable doors and windows open and confirm concentrations are 1 ppm or less before the structure is reoccupied.

Both aeration procedures require the fumigator to aerate the structure with operable doors and windows open and with the aid of one or more fans for a minimum of one hour before securing the structure and allowing a total of six or eight hours of aeration for Procedures 1 and 2, respectively. This time will be adequate to allow for diffusion to occur and prevent fumigant levels from exceeding 1 ppm following

clearance, even under worst-case conditions in which ventilation systems are turned off and all doors and windows closed. If the one hour of active aeration is exceeded, then the extended aeration period may be decreased by a corresponding time. For example, if the active aeration period lasted two hours, an additional minimum four-hour aeration with the structure secured would be required for Aeration Procedure 1. The fumigator may increase the extended aeration period beyond a total six to eight hours for ease in scheduling. Without exception, however, the product label for Vikane requires at least one hour of active ventilation prior to resecuring the structure for extended aeration when using Procedures 1 and 2.

At the conclusion of the aeration period, the structure must be tested with an approved detection device of sufficient sensitivity such as the INTERSCAN, MIRAN [SapphlRe] or Spectros ExplorlR gas analyzers to confirm a concentration of Vikane of 1 ppm or less in the breathing zones or each room. Breathing zones are defined as areas within the structure where individuals typically stand, sit or lie down. If the concentration of Vikane is greater than 1 ppm, further aeration and re-testing is required. Note that until the final clearance is obtained, the structure is still considered under fumigation and appropriate precautions are to be taken.

SAFETY CONSIDERATIONS AT AERATION

Two persons trained in the use of this Vikane must be present at the time of the initiation of aeration. The "opening" of a fumigation should be carried out so the exposures to Vikane are as minimal for the opening crew as for neighbors or non-target areas. In general, the following steps will help to prevent non-target exposure.

Open the downwind side of the tarps or building first. Then, open the upwind side.

If entry into the fumigation space is necessary before the initial one-hour aeration procedure is complete or when concentrations are unknown, use proper respiratory equipment.

Do not work (fold tarps, etc.) downwind next to a fumigation until the concentration of Vikane reaches 1 ppm or less.

When opening fumigations, start the aeration slowly so plants and other non-target areas are not overexposed. If possible, open seams initially over driveways and/or other open areas to prevent plant damage. When aerating high concentrations, such as fumigations for beetles, allow the bulk of the fumigant to escape from the tent through opened seams before continuing to work around the structure. During the initial one hour aeration procedure, approved respiratory protection must be worn until the concentration of Vikane is confirmed not to exceed 1 ppm with an approved detection device.

Clearly marked warning signs must remain posted on the structure at each entrance until the concentration of Vikane is determined to be 1 ppm or less in the treated site as determined using a detection device of sufficient sensitivity. This includes time allowed for extended aeration, as required by the product label for Vikane. Only a certified applicator may authorize the removal of the warning signs. Consult your local authorities for instructions regarding documentation of clearance such as posting clearance notices.

REMOVING CLAMPS, TARPS AND/OR TAPE

The sequence for opening the seal should be as follows:

Tarp Seal

1. Open downwind seam by removing clamps and folding tarps back.
2. Open upwind seam in similar manner.
3. Remove weights (i.e., sand or water snakes) and clamps.

4. Drop tents. Peeling tarps off the structure, keeping tarp between the worker and the building, has been shown to reduce worker exposure to fumigant confined in the space between the building and the tarp. This is best accomplished by working in pairs consisting of roof and ground workers.
5. Turn on fans and reposition, if necessary, to facilitate aeration. If entering the structure to turn fans on and/or reposition them, respiratory protection is necessary.
6. Aerate and verify concentrations of Vikane according to the procedures detailed on the product label for Vikane.

Tape and Seal

1. Remove exterior tape and seal materials from doors and windows; open structure from outside, where possible.
2. Put on proper respiratory protection (SCBA); enter structure to open remaining doors and windows.
3. Turn on and, if necessary, reposition fans.
4. Aerate and test according to the procedures detailed on the product label for Vikane.

COMMON CHLOROPICRIN COMPLAINTS

Fumigators are most likely to find chloropicrin in a building at the end of the aeration period during the winter months. Cold, wet weather makes chloropicrin much more difficult to aerate from a building.

The following procedures were added to the label for Vikane to aid in aerating chloropicrin:
- Open all operable attic doors and accesses and direct a fan into the attic.
- If the structure has an attached garage, the door between the garage and structure should be open.
- If the structure has a central air handling system, the fan (or blower) should be activated for each unit if operational. As an alternative, a fan may be placed in front of a furnace inlet to blow air into central heating and cooling ducts.

Chloropicrin complaints are more common in houses that are cluttered with goods. Examples are houses or garages filled with boxes of items and small rooms with lots of furniture (especially leather or down). Chloropicrin complaints are more common on same day clears. Chloropicrin complaints are more common with modern office buildings that do not have windows that open reducing the ability to ventilate the structure. It can be beneficial to place fans in the corners of these buildings and run ducting towards an entrance. The use of ducting can help force proper ventilation. Chloropicrin complaints also occur in enclosed areas that are difficult to aerate. Examples are bank vaults, small utility rooms, and houses that are tightly constructed with dead air space.

CLEARING THE STRUCTURE.....11

After a fumigation, it is essential no occupant re-enter the home, vehicle, or other fumigation site until the fumigant has been aerated and the site has been tested for fumigant clearance.

Following the aeration period, the fumigator must test the breathing spaces in the structure to make certain that the concentration of Vikane is 1 ppm or less before allowing reoccupation of the structure.

DETECTION OF FUMIGANT

No one should enter the treated area if the level of sulfuryl fluoride is unknown or >1 ppm unless provided with a NIOSH or MSHA approved respiratory protection device (positive pressure SCBA or combination air supplied/SCBA respirator).

Before occupants re-enter the site, it must be "cleared," indicating that the fumigant has been reduced to a level of 1 ppm or less and maintained at or below that level. It is the responsibility of the licensed fumigator to measure the concentration of Vikane using a detector with sufficient sensitivity such as the ones described below.

Aeration is not considered complete until the level of sulfuryl fluoride has been determined to be no greater than 1 ppm with an appropriate detection device. Warning signs must remain posted on the structure at each entrance until aeration is determined to be complete.

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 reentry and leak detection. **(Note: 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 SO_2 which then passes through an SO_2 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 to 50 ppm sulfuryl fluoride
Accuracy:	±1 ppm
Warm-up Time:	Approx. 10 minutes
Response Time:	90% of response within 120 seconds
Dimensions:	8.5H x 7W x 12.75D inches (216 x 178 x 324 mm)
Weight:	8.5 lb. (3.9 kg)
Power:	24 volt DC. Two external 12-volt, rechargeable batteries or AC power supply with 50 ft cable on output side.
Operation Time:	The battery pack can operate the instrument for up to 70 minutes before recharging (recharge overnight).
Valid Calibration Period to Specifications:	Within 30 days of use
Manufactured By:	Interscan Corporation 21700 Nordhoff St. P.O. Box 2496 Chatsworth, CA 91313-2496 1-800-458-6153 fax: (818) 341-0642 e-mail: service@gasdetection.com website: www.gasdetection.com

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

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.
5. After the "ready" light comes on, adjust the meter to 20 ppm in ambient air using the zero knob. Observe the needle for about 2 minutes and look for any drifting of the pointer. If it has drifted more than 3 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.
6. Adjust the meter to read "zero" using the zero knob.
7. 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.
8. Recharge batteries overnight.

Calibration Procedure

Small sample cylinders containing known concentrations of Vikane of about 5 ppm 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 3 to 5 psi.
6. Close cylinder valve and open regulator valve to bleed regulator.
7. Repeat steps 3 through 5.
8. Attach sample bag to regulator outlet and slowly open outlet valve to fill bag approx. 90% full (do not overfill as bag will burst).
9. Disconnect sample bag from regulator and connect to analyzer.
10. Wait 2 to 3 minutes and then adjust the meter to the gas concentration with the SPAN adjust.
11. Remove the bag and allow the meter to return to zero. If it does not return to zero, re-zero it and re-calibrate.

Pyrolzer (Furnace)

- Average lifespan - 3 to 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 SO_2 sensor. If the pump stops, there are no leaks.

SO_2 Sensor
- Average lifespan - 3 to 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: (727) 572-1159
Fax: (727) 572-4595

Interfering Gases of the Interscan Analyzer GF1900

No analytical method is totally specific. Various gases may affect instrument response. The chart below shows common chemicals documented by Interscan Company to interfere with the accuracy of the Interscan Analyzer GF1900. These chemicals can be found in laboratories, animal rearing facilities, medical or manufacturing facilities. An SO_2 scrubber is available to remove these chemicals before the SO_2 sensor detects them.

Chemical Formula	Chemical Name	Application
Cl_2	Chlorine Gas	Manufacturing processes Bleaching & Disinfecting Water purification
CO	Carbon Monoxide	A reducing agent in metallurgical operations
HCl	Hydrogen Chloride	Manufacturing of pharmaceuticals Used in various organic and inorganic chemical processes
HCN	Hydrogen Cyanide	Was used as a pesticide
H_4N_2	Hydrazine anhydrous	Reducing agent Rocket fuel
H_2S	Hydrogen Sulfide	Manufacturing of other chemicals Analytical reagent Metallurgy
NH_3	Ammonia	Manufacturing of other chemicals and products (explosives, synthetic fibbers, fertilizers, etc.) Refrigeration
NO	Nitric Oxide	Manufacturing processes Bleaching agent Stabilizer for other chemicals
NO_2	Nitrogen Dioxide	Oxidizing agent Manufacturing processes Has been used to bleach flour
SO_2	Sulfur Dioxide	Preserving fruits, vegetables, etc. Disinfectant in breweries and food factories Bleaching agent fabrics and foods Solvent

Sulfur Dioxide Scrubber for the Interscan GF1900 (Vikane Gas Monitoring Instrument)

Background

A scrubber was developed to remove ambient sulfur dioxide (SO_2) from air samples. This scrubber must be used any time the operator suspects that SO_2 is present in the environment. SO_2 is used as a preservative in many food products such as dried fruits (raisins, figs, etc.).

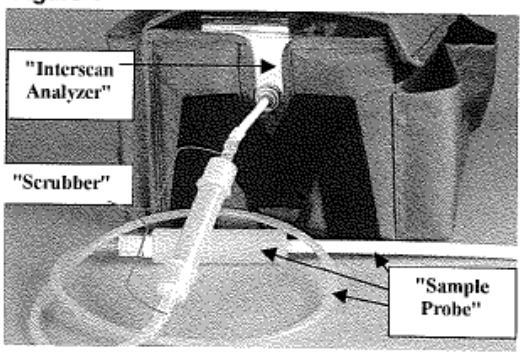
The Interscan Monitoring Instrument for Vikane utilizes a special furnace which converts sulfuryl fluoride to SO_2. The sensor in the Interscan analyzer measures SO_2, then displays readings on a scale of 0 to 50 parts per million (ppm).

Certain applications exist in which SO_2 concentrations would affect the instrument's ability to correctly measure sulfuryl fluoride. SO_2 in the sampling area would be added to the SO_2 produced in the furnace, resulting in an erroneously high reading for the fumigant concentration.

Method of Use

1. Install the scrubber (Catalog # 158-VK) between the sampling probe (SP-12-T) and the inlet of the instrument (GF1900). (Figure 1)

Figure 1

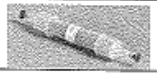


2. The scrubber should be checked before each use. If most of the pellets inside the tube have turned brown, from their original purple color, it is time to change the scrubber chemical (Purafil). To do

this, open the scrubber tube at one end, and pour out the used Purafil into a double plastic bag. Take care not to lose the screen and retainer! Small amounts of Purafil can be disposed of in your normal trash. Then, pour in new Purafil and re-assemble the scrubber tube.
3. Power up the instrument using proper operating procedures (with AC power supply or battery pack).
4. The instrument MUST be calibrated with the scrubber installed. (Follow the calibration procedures described earlier in this chapter.)

For further details, please contact:
Interscan Corporation
PO Box 2496
Chatsworth, CA 91313-2496
1-800-458-6153
Fax: (818) 341-0642
e-mail: service@gasdetection.com
www.gasdetection.com

Ordering Information

DESCRIPTION	CATALOG #	IMAGE	PRICE (As of February 2003)
Sample probe with tubing	SP-12-T		$ 45.00
Purafil scrubber tube (10 cm)	158-VK		$ 53.00
Special sample probe with Purafil tube in-line	SP-12-T-158-VK		$ 105.00
1 pound of Purafil in bulk, supplied in sealed bag	158-VK-1LB		$ 22.50

Miran SapphIRe

The **Miran SapphIRe** utilizes a single beam, infrared detection technology to directly measure low concentrations (0 to 5 ppm) of sulfuryl fluoride. (Note: The **Miran 203** and **Miran 101**, previously used to measure low concentrations of sulfuryl fluoride, have been discontinued and are no longer being serviced by Thermo Fisher Scientific.)

Specifications

Sensitivity:	1 ppm (minimum)
Accuracy:	±5% of reading
Response Time:	90% of response within 18 seconds
Power:	Internal, rechargeable NiCd; provides 4 hours of operation; recharges in 4 to 6 hours
Alarm:	User defined
Dimensions:	7.6D x 14.4L x 21.8W inches (193 x 365 x 553 mm)
Weight:	24 lb (10 kg) including battery
Valid Calibration Period to Specifications:	1 year

Manufactured by:
Thermo Fisher Scientific
27 West Forge Parkway

Franklin, MA 02038
Phone: (508) 520-0430
website: www.Thermo.com

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

Calibration Procedure
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 cylinder of Vikane.
4. Place end of 3/16" Tygon tubing in container of water.
5. Turn on cylinder valve and use needle valve to adjust the flow of Vikane 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 Vikane (13 microliters (µl) = 5 ppm[†]) from the tubing on the cylinder of Vikane 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.

Spectros ExplorIR

The Spectros ExplorIR is a rugged, portable monitor to detect low level (0 to 5 ppm) concentrations of sulfuryl fluoride for clearing structures. The monitor utilizes a unique infrared detection technology to directly measure sulfuryl fluoride. The monitor contains an internal purge air bag which is used to automatically re-zero readings. The purge air bag must be refilled with fresh air about every 30 minutes of detector operation. Calibrations are fixed and require no user adjustments. The digital display is backlit for ease of reading low light.

Specifications

Warm-Up Time:	15 minutes
Operating Time:	30 plus minutes before the purge air bag need refilling
Sensitivity:	1 ppm (minimum)
Accuracy:	±1 ppm (0 to 10 ppm range)
Response Time:	90% of response within 5 seconds; 100% in 7 seconds
Power:	DC power pack provides at least 8 hours of operation
Alarm:	Red light flashes when the detected gas lavel reaches the alarm level (alarm level factory set at 5 ppm)
Audible Alarm:	Internal audible alarm activated when a gas alarm (5 ppm) occurs
Dimensions:	8D x 19L x 5W inches (203 x 483 x 127 mm)
Weight:	Less than 9 lb (4 kg) including battery
Valid Calibration Period to Specifications:	6 months

Manufactured by:
Spectros Instruments, Inc.
4 Evergreen Lane, #12A
Hopedale, MA 01747
Phone: (508) 478-1648
Fax: (508) 590-0262
website: www.SpectrosInstruments.com

Operation
Read the manual for the Spectros ExplorIR for complete operating directions before using the detector. The manual is available on line. General operating directions are as follows:

1. To turn ON the monitor, first lift up the shield located in front of the handle and then press the red power ON/OFF toggle switch.
2. Once the monitor has been turned ON, allow it to warm up for 15 minutes, after which press the ENTER button to fill the purge air bag with clean, fresh air that is of the same temperature and humidity as the area being checked for gas. DO NOT fill the purge air bag in an area that is contaminated with sulfuryl fluoride gas.
3. After the purge air bag has been filled, the monitor will automatically start making measurements in the area being sampled. The results of those measurements are displayed on the front panel display.
4. MEASURE indicates when the monitor is actively measuring gas. The screen to the left shows that currently 2 ppm of sulfuryl fluoride gas is being detected. The measurement cycle runs for 4 minutes. A log of up to 200 previous measurements can be viewed using the PPM LOG function.
5. PURGE indicates when the monitor is resetting its infrared detector to a baseline of 0 ppm using the air stored in the internal purge air bag. The purge cycle runs for 10 seconds.

Calibration
The Spectros ExplorIR can only be calibrated by service providers authorized by Spectros Instruments. Contact Spectros Instruments, Dow AgroSciences or your distributor representative for Vikane for information on service providers for the Spectros ExplorIR.

Other Units

As new technology is developed, new devices may be developed to detect Vikane. 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 Vikane. 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.

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.

Follow all federal, state, and local requirements.

CHAMBER FUMIGATIONS 12

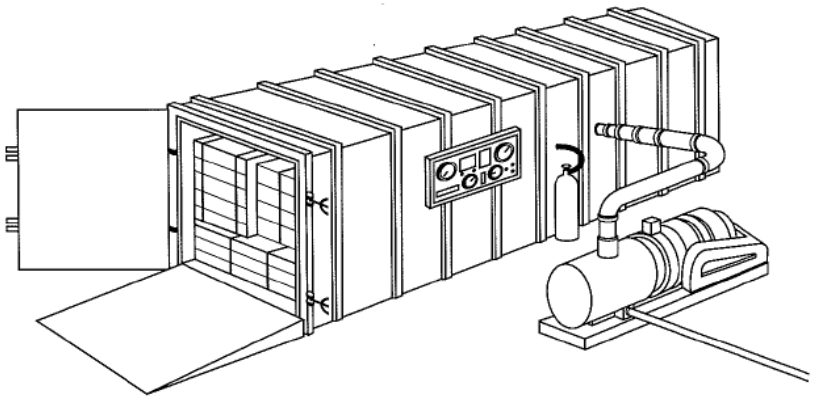
Maximum results with a minimum amount of fumigant can best be achieved by chamber fumigation. Precise control over the fumigation of a wide variety of pests can be accomplished in chambers especially constructed for this purpose. Fumigation in either vacuum or atmospheric chambers cuts fumigant costs, since it eliminates the necessity to disperse the fumigant in large empty areas of storage buildings.

Vikane 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.

VACUUM CHAMBERS

Specially built steel chambers provide the fastest and most effective fumigation. After the material to be fumigated is placed in the chamber, air is evacuated by pumps. Vikane is admitted which rapidly penetrates all space previously occupied by air.

A lethal concentration of gas results when the proper ounce-hours are maintained for the required fumigation period. With the sustained concentration (no leakage) and a vacuum of from 25 to 27 inches Hg, the time of exposure and the dosage can be reduced.



ATMOSPHERIC CHAMBERS

For low cost fumigation, a suitable chamber can be constructed. It consists of a gas-tight room with an appropriate door and a minimum of equipment. An applicator, 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 maintain at least a 60°F (16°C) temperature during fumigation. Open flames or hot elements (752°F plus) cannot be used as they will cause the sulfuryl fluoride gas to decompose. Certain well built truck bodies have been successfully converted to efficient atmospheric chambers. Temporary tarp chambers may also be used. In addition, B & G Equipment Company (Plumbsteadville, PA) is currently marketing a mini-fumigation bubble developed by Rentokil that may be useful for fumigating small items.

REQUIREMENTS FOR EQUIPMENT

The requirements for equipment to be used with Vikane are similar to those used with methyl bromide.

Atmospheric Chambers

Construction details of a typical atmospheric chamber are given in Figure 12a. This construction needs to be altered to fit the conditions under which the fumigation chamber is to be used. If the chamber is to be loaded with large, heavy packages, it may be advisable to add a protective sheeting behind the inside

lining. 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.

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. Do not locate chamber in an occupied building.

In the construction of the chamber (see Figure 12a), two openings are provided: the large loading door and the small vent door. The vent door is hinged at the back and provided with a counterweight on the front edge. A rubber strip seal is used around the edge. The door is closed by a light cable and pulleys. It is held in place by clamps to provide a final seal.

A vault door hinged at the top may be used for the main opening. Such a door is less apt to sag. If provided with proper counterweight, it is easy to use and is out of the way when the vault is being loaded. Plywood and light lumber tongue-and-groove lumber, and sheet metal are suggested materials for the vault doors. The entire edge of the door must be provided with a rubber strip seal. When a door of this type is used, no special fresh air inlets are needed since the entrance of fresh air to the floor of the vault is easily accomplished by opening the door slightly.

If a door hinged at the side is preferred, refrigerator hinges and clamps are recommended. A fresh air inlet in the front of the chamber to the side of the door and near the floor is recommended for side opening doors. This type of door must likewise be sealed with rubber stripping.

A small circulating fan inside the chamber will proved a gentle movement of air adequate to secure even gas distribution throughout the chamber.

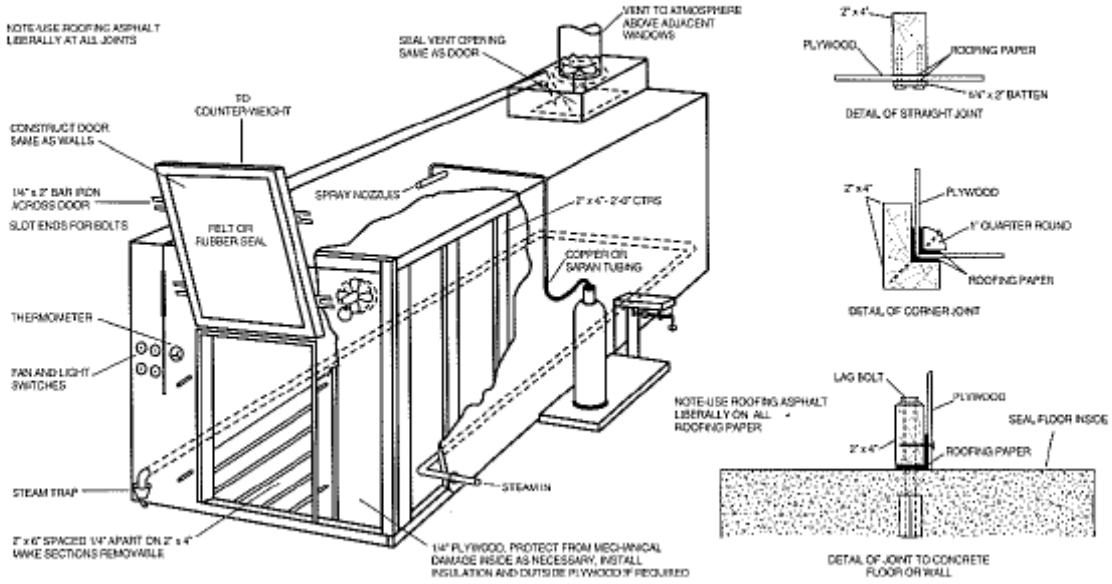
The size of the exhaust blower will depend on the size of the fumigation chamber, the aeration time requirements and the type of material being fumigated. Generally a fan capable of changing the air in the chamber in five to 10 minutes is sufficient. Local representatives of the various blower manufacturers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

Where heat is required, steam pipes or temperature electric strip heaters are recommended — maximum temperature limit of heat source is 752°F. Open flame or high temperature electrical heaters should not be used, since this may result in changing sulfuryl fluoride to hydrofluoric acid, which may damage commodities and equipment.

A thermometer should be installed to register chamber temperature. It should be realized that it is the temperature of the commodity being fumigated that is important. Sufficient time should always be allowed for the chamber load to warm up to the desired temperature before starting to fumigate. This ensures that the pests are active and will rapidly assimilate lethal concentrations of the chemical.

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

Figure 12a



Vacuum Chambers

These 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 construction a vacuum chamber. Contact Dow AgroSciences LLC for a list of firms who can provide this service.

PREPARATION FOR CHAMBER OR STACK FUMIGATION

Before any materials are fumigated, it is appropriate to:

1. Determine the correct dosage (concentration x time = ounce-hours) to control the designated pest in the volume to be treated.
2. Ascertain that the chamber and its accessory equipment perform as intended.
3. Determine that the gas is confined in the chamber by making a test run and monitoring for leaks with appropriate equipment.
4. Have on hand proper respiratory protection equipment (SCBA) and personnel trained in how to properly use it.
5. Train personnel in the proper handling of the cylinders of Vikane.
6. Educate personnel in the proper procedures to be followed should an accident occur and personnel be exposed to Vikane.
7. Inform the company physician about Vikane so that he or she may be knowledgeable about the product and first aid procedures.
8. Notify other appropriate individuals that fumigations of Vikane will be taking place: Company employees other than those performing the fumigations such as security patrols, janitors, etc., police and fire department personnel and others required by local, state and federal laws.

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

INTRODUCING FUMIGANT

Atmospheric Chambers

Atmospheric fumigation chambers are easy to operate. After loading the chamber, close the trap door to the exhaust fan. Turn on the circulating fan. Close the front door tightly. Place warning signs to alert people that a fumigation with Vikane is in process. Introduce the required dosage of Vikane and check with a monitoring device to determine that no leakage is occurring during fumigation.

Vacuum Chamber

Because of the special design of vacuum chambers, it is recommended that the manufacturer or design engineer's operation procedure be followed. If for any reason the chamber must be opened before aeration is complete or a leak occurs, respiratory protection is required for all personnel in immediate area.

AERATION

Atmospheric Chamber

Open the trap door to the exhaust vent, turn on the exhaust blower 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 Vikane is very rapid, usually taking less than 30 minutes, but desorption can occur for a longer period of time. You should always check for the presence of sulfuryl fluoride with a suitable detector before entering the chamber without proper respiratory protection (SCBA).

Vacuum Chamber

Follow the directions given by the manufacturer or design engineer.

CLEARING AND RE-ENTRY

Vikane aerates very quickly; however, you should always check with a gas detector to determine the concentration of gas in the chamber before re-entry. Do not re-enter without respiratory protection unless the sulfuryl fluoride concentration is 1 ppm or less. Keep the exhaust fans running during the aeration period and also while unloading the chamber. Remove the warning signs when aeration has been complete and it has been determined that the area is safe to enter.

USING TARPS AS CHAMBERS

When fumigating items, a fumigation tarp can act as a chamber. The items should be placed on an airtight foundation, such as another tarp or on concrete, and covered with a fumigation tarp so as 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 must be sealed either by weighting edges with sand or water "snakes" or equivalent. The Vikane will be released from the cylinder positioned near the site through copper, polyethylene, impolene, saran or other suitable hose through a proper size nozzle. This will prevent the liquid from splashing on the items or tarp and will allow the liquid to volatilize completely. The hose should be secured so it will not move. A small fan of at least 2-amp capacity will distribute the gas uniformly under the tarp. Use one fan for each 5000 cu ft.

Tarp fumigations should be conducted out of doors or in a building that will not be occupied during fumigation and aeration periods. If it is to be conducted in a building that is used for a purpose other than fumigation, the requirements for structural fumigation should be followed (removal of people, food, pets and plants, use of warning agents, posting of warning signs, etc.). Follow procedures used for structural fumigation.

If the fumigation chamber is in a structure or enclosure that requires the gas to be released from inside that structure or enclosure, then it is mandatory that the applicator and other persons in the area wear proper respiratory protection. A positive-pressure, self-contained breathing apparatus (SCBA, not SCUBA) or air-supplied/SCBA respirator must be used. An additional person trained in the use of the product must be present.

Dosage is calculated using the Fumiguide Calculator. Please note that the HLT of fumigations in which tarps act as chambers are difficult to estimate and, therefore, should be monitored using a Fumiscope unit.

Prior to releasing the fumigant, post warning signs on the tarp. If the tarpaulin fumigation is inside a building, it is required that the building be locked and posted outside at all entry points with warning signs to prevent unauthorized and unprotected personnel from entering the building during fumigation and aeration periods.

When the fumigation period is over, the tarp is pulled back (opened) slightly and left for at least 30 minutes to allow the fumigated material to air out before the cover is removed completely. If this is done in an enclosure/structure, then proper respiratory protection must be used as with introducing the gas. A fan (or fans) is recommended to hasten the aeration, particularly when the fumigation is done in an enclosure.

The fumigation site must not be entered during the fumigation or aeration period without proper respiratory protection. The items must not be moved until the area has been cleared to 1 ppm or less using a suitable detection device and the warning signs removed.

CONSTRUCTION MATERIALS AND FURNISHINGS

Household furnishings and construction materials can remain in a structure being fumigated, or they may be fumigated separately in chambers or under tarps.

Construction Materials

Occasionally, such items as lumber, logs, burlap and other construction materials become infested with pests before they are used. The most likely time for infestation to occur is during storage, particularly if the items are stored unprotected outside. Vikane will control the existing infestations of many pests when applied properly; however, it leaves no residues and cannot protect the treated items from reinvasion by additional pests. It is therefore recommended that if the materials will continue to be stored in areas of potential infestation, that they be treated with a residual pesticide.

Household Furnishings

Sometimes, one or a few items within a structure or location become infested with pests and require treatment. These items may be removed from their location, treated in a chamber or under tarps and then returned, rather than fumigate the entire structure. Again, it should be pointed out that Vikane does not impart residual control; therefore, it will not prevent reinvasion of pests. A residual pesticide is needed. If the infestation is also present in parts of the permanent structure, then a fumigation of the entire structure should be considered.

Treatment

The same safety practices, general principles of maintaining the required ounce-hours at the site of the pest, the proper preparation, fumigant introduction, posting, aeration and clearing practices must be followed as previously described in this manual. Contact Dow AgroSciences for further information.

VEHICLES.....13

Vikane is not registered for the treatment of aircraft or underwater craft.

Numerous pests find their way into various kinds of vehicles – some by natural means, some brought in by humans. Most common are woodboring insects, carpet beetles, cockroaches, rats and mice, and bed bugs. Vikane can provide excellent control of existing infestations without harmful effects to the vehicles themselves.

AUTOMOBILES, BUSES, RAILROAD CARS AND RECREATIONAL VEHICLES (INCLUDING CAMPERS AND TRAILERS)

These vehicles should be treated as small structures with the following exceptions or comments.

Selection of Fumigation Location

The vehicles must be placed in a location that is appropriate for conducting a fumigation. It should be a location that is away from other work areas in a secured place. If they are placed in a building or a fumigation chamber, follow the correct procedures.

Securing the Vehicles

After the fumigation site has been selected, the vehicles 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. Never move a vehicle while it is under fumigation as the gas may be lost resulting in a poor fumigation job, and, most importantly, may expose unsuspecting individuals to the hazardous vapors.

Sealing the Vehicles

If they are not placed in an enclosure such as a building or chamber, they may be either sealed by tarps or taped if they are of a type of construction that lends itself to adequate containment of the Vikane.

Removal of Certain Items, Calculating the Dosage, Warning Agent Use, Introducing the Fumigant, Warning Sign Posting, Events During Fumigation, Aeration and Clearing

All the above subjects are discussed and are to be followed as presented. At the end of the aeration time when the vehicle has been cleared for re-entry, the warning signs can be removed, the chocks removed from the wheels, and the vehicle put back into service.

Over the years, numerous automobiles have been left in garages while the house and garage areas were fumigated with Vikane without any damage to them. It should be cautioned, however, that liquid Vikane should not be allowed to contact any part of the vehicle as it can damage paint, corrode or tarnish metals and stain fabrics. Follow all local, state and federal regulations covering the fumigation of vehicles.

SURFACE SHIPS

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

Rodents and insect pests on ships are objectionable for several reasons. They are capable of spreading disease and infection, can cause damage to cargoes and may contaminate food products. Some may only annoy persons aboard without causing any economic loss or endangering health.

Maintenance and Sanitation

Fumigation is one means of ridding ships of unwanted infestations of pests; however, these chemicals leave no residues to prevent the reinvasion of the site. It is, therefore, imperative that "good housekeeping" be maintained. All parts of the ship should be kept in a good state of repair to prevent infestations, and cleanliness (good housekeeping) is an important means of reducing, if not, in some cases eliminating, certain pest problems.

Control of Infestation

Localized problems may be handled by a residual chemical pesticide. In the case of wood destroying insects, infested wood can be replaced with new wood. Fumigants have the advantage of being able to move into all corners of the vessel to control known infestations as well as into pest sites that may be unknown or inaccessible to the persons responsible for the vessel.

Because of its physical properties, Vikane is ideally suited to control pest infestations in surface ships. Its high volatility allows the gas to penetrate into all areas of the vessel very quickly, control the pest and aerate rapidly.

Due to its lack of warning properties and high inhalation toxicity, Vikane must not be used to fumigate boats or other vessels while they are in use. People, plants or pets must not remain on board during the fumigation. Small pleasure craft may either be removed from the water and fumigated in an appropriate site or fumigated in the water; however, large ocean-going vessels can be fumigated at dockside.

As with all fumigations with Vikane, 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 United States Department of Transportation, Chapter 1, Parts 147A.1-147A.43 in the Code of Federal Regulations, Section 46 Shipping and the label for Vikane.

Since the codes listed are for fumigants in general, do not use procedures that are not permissible for Vikane as directed by label instructions and regulations.

Fumigation Procedure

Small Pleasure Craft

These may be removed from the water to an appropriate fumigation site or left in the water and fumigated in position.

Fumigation out of the water – Small craft, such as canoes or speedboats, should be moved to a safe area in which to conduct the fumigation. If a small size, it may be placed in a fumigation chamber for treatment, or it can be treated by tarp fumigation similar to that conducted for household affects.

Larger pleasure craft, such as cabin cruisers or sailboats having more that one enclosed compartment, must be treated as a structure requiring proper sealing, use of warning agent, adequate gas distribution, warning signs, etc. Boats tarped and fumigated out of water should be monitored with a Fumiscope unit during the fumigation since HLT is difficult to estimate.

After the fumigation, vessels must be cleared with a suitable device before re-entry or moving the vessel.

Fumigation in the water – Small pleasure craft may be left in the water at dockside during fumigation. Tarps should be dropped over the vessel and should extend below the water surface. Because of its low water solubility, the water acts as an excellent barrier for the Vikane.

Since 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 and "fogging out" the vessel causing corrosion and staining.

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, as noted on the label.

Large Vessels

Fumigation of large vessels, such as houseboats, and ocean-going vessels, such as freighters and cruise ships, with Vikane shall be done at dockside and not when the vessels are underway. All people, plants and pets shall be removed from the vessel during fumigation. Food, feeds, drugs and medicinals not in highly resistant containers shall be removed or protected by sealing in glass, metal, or double bagged in Nylofume bags. The infested vessel shall be treated as if it were a building or structure and be fumigated accordingly by following the requirements for tape or tarp jobs. The water will act as an excellent underseal; therefore, when using the Fumiguide Calculator or Fumiguide B to estimate HLT and the amount of Vikane to release, use the slab rating for ground seal. The entire vessel must be tarped if pest damage is occurring on deck. It can be taped if infestation is interior and below decks and an adequate seal can be made to confine the gas.

Due to uncertainties in estimating HLT for tape and seal fumigations, it is strongly suggested to monitor the job using a Fumiscope.

If only localized pest damage is present (i.e., one deck or one or two holds), the effected areas may be treated by compartmentalization. Because of common air ducts, however, even though only a part of the vessel is to be treated, all people, plants and pets must be removed from the entire ship during fumigation. Edible items must also be removed or protected on the vessel.

If entry is to be made into the vessel during the fumigation or aeration periods, a self-contained breathing apparatus must be worn.

The fumigation shall be done by a person certified to use Vikane and he and the ship's captain or owner shall follow the requirements listed on the label for Vikane and local and state requirements.

TROUBLESHOOTING 14

Vikane in the gaseous phase is a very slightly reactive chemical compared to other fumigants such as methyl bromide, hydrocyanic acid (HCN), or acrylonitrile, which leads to its superior performance as a structural and non-food commodity fumigant.

No odor…no corrosion: Vikane imparts no odors to any known household materials and causes no corrosion when correctly used. When fumigating structures, furniture and rugs remain in place: only people, domestic animals, pets, and desirable growing plants, food, feed, drugs (including tobacco products) and medicinals (including those items in refrigerators and freezers) must be removed or protected before the application. Mattresses (except waterbeds) and pillows with waterproof covers must be removed or the plastic covers removed or open seal of waterproof covers.

CYLINDERS

Valve Problems

Cylinders containing Vikane are fitted with special valves that are appropriate for use with sulfuryl fluoride. These valves can be damaged if the wrong size wrench is used. A 10 to 12" crescent 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 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, 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, return the cylinder to your distributor so that it may be sent to Dow AgroSciences LLC for repairs.

Dip Tubes

A broken dip tube is usually the reason liquid Vikane cannot be moved out of the cylinder when the valve is wide open. Sharp blows to the cylinder, rough handling, or dropping the cylinder can break off the dip tube from the bottom of the valve. Do not attempt to remove Vikane from a cylinder having a broken tube.

You can usually tell if the dip tube is broken by rocking the cylinder back and forth – you can hear the dip tube rolling around inside the cylinder if it is broken off from the valve. If the dip tube is broken, do not attempt to remove any more Vikane from the cylinder. Replace the bonnet and call your distributor for instructions on cylinder return.

Leaking Cylinders

Leaking may occur if cylinders receive rough handling which can cause abrasion on the side of the cylinder and produce pinholes in the metal.

Always identify faulty cylinders, valves, and dip tube by red tagging, describing the problem in detail. Return the cylinders to your distributor.

CORROSION OF METALS

Vikane is not known to have caused any corrosion to household objects of any nature when it is in the vapor (gas) phase under normal temperatures. Every batch of Vikane is tested for metal corrosion before being released for sale.

Metal surfaces of copper, silver, steel, stainless steel, brass, aluminum, etc., may, however, become corroded or rusted if Vikane is released *incorrectly*. If Vikane is introduced too rapidly given the cfm of the fumigant introduction fan and environmental conditions, 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 introduction of Vikane. Minute quantities of acids (by-products of the manufacturing process which represent less than 1% inerts) are soluble in water condensation and can etch metal surfaces. The fumigant introduction rate should not exceed the fan capacity (1 lb Vikane per 1000 cfm of fan capacity) to thoroughly mix the colder air when Vikane is introduced into the warm air in the structure.

Metal corrosion can also occur if heat sources are left on during fumigation. Vikane is decomposed by heat from gas flames such as pilot lights in furnaces, stoves, or refrigerators and such glowing heat sources as electric heaters and organ motors. Heat sources having a temperature above 752°F decompose Vikane to corrosive materials (mainly HF). 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 tent of the new type swimming pool chlorinators that generate chlorine gas for chlorination. These pieces of equipment should either be turned off or excluded from the fumigation.

Damage to metals can usually be corrected by cleaning the metal items with a good metal cleanser as the corrosion or rust is usually only on the surface. A product called Howard's "Pine Ola" has also been used successfully. It can be obtained from most metal plating shops and antique refinishers.

GLASS ETCHING

Vikane is not known to cause etching of glass. HF, the decomposition product of Vikane, 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 a fumigation. Fog-outs can also cause etching of glass and ceramic tile. Each batch of Vikane is also tested for glass etching before it leaves the production plant.

RUN STAINS

Vikane in the gas 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 when Vikane is introduced with the air in the structure. "Coke bottle staining" (dark syrup color) is a condition whereby the interior and/or exterior walls and surfaces of the structures "sweat" and a "sticky" watery liquid with a light to dark brown coloring (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 Vikane. 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 (an example would be the fogging of sunglasses when exiting an air conditioned car in the summer). This condition can be avoided by either warming the structure slowly prior to tenting or waiting until all tents are in place before opening windows and doors to avoid introducing outside air.

STAINING

Vikane 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, SO_2 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 Vikane 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. Initially, slowly open the valve a quarter to one-half turn to begin the flow of liquid Vikane. 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., upon which the hose rests. Also, Vikane 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 Vikane on surfaces. Replace kinked hoses. Purchase flexible hosing of proper specifications with mesh-reinforced walls to avoid this problem.

During release of Vikane from the cylinder, some chilling of the valves, cylinder, and fumigant introduction hoses can occur under normal circumstances. Valves can freeze if Vikane is allowed to change from a liquid to a gas within the valve area 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

Vikane 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. Structural foundation plantings of ornamental shrubs and trees can be protected to a certain degree from the gas by wetting the soil out from the structure or site thereby seating off the gas so that it will be unable to reach the plant root system. Water is an excellent barrier and Vikane will not readily move through moist soil.

Certain plants have been found to be more sensitive to Vikane than others. These include junipers, some dwarf palms, springeri 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 Vikane. 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.

PHOTOGRAPHIC MATERIALS

Vikane has successfully been used to fumigate commercial photographic establishments containing films and photographic papers. It is recommended that developing materials not be left in open trays. Developer and fixing solutions should be placed in sealed bottles or the solutions should be made up fresh after the fumigation. A brown cast has been seen on color prints developed with exposed solutions. No problems have occurred with photographic paper or plates.

ODOR PROBLEMS

Odor problems can occur if a building is tarped for fumigation soon after the crawl space was treated with a residual pesticide having an odor or there is high moisture in the crawl area. Tarping can confine moisture and odors of the crawl area in the structure. Therefore, a building should be fumigated prior to a subterranean termite treatment or wait until the crawl space has completely dried before tarping. Algae and debris on rooftops of flat-roof buildings can create odor problems if tarps are placed over standing water on roofs.

High moisture in the structure from wet shingles, enclosed pools, etc., can cause fungal growth and or a musty damp odor when this structure is tarped or closed up during the fumigation period.

Odors can also be caused by the decomposition of dead animals. Occasionally pets, 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.

Minor sewer leaks, normally not noticed, may have intensified when the site is tarped or sealed.

POOR CONTROL OF PESTS

Experience has shown that poor control of the target pest is caused by not generating enough ounce hours (OH) for the temperature to kill the pest. Accumulation of OH does not begin until the fumigant is uniformly mixed throughout the site (reached equilibrium). Many factors may contribute to poor OH 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 OH).
4. Using the wrong dosage (insufficient OH).
5. Not using adequate fans to distribute the gas properly within the site.
6. Not accurately determining the temperature of the pest site – in structural fumigations the temperature of the soil or slab most appropriately predicts this, not the air temperature.
7. Error in calculating volume to be fumigated; overhangs and porches are often times not included.
8. High winds which can cause excessive loss of gas.

PLASTICS

Liquid Vikane is a good solvent of some plastic materials. Vikane 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 Vikane. 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 containers; 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.

SPECIAL FUMIGATION JOBS.....15

Occasionally, it is necessary to conduct fumigations that are of a special nature. These types of fumigations are discussed below.

FUMIGATION OF LARGE OR MULTI-UNIT STRUCTURES

When fumigating a single unit/room within a larger structure (such as townhouses, apartments, condominiums), all units of the entire structure must be prepared as a fumigated structure, and all applicable rules, regulations and label instructions apply, such as occupant notification, structure preparation, posting, securing and aeration. Fumigations that involve large structures over 100,000 cu ft often require special considerations. The cost to conduct these fumigations is considerable. Failure to achieve desired control results in a significant financial loss to a company if they have to re-fumigate a large structure to achieve control of the target pest. The following are important considerations for large jobs.

Planning

Fumigation of a large or multi-unit structure generally requires extensive planning. Sufficient time and manpower must be allocated for planning, as well as conducting the fumigation. One employee should be designated as the coordinator to oversee the entire process.

Obtain a floor plan of the structure to be fumigated, if available. If the structure has designated maintenance personnel, conduct a walk-through inspection with them prior to the fumigation. The following should be reviewed during the inspection:

1. Alarm system, if present.
2. Presence of attics and sub-areas and access openings to these areas, if present.
3. Air handling system – Determine how to activate the system following fumigation to enhance the aeration process.
4. Location of all areas where food and medicinals are stored. This would include concession machines, emergency and first aid kits, and items in storage lockers or desks.
5. Location of items sensitive to increased heat and humidity when air conditioning is turned off (i.e., laboratory chemicals and analytical equipment, mainframe computers, etc.).
6. Roof condition and drainage – When tarping flat roofs with parapet walls, drainage may have to be provided in case of rain during the fumigation. The weight of accumulating water can severely damage roofs. Drainage can be provided by running PVC pipe through the scuppers in the parapet walls, aligning tarp seams with the scuppers, and sealing the tarps around the PVC pipe on both sides of the parapet wall. Water can then drain from the roof via the PVC pipes, while the structure remains sealed for the fumigation.
7. Plumbing – Location of all floor drains (a significant amount of gas could be lost if the sewer trap is dried out).
8. Presence of gas pilot lights or glowing heat elements.
9. Location of suspended ceilings.
10. Locked vaults or other security areas.
11. Presence of any unusual structural features or contents.
12. Location of walkways, pipes or conduits leading from buildings to be fumigated to adjacent structures.

Preparation

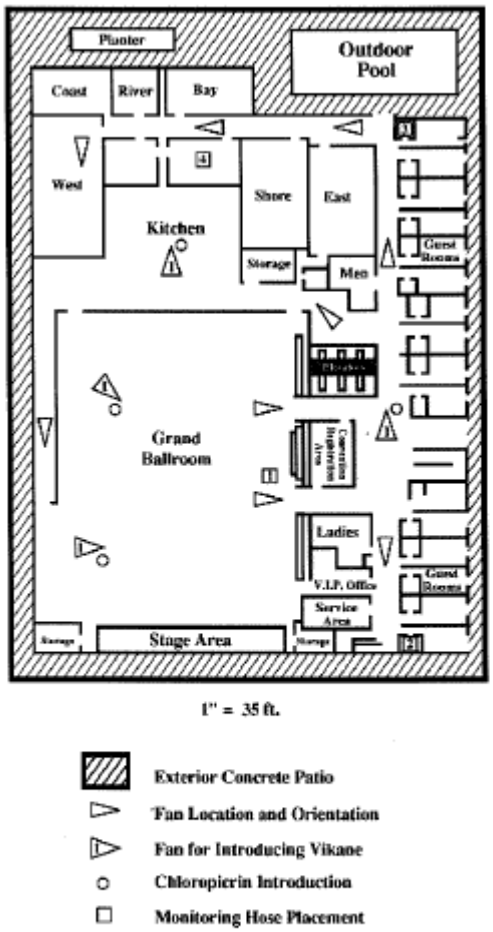
Large jobs often involve special preparation. Provide written instructions to the customer outlining their responsibilities for preparation.

These instructions may need to be modified to address conditions specific to the fumigation site (i.e., school, office, laboratory, museum, etc.). Negotiate for the fumigation contract to allow the fumigator to

postpone the fumigation without penalty due to inclement weather. Without this contractual allowance, the fumigator may be required by the customer to conduct a fumigation in unsuitable weather or forfeit part of the payment to compensate the customer preparing the structure a second time.

Prior to the fumigation, prepare a detailed graph of the structure with fumigant and warning agent introduction sites, fan locations and monitoring sites noted (see Figure 1). This pre-planning will help determine the number of fans and length of fumigant introduction and monitoring hoses needed for the fumigation. An outline of fumigation, aeration and clearing plans and expected timing of events will also prove helpful.

Figure 1



Floor plan for fumigation of a conference facility (27,000 ft³). The site has 13 fans, including four fumigant introduction fans. Chloropicrin is placed at each fumigant introduction location. There are four monitoring line locations; two near the introduction locations and two distant from the fumigant introduction sites.

For multi-unit structures, communication with occupants is especially important. Provide each occupant with a homeowner checklist and other relevant information regarding proper preparation of his or her unit.

Consider each unit an individual structure. When conducting the walk-through prior to release of the warning agent, each and every unit must checked to ensure that the unit has been properly prepared and that people, pets and plants are not present.

Conserving Fumigant

Large jobs can require significant quantities of fumigant. The fumigator should determine options for conserving fumigant while obtaining the ounce-hours required to kill the target pests. Consider the following options:

1. Monitor the fumigation using a Fumiscope. Monitoring lines should be placed on all levels of the fumigated structure, including attics and sub-flooring, if accessible. At least half the lines should be placed in rooms/areas distant from fumigant introduction points. If the structure is compartmentalized into separate towers, wings, or other sub-units, place lines in areas representative of different sub-units. If time permits, monitoring can be conducted in a manner so that the exact amount of Vikane required is introduced based on the measured half-loss time. This type of precision fumigation is conducted by initially introducing part (i.e., one-half) of the calculated dosage of Vikane, monitoring to determine the actual half-loss time, and then introducing additional Vikane to achieve sufficient ounce-hours in the time remaining for the fumigation.

   Construction of a manifold can significantly speed the process of taking concentration readings, as can the use of auxiliary air pumps to purge multiple monitoring lines.

   Monitoring fumigant concentration can provide important information to the fumigator regarding the placement of fumigant/warning agent introduction sites, which 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 large or multi-unit structure to be fumigated.

2. Extend the fumigation period. Large jobs generally have good fumigant confinement due to the large volume to surface area ratio. Extending the hours of fumigant exposure would reduce the concentration of fumigant required.

3. Conduct the fumigation during the time of year when temperatures are warmest. Increasing the temperature can significantly decrease the ounce-hours required to control the target pests. Fumigating at the warmest time of the year can therefore help conserve fumigant and reduce the chemical cost for their fumigation. As shown in the example below, by fumigating during warmer times of the year and increasing exposure time, less fumigant is required. The result is a more economical job (see Table 16a).

4. Determine the best method (tarp, tape and seal, or a combination) to seal the structure.

5. If tarping the structure, determine the best way to improve the ground seal. For crawl space construction, if the crawl space is accessible, consider covering this area with polyethylene or tarps prior to the fumigation. Consider all the available methods (sand, water, polyethylene) for improving their ground seal around the exterior perimeter foundation.

Table 16a
Fumigation of a 3.85M ft³ building for drywood termites
Job — Dosage Comparisons of Fumiguide® B and Y

	AMOUNTS OF VIKANE REQUIRED FOR VARIOUS CONDITIONS			
INFLUENCE	FUMIGUIDE B	FUMIGUIDE Y		
HE	24	24	24	48
°F	50	50	65	50
HLT	72	72	72	72
Oz/Mcf	16	11.5	6	6
Lbs. Vikane	3,855	2,770	1,446	1,446

Equipment

Large jobs require more equipment compared to standard jobs. Availability of sufficient equipment such as additional fans, tarps, chloropicrin pans, extension cords, power strips, etc., should be arranged in

advance. To obtain more of the standard fumigation equipment for a large job, you may need to do one or more of the following:

1. Purchase new equipment.
2. In a multi-branch company, pool equipment from fumigation branches. Be sure to label or mark the source of the equipment. One exception would be clamps, and they can be weighed before and after use to ensure proper redistribution after the fumigation.
3. Borrow or rent equipment from other fumigation companies (again, label or mark equipment).
4. Subcontract other fumigation companies to assist with the job.

Large jobs may require specialized equipment, such as cranes, lifts, C-clamps and ropes for tarping, voice-activated radio headsets, manifolds for fumigant introduction, manifolds and vacuum pumps for monitoring and remote controlled fans. When renting or purchasing specialized equipment, make certain the equipment is in good operating order and that you fully understand how to use it. For example, if renting a crane, make certain there is sufficient access adjacent to the fumigated structure to use a crane.

The Fumigation Crew

More labor and time for sealing and preparation may be required for large jobs. If pooling employees from multiple fumigation branches, or subcontracting other fumigation companies, have each pre-established fumigation crew remain together as a team. Each team should know how to work together efficiently based on their previous experience. Assign each team specific tasks.

Arrangements should be made to ensure communication on the job. "Walkie-talkies" have been used for this purpose with success.

Determine if arrangements for food, rest rooms (i.e., portable rest rooms), lodging, and transportation should be made for employees. For example, catering food to the work site can save the time employees would spend traveling to food service facilities and waiting for service.

Aerating Large or Multi-Unit Structures

Extra consideration should be given to aeration of the large or multi-unit structure that has been fumigated, and adequate time should be allowed for ventilation of all units within the structure.

If the warning agent is properly applied at each fumigant introduction site, on at least each story, away from highly adsorptive furnishings, aerating it from the building should not be a problem. Difficulties in aerating chloropicrin from structures can frequently be traced to overloading the warning agent on the lower floors and/or not using proper pans and wicking.

An organic molecule with a high boiling point and low vapor pressure, chloropicrin tends to be adsorbed onto furnishings. Overloading the application at any point in the structure creates conditions conducive to adsorption, whereas under-application could create a potentially hazardous condition if an insufficient quantity is available to act as a warning agent. Great care should be taken to ensure the proper application of the correct amount of warning agent.

Safety Considerations for Large Jobs

If the fumigated property is in a public access area (one building in a multi-building complex), make arrangements (security guards, barricades, warning tape, etc.) to limit pedestrian traffic near the fumigated structure. Limiting public access may be particularly important during the aeration process, depending on how fumigant will be ventilated from the structure.

SEPARATION DISTANCE

Sometimes fumigated structures are located in very close proximity to structures that will be occupied during the fumigation. If the occupied structure has openings (i.e., windows, air-intake vents) in close proximity to the fumigated structure, fumigant leakage into the occupied structure may be a concern. Some states have procedures required by state law that the fumigator must follow to ensure public safety in these circumstances. In the absence of state guidelines, the fumigator should consider doing the following:

1. Prepare units in non-fumigated structure, which are adjacent to the fumigated structure, as if they were going to be fumigated; i.e., vacate occupants, turn off heating elements and flames, remove plants, prepare food and other edible commodities. These units should be tested for clearance following fumigation.

   Vacating and preparing adjacent units in the non-fumigated structure may not be possible. As an alternative, the fumigator could do the following:

2. Close windows and air intake vents on the side of the non-fumigated structure adjacent to the fumigated structure. Provide fresh air circulation in the non-fumigated units. Periodically test the non-fumigated units throughout the fumigation, using an Interscan, ExplorlR, or instrument of similar sensitivity, to detect leakage of Vikane. The fumigator should be prepared to terminate the fumigation if leakage of Vikane in the non-fumigated structure cannot be prevented or minimized to concentrations at or below 1 ppm.

3. If access to the non-fumigated structure is not possible, the fumigator could periodically test the airspace between the fumigated structure and non-fumigated structure throughout the fumigation using an Interscan, ExplorlR, or instrument of similar sensitivity. The fumigator should be prepared to terminate the fumigation if concentrations of Vikane cannot be maintained at or below 1 ppm in the airspace contacting the non-fumigated units.

   If the space between the fumigated and non-fumigated structure is not wide enough to permit passage for the fumigator to conduct air testing and the above Procedures 1 and 2 are not possible, the fumigator should consider other options for pest control.

COMPARTMENTALIZATION

Fumigation of a 150,000 cu ft open warehouse is very different from fumigation of a 150,000 cu-ft apartment building. Available methods involving the use of the Fumiguide Calculators make it possible to segment structures into compartments and handle each in accordance with its needs.

Multiple Release Sites

In highly compartmentalized structures, additional fumigant/warning agent introduction sites will be necessary, as will the use of additional fans to achieve rapid equilibrium. When fumigating this type of structure, achieving equilibrium of both the fumigant and warning agent in an hour is an important goal. Multiple release sites offer the fumigator the flexibility to compensate for differential fumigant loss by enabling the fumigator to introduce more fumigant only in areas requiring it.

Construction of a manifold for introducing fumigant to multiple release sites may speed the process considerably.

Introduction of chloropicrin at each fumigant release site and at least on each floor of a multi-unit structure is necessary to ensure the presence of warning agent consistently throughout the fumigation period. The process of chloropicrin introduction then is more complex in a large or multi-unit structure and requires coordination of applicator(s) and possibly the use of respiratory protection. The use of multiple release sites for the warning agent will assist in aerating the warning agent from the structure once the fumigation is complete.

In addition, because of the large number of variables involved in compartmentalization, measurements with the Fumiscope unit should be made to determine the fumigant loss rate (HLT) so that the corrections can be made if required.

Fumigation of Sub-Units

Sub-units, such as a single apartment, condominium, store, or room in a multi-unit structure, can be fumigated and not cause a hazard to humans if, in addition to good fumigation practices the following points are followed:

1. The extent of the multi-unit structure containing the sub-unit(s) to be fumigated must be determined. The entire multi-unit structure must be vacated during the fumigation and aeration periods. Fumigant can leak through undetectable voids, including pipe chases, eaves, attics, subflooring, and walls, to areas within multi-unit structures distant from fumigated areas.

2. The unit(s) to be fumigated must be sealed off from other areas. The non-fumigated units should be prepared as if they were going to be fumigated; i.e., turn off heating elements and flames, remove plants, prepare food and other edible commodities. This is necessary in case Vikane leaks into non-fumigated units. If it is not possible to prepare the non-fumigated units for fumigant leakage, then the fumigator must be prepared to do the following:

   a. If possible, provide fresh air circulation in non-fumigated units
   b. Regularly test non-fumigated units with an Interscan, ExplorlR, or instrument of similar sensitivity, throughout the fumigation for leakage of Vikane;
   c. Be prepared to terminate the fumigation if concentrations of Vikane cannot be maintained at or below 1 ppm in non-fumigated units.

3. Following equilibrium, non-fumigated units within the structure should be tested with an Interscan, ExplorlR, or instrument of similar sensitivity for leakage of Vikane. If Vikane is detected, the sealing of the fumigated areas should then be rechecked to determine where fumigant leakage is occurring. Additional sealing may be necessary.

4. The entire multi-unit structure should be posted with warning signs. All units, fumigated and non-fumigated, within the multi-unit structure should be tested for fumigant clearance prior to occupant reentry.

TIDAL AREAS

A high water table will generally not cause fumigation problems if the water table is stationary during the fumigation period. If, on the other hand, the structure is on or near the coast, high and low tides can be involved. Experience has shown that changing of the tide from high to low over the fumigation period can result in increased fumigant loss as the water moves out. This usually ends in a fumigation failure, if it occurs before the pest has been exposed to the proper ounce-hours of Vikane.

The fumigator should be aware of this potential problem and become familiar with the high water table locations and tidal schedules for his area. In some cases, it may be necessary to seal the crawl space to prevent the loss of fumigant through the undersoil. Tarping the soil surface beneath the structure might be necessary. These fumigations should be monitored.

HIGH VALUE ITEMS

Great care should be exercised when fumigating extremely valuable objects such as art objects found in museums, special furnishings, mainframe computers, or specialized analytical equipment. History has shown that when Vikane has been used according to label directions to fumigate the above listed items, no damage results. If high value items do not require fumigation, they should be removed from the site or sealed in Nylofume bags or fumigation tarps. It should be noted that due to the high vapor pressure

of Vikane, it can be very difficult to prevent Vikane from contacting objects by tarping the objects or sealing the rooms in which the objects are found.

In one example, the mainframe computer supporting an emergency relay telephone network was in one room of a building to be fumigated with Vikane. The room was carefully sealed from the rest of the building and intake and exhaust vents were created in two of its exterior windows. During the fumigation, a refrigeration truck provided fresh, cooled air through the intake vent of the room. Positive air pressure was maintained throughout the fumigation period. In spite of these efforts, concentrations of Vikane were measured in the room, using a Fumiscope, during the fumigation period. The mainframe computer remained operational during the fumigation period and no adverse effects were observed.

In another example, a chemistry building at a university was fumigated with Vikane. Prior to the fumigation, a faculty member with the responsibility of overseeing acquisition and maintenance of all analytical equipment had the staff run standard tests on all equipment remaining in the building. This equipment was then sealed in 4 to 6 mil polyethylene. After the fumigation, the standard tests were conducted again. One professor claimed that the fumigation damaged a very expensive gas chromatograph. The initial standards run by his technician documented that the chromatograph was malfunctioning prior to the fumigation. This case documents the importance of removing expensive, sophisticated items prior to fumigation if possible. Determining the cause of damage to items can be difficult or impossible after a fumigation if a customer claims that the fumigation caused the damage. Correct fumigation procedures must be followed or damage may result.

HIGH DOSAGE FUMIGATIONS

Powderpost Beetle Fumigation

Fumigating for powderpost beetles with Vikane requires a modification of your normal drywood termite practices in order to be most economical. The main stage is the larval stage which does the damage and lives from about 8 months to 6 to 7 years depending on the species and conditions. Adult, pupae and egg stages are very short lived and usually only last 2 to 3 weeks each. Adults, pupae and larvae are relatively easy to control but the egg stage requires a higher dosage (10x) than drywood termites. Therefore it is important of know what species and life stages are present.

The 10x dosage means you need to accumulate ten times the OH necessary to control drywood termites to control the egg stage of the beetles. The most economical way to do this is to extend the exposure time beyond the normal 20 to 24 hours, improve the HLT, and fumigate when the temperature is the warmest (measured at the site of the pest). It is also recommended that you monitor all beetle jobs with a Fumiscope to determine the actual HLT (this will allow a 25% reduction in the required dosage).

In order to benefit from extended exposure time, you must have a good HLT. If the house has a crawlspace with a loam or sandy loam soil, it will pay to put down a polyethylene vapor barrier to reduce the gas loss through the soil. Generally, this will allow you to calculate the underseal as a "clay" or "slab." Use only tarps in good to excellent condition and spend extra time in preparation to assure a good ground seal.

Table 15b illustrates the increased efficiency by following the above suggestions for a 10x powderpost beetle job.

Table 15b
Crawl Space House

	Non-Monitored 24 hrs.	Monitored 24 hrs.	Monitored 36 hrs.	Monitored 48 hrs.	Monitored 36 hrs.	Monitored 48 hrs.
					with vapor barrier in crawl space	
Tarp	Good	Good	Good	Good	Good	Good
Seal	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Wind (MPH)	5	5	5	5	5	5
Volume (Mcf)	30	30	30	30	30	30
Underseal	Loam	Loam	Loam	Loam	Slab[1]	Slab[1]
Temp (°F)	60	60	60	60	60	60
Hrs. exp.	24	24	36	48	36	48
HLT (hrs.)	10	10	10	10	31	31
Dosage (oz/Mcf)	162	121	107	101	59	49
Pounds	303	228	200	190	110	92

[1] Use "clay" or "slab" if entire crawl space has a good polyethylene vapor barrier.

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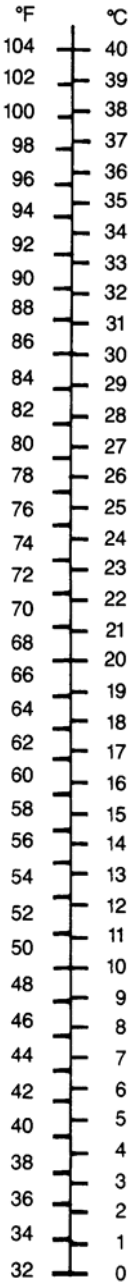
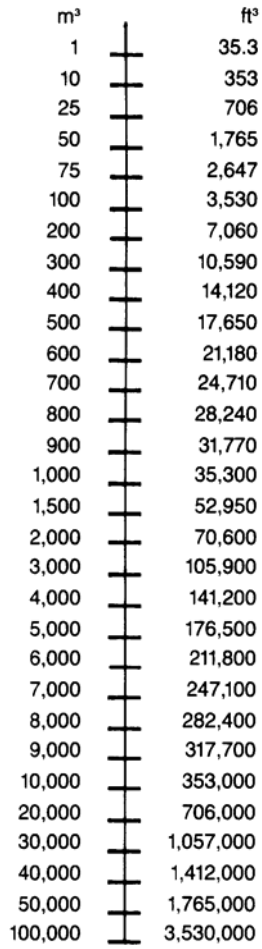
APPENDIX 17

ENGLISH-METRIC CONVERSION TABLES

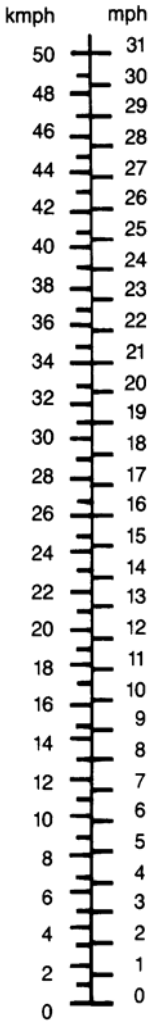
Temperature
(°C x 1.8) + 32 = °F
(°F – 32) ÷ 1.8 = °C



Volume
1 ft^3 = 0.0283 m^3
1 m^3 = 35.31 ft^3



Wind Speed
1.609 kph = 1 mph
0.621 = 1 kph



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.

ADSORBTION/ABSORBTION = SORPTION: The action of a material in holding a gas or substance. The opposite of desorption.

AERATE: Exchange fumigant-laden air with fresh air.

AERATION: The final step of a fumigation that involves proper ventilation and clearance of Vikane and the warning agent chloropicrin from the structure.

AMERICAN COCKROACH [*Periplaneta americana* (L.)]: Also known as the water bug, it is the largest of the peridomestic cockroach species, growing to 1.5 inches or more in length.

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.

ANOBIIDAE: A family of beetles which includes furniture and death watch beetles. Anobiids infest all types of seasoned wood but, unlike termites, some anobiids are able to digest the wood without the aid of protozoa.

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).

BED BUG [*Cimex lectularius* (L.)]: Primarily a human ectoparasite in the order of *Heteroptera* and the family *Cimicidae*, it is also known as "mahogany flat," "chinch," and "red coat." It got its name from its close association with human sleeping beds.

BOILING POINT (BP): 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.

BROWN BANDED COCKROACH [*Supella longipatpa* (F.)]: One of the smaller domestic cockroaches in the family *Blattellidae*, they prefer feeding on starchy materials and do not require association with moisture as German cockroaches. They are frequently transported in furniture and will rapidly spread throughout a building.

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

CARPENTER ANTS (*Camponotus* spp.): Conspicuous, large, black or dark bodies ants found in and around homes throughout the United States. Carpenter ants do not use wood for food, but hollow it out for nesting.

CELLULOSE: A polysaccharide consisting of repeated glucose units, which is a major component of plant cell walls. Termites help to convert dead wood and other organic materials containing cellulose to humus. Termites harbor one-celled organisms in their digestive tracts, and these organisms convert cellulose into substances the termites can digest.

CENTRAL NERVOUS SYSTEM (CNS) DEPRESSION: An alteration of level of consciousness that proceeds other changes in vital and neurologic signs.

CERAMBYCIDAE: Family of insects also called long-horned beetles which consists of over 1200 species that feed as larvae on living trees, recently felled trees and logs, and seasoned lumber.

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," it is a highly toxic, non-flammable liquid at room temperature which vaporizes slowly and serves as a warning agent for odorless fumigants.

CIRCULATION: Mechanically stir or circulate the fumigation atmosphere.

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 Vikane is 1 ppm or less before allowing re-occupancy.

CONCENTRATION: Amount of fumigant within the fumigated site during exposure period. Usually measured in ounces per 1000 cu ft 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 blush discoloration of the skin.

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

DEATH WATCH BEETLE: Found throughout the U.S., they attack building timbers in poorly ventilated areas where moisture tends to collect.

DEPARTMENT OF TRANSPORTATION (DOT): Federal agency which regulated the packaging, storage and transportation of hazardous materials.

DERMESTID BEETLES: Family of beetles that cause damage to fabrics. Most common species include the black carpet beetle, varied carpet beetle, common carpet beetle, and furniture carpet beetle. The beetles are extremely small and rarely seen by homeowners.

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 to form.

DIP TUBE: A PVC tube that extends from the bottom of the cylinder to the valve on the top.

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 accumulated during the exposure period.

DOSE: The amount of fumigant introduced into the fumigation space — oz/Mcf.

DRIERITE: The hygroscopic material used in the Fumiscope unit to remove moisture from the air. Drierite in good condition is normally blue in color.

DRYWOOD TERMITE: A highly destructive wood destroying termite in the family *Kalotermitidae* found in subtropical and tropical regions of the world. They generally live in undecayed wood, which has a very low moisture content. Unlike subterranean termites, they do not need any contact with soil.

EMBRYOLETHALITY: The ration of embryo fatalities from a given exposure to the number of embryos exposed to a given test substance.

ENTRAINED AIR: To draw in and transport.

EQUILIBRIUM: The state when all the sulfuryl fluoride molecules are equal distance and 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. It does not begin until equilibrium has been reached.

°F: Working temperature. Usually the temperature of a sub-area soil or slab of a structure expressed in degrees Fahrenheit. In the case of chamber fumigations, the internal temperature of the commodities to be fumigated (i.e., site of pest). Can also refer to °C working temperature (degrees centigrade).

FACE SHIELD: One of two pieces of safety equipment to protect the eyes required when releasing the fumigant or the chloropicrin (see goggles).

FLASH POINT: The temperature at which vapor explodes. Structural fumigants now available have no hazards from explosion even when used at very high concentrations.

FLUOROSIS: A blackening of the teeth caused by an overexposure to fluorine.

FOG: Very fine droplets of liquid moisture in air.

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 Vikane gas.

FORMOSAN SUBTERRANEAN TERMITE (*Coptotermes formosanus* Shiraki): One of the most aggressive and economically important subterranean termite species, they are mainly found in tropical regions.

FRASS: Tiny sand-like fecal pellets excreted by drywood termites which can be an indication of a drywood termite infestation. While their color can vary depending upon wood consumed, they will always be elongated oval, less than one millimeter in length, with rounded ends and six concave sides.

FUMIGANT INTRODUCTION: Release of the fumigant from its containers into the fumigation space.

FUMIGUARD INTRUDER ALERT SYSTEM: A detection device which senses heat and motion which can be used during a fumigation to alert the fumigator of an intruder.

FUMIGUIDE B: Calculator used to (1) estimate HLT, (2) coordinate estimated fumigation dosages for a 20 to 24 hour non-monitored fumigation, and (3) convert oz/Mcf to pounds.

FUMIGUIDE Y: Calculator for fumigation exposures between 2 to 72 hours in length. Coordinates dosage requirements for Vikane for various HLT, HE, and °F. For corrective procedures, it coordinates percent fumigant with actual HLT and additional fumigant dosage requirements.

FUMISCOPE: A thermal conductivity analyzer used to monitor a fumigation while in progress.

FURNITURE BEETLES: Common group name of beetles in the family *Anobiidae*. Found primarily in the eastern half of the U.S. they attack not only furniture but structural timbers as well.

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.

GERMAN COCKROACH [*Blattella germanica* (L.)]: The most common domestic cockroach species in houses, apartments, restaurants, etc., which hides in cracks and crevices in areas which are dark, humid, warm and close to water and food.

GOGGLES: One of two pieces of safety equipment to protect the eyes required when releasing the fumigant or the chloropicrin (see face shield).

GROUND SEAL: The sealing of tarps to the ground to prevent fumigant loss during a fumigation.

HALF-LOSS TIME (HLT): Time required to lose one-half of the fumigant concentration measured in hours. The characteristics of fumigant loss rate from a sealed structure are fairly well established except for wind, and fumigant distribution influences. The HLT can be *estimated* by using the Fumiguide B. However, the *actual* HLT can be established only by measuring the fumigant concentration during the exposure period with a gas measuring instrument.

HEAT OF VAPORIZATION: The moisture of 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. Exposure periods from 2 to 72 hours are provided by the Fumiguide Y which coordinates the necessary adjustment to obtain proper dose for the job. The hours of exposure begin only after equilibrium has been reached.

HYDROFLUORIC ACID: A highly reactive chemical which can corrode or damage many household effects. Vikane 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 of a compound with water.

INSIDE DIAMETER (ID): The measurement of the interior width of the fumigant introduction and monitoring hoses.

INERT INGREDIENT: Other ingredients that when combined with the active ingredient from the pesticide formulation.

INTERSCAN GAS ANALYZER: A portable analyzer designed for leak detection and clearing of sulfuryl fluoride which 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 Vikane, this is 4600 cal/mole. When liquid fumigants under pressure are released, available heat is "pulled" from the immediate surroundings as the liquid changes to a gas.

LATENT MORTALITY: The effect of an organism receiving a toxic dose and dying eventually.

LEAK DETECTOR: Device used to detect leaks in tarpaulin clamping and the ground seal during a fumigation. An example would be a TIF detector.

LOAD FACTOR: A way of estimating the amount of fumigant sorbed by materials being fumigated and thus made unavailable for insect control.

MAXIMUM CONCENTRATION: The greatest amount of chemical that can exist as a gas in a given space. As temperatures increase, so does the maximum concentration. The higher the maximum concentration of the fumigant, the more that can be applied in a given space.

MCF: 1000 cu ft.

MIRAN (MOBILE INFRARED ANALYZER): A type of clearance device used to clear a structure for re-occupancy after a fumigation.

MODIFIED BONNET: A type of cap or ring used to suspend the fumigation cylinder.

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: Possessing the power, ability or tendency to produce genetic changes or mutations.

NATIONAL PEST CONTROL ASSOCIATION (NCPA): 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 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.

NYLOFUME BAGS: Protective nylon bags available from distributors of Vikane used to seal and protect food, feed and medicines during a fumigation.

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.

OLD HOUSE BORER [*Hylotrupes bajulus* (L.)]: A re-infesting *Cerambycid* frequently a pest of newer structures. The larvae hollow out extensive galleries in seasoned softwood.

ORGANOGENESIS: The development or growth in the body.

ORIENTAL COCKROACH [(*Blatta orientalis* (L.)]: Also referred to as the waterbug, black beetle or shad roach, they are found across the U.S. and feed on rubbish and other decaying matter.

OUNCE-HOURS (OH): 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 present alone 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 wood, tarps, soil, etc.

PHOSGENE: A colorless gas with an odor of freshly cut hay. Frequently used in organic chemistry as a chlorinating agent.

POSTEMBRYONIC: After the formulation of the embryo.

POUNDS PER SQUARE INCH ABSOLUTE (PSIA): A measure of atmospheric pressure.

POWDERPOST BEETLES: The common name for the family of wood destroying beetles (Coleoptera: *Lyctidae*) whose larvae attack wood and wood products and reduce timbers to a mass of very fine, powderlike material. True powderpost beetles are *Lyctid* beetles, including *Lyctus brunneus* and *Lyctus planicollis*.

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.

SAFETY CAP: A covering that protects the cylinder valve from damage or accidental release of the fumigant.

SAND/WATER 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: 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.

SOCIAL INSECTS: Category of insects that live within a colony where there is 1) a division of labor between types of individuals (castes), 2) more than one generation is present and, 3) immature stages are cared for.

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 FAN: A fan in which the air flow through the impeller is primarily axil 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.

SUBTERRANEAN TERMITES: Social insects in the order *Isoptera*, family *Rhinot ermitidae*, which generally live underground in self-supporting colonies and require food (cellulose), moisture and soil to survive.

SULFURYL FLUORIDE: The active ingredient of Vikane, which is non-flammable, non-corrosive and does not cause undesirable odors, is a gas at temperatures above -67°F.

SWARMERS: Winged reproductive termites which fly out from established colonies looking for areas to establish new colonies.

TARPAULIN: Semi-permeable membranes used during fumigation to confine the fumigant in a specific area during the exposure period.

TEMPERATURE (°F): The pesticidal activity of a fumigant varies with temperature. The ounce-hour requirements for Vikane 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 sub-area soil or slab. A probe or surface thermometer can be used to measure temperature. The required ounce-hours are on the lower scale of the Fumiguide Y and can read opposite temperatures room 40 to 100°F. 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.

TERMITE: Wood destroying insects in the order *Isoptera* generally found in warmer regions which feed on the cellulose in wood to survive.

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.

TRAP METHOD: Tarpaulin removal aeration plan developed in California which can be used as a guide to minimize worker exposure during aeration procedures following a fumigation at a typical family residential structure.

UNDERSEAL: The rating of the surface below or under the structure being fumigated. The underseal can vary from a slab (concrete) to sandy soil. This factor is one of the five that will impact the estimated HLT for a fumigation.

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, Vikane is not corrosive.

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.

Specialty **P**roducts
Product **B**ulletin

Dow AgroSciences

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Fact Sheet for Vikane Gas Fumigant (Sulfuryl Fluoride)

In the interest of Dow AgroSciences' commitment to product stewardship, this fact sheet is intended to provide basic information about the product and how it is used. If you have specific questions about your fumigation, refer to documents provided by the fumigator or call the fumigator listed on the warning signs posted on your structure. If you have questions about Vikane* gas fumigant (the fumigant used) or the procedures described, call the Dow AgroSciences Customer Information Center at 1-800-352-6776.

WHY BUILDINGS ARE FUMIGATED

Insects that feed or tunnel into wood can seriously damage houses, apartments, and other dwellings or structures. Each year termites or other wood destroying insects damage approximately 2 million homes. Depending on the extent or location of the infestation, fumigation is the only total control method proven to eliminate certain infestations of wood destroying insects.

HOW BUILDINGS ARE FUMIGATED

Because Vikane is a gas, prior to fumigation, the structure is completely sealed. This serves to contain Vikane in the building so it can penetrate wood thoroughly and eliminate the pests. Depending on the construction of the building, the doors and windows may be sealed with tape and a plastic sheet, or the structure may be covered with a tarp. The building will remain sealed for 2-72 hours depending on the specifics of the job. Warning signs are posted around the building notifying people to keep out.

After the tarp or tape is removed, a professional fumigator will aerate the structure by opening the doors and windows. Fans may also be used to clear out the building. Once the dwelling has been thoroughly aerated, the fumigator is required to measure the level of any fumigant remaining in the living space to ensure it is below the EPA approved concentration for reentry by the occupants. Extremely low levels of fumigant can remain for a short period of time in dead air spaces between walls and inside cabinets as well as porous materials such as furniture. The small amount of fumigant in these areas will continue to dissipate for a few hours after the fumigation but at levels well below the established safe reentry concentration. Your building should not be cleared for reoccupancy until it is safe to enter. The fumigator will post a notice on your building indicating the day and time for reentry. Structures can be occupied only when the concentration is 5 parts per million or less (this represents a margin of safety - laboratory animals have been exposed to 100 parts per million for 2 weeks with no adverse effects.) Because Vikane is a true gas and not a vapor, aeration is rapid. Recent studies demonstrated that in most structures levels are less than 1 part per million within 6 hours of clearing and have no detectable levels of Vikane within 24 hours after the start of aeration.

Vikane is a federally Restricted Use Pesticide.

Sulfuryl fluoride is a colorless, odorless gas, so a warning agent is added to the building that causes watery eyes and a scratchy throat. If you experience these symptoms in a structure that has been recently fumigated, you should leave immediately and call the pest control company to have your building retested.

SULFURYL FLUORIDE (POTENTIAL HEALTH RISKS FROM OVEREXPOSURE)
Sulfuryl fluoride is a gas and can potentially enter your body only through inhalation. Because it is a gas, it does not stay on dry surfaces, therefore, there is no exposure from touching treated surfaces.

Nervous system and respiratory irritation:
Overexposure to high levels of sulfuryl fluoride can result in nose and throat irritation and nausea. At high concentrations (such as those used during the fumigation) it can cause excess fluid in the lungs, sleepiness, pneumonia, and convulsions. These symptoms would be expected to appear within 8 hours after such an exposure. In the unlikely event you experience these symptoms in the building that has been recently fumigated, you should leave immediately. Consult your physician and call the pest control company to have your building retested.

Additional studies:
Sulfuryl fluoride has not been shown to cause birth defects in pregnant animals exposed under experimental conditions. In addition, current studies have demonstrated there are no mutagenic or genotoxic effects caused by exposure to sulfuryl fluoride.

Safety Precautions and Homeowner Preparation

- Discuss the treatment program in advance with your pest control company so you fully understand what will be done and what you need to do.
- Carefully follow the instructions you are given about what items you are to remove from your building.
- Stay out of the treated building until it is cleared for reentry.
- If you are interested or concerned, you should ask your pest control company to show the records of how your building was aerated before it was cleared to reentry.
- You may wish to increase ventilation by opening doors and windows.

If you have specific questions about your fumigation, refer to documents provided by the fumigator or call the fumigator listed on the warning signs posted on your structure. Call the Dow AgroSciences Customer Information Center at 1-800-352-6776 if you need additional information or have questions concerning the product.