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Ref. T1/1.02

MSC.1/Circ.1358  
30 June 2010

**RECOMMENDATIONS ON THE SAFE USE OF PESTICIDES IN SHIPS**

- 1 The Maritime Safety Committee, at its sixty-second session (24 to 28 May 1993), approved the Recommendations on the safe use of pesticides in ships (MSC/Circ.612), proposed by the Sub-Committee on Containers and Cargoes at its thirty-second session.
- 2 The Maritime Safety Committee, at its eighty-seventh session (12 to 21 May 2010), approved the revised Recommendations on the safe use of pesticides in ships in pursuance of the requirement of SOLAS regulation VI/4, proposed by the Sub-Committee on Dangerous Goods, Solid Cargoes and Containers at its fourteenth session, as set out in the annex to the present circular.
- 3 Member Governments are invited to bring the revised Recommendations to the attention of competent authorities, mariners, fumigators, fumigant and pesticide manufacturers and others concerned.
- 4 The present circular supersedes MSC/Circ.612, as amended by MSC/Circ.689 and MSC/Circ.746.

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## **ANNEX**

### **REVISED RECOMMENDATIONS ON THE SAFE USE OF PESTICIDES IN SHIPS**

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## **1 INTRODUCTION**

1.1 These Recommendations have been compiled by the Sub-Committee on Dangerous Goods, Solid Cargoes and Containers under the direction of the Maritime Safety Committee of the International Maritime Organization (IMO).

1.2 Insects and rodents on ships are objectionable for various reasons. In addition to aesthetic and nuisance aspects, pests may damage equipment and spread disease and infection, contaminate food in galleys and food stores and cause damage to cargoes that will result in commercial or other losses. Very few pesticides are suitable for use against all kinds of pests that may occur aboard or in different parts of ships. It is therefore necessary to consider the main categories of pesticides individually.

### **1.2.1 Insects in cargo spaces and cargoes**

1.2.1.1 Insect and mite pests of plant and animal products may be carried into the cargo spaces with goods (introduced infestation): they may move from one kind of product to another (cross infestation) and may remain to attack subsequent cargoes (residual infestation). Their control may be required to comply with phytosanitary requirements to prevent spread of pests and for commercial reasons to prevent infestation and contamination of, or damage to cargoes of human and animal food.\* In severe cases of infestation of bulk cargoes such as cereals, excessive heating may occur.

### **1.2.2 Rodents**

1.2.2.1 Rodents should be controlled not only because of the damage they may do to cargo or the ship's equipment, but also, as required by the international health regulations, to prevent the spread of disease.

1.3 The following sections provide guidance to shipmasters in the use of pesticides\*\* with a view to safety of personnel and to avoidance of excessive residues of toxic agents in human and animal food. They cover pesticides used for control of insect\*\*\* and rodent pests in empty and loaded cargo spaces, in crew and passenger accommodation and in food stores. Account has been taken of existing recommendations of the World Health Organization (WHO), the International Labour Organization (ILO), and the Food and Agriculture Organization (FAO) of the United Nations, in regard to pesticide residues and occupational safety.

## **2 PREVENTION OF INFESTATION**

### **2.1 Maintenance and sanitation**

2.1.1 Ship cargo spaces, tank top ceilings and other parts of the ship should be kept in a good state of repair to avoid infestation. Many ports of the world have rules and by-laws dealing specifically with the maintenance of ships intended to carry grain cargoes; for example, boards and ceilings should be completely grain tight.

2.1.2 Cleanliness, or good housekeeping, is as important a means of controlling pests on a ship as it is in a home, warehouse, mill or factory. Since insect pests on ships become established and multiply in debris, much can be done to prevent their increase by simple, thorough cleaning. Box beams and stiffeners, for example, become filled with debris during

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\* References to human and animal food include both raw and processed material.

\*\* The word "pesticide" as used throughout the text means insecticides, fumigants and rodenticides. Examples of some commonly used pesticides are listed in the annex.

\*\*\* The word "insect" as used throughout the text includes mites.

discharge of cargo and unless kept clean can become a source of heavy infestation. It is important to remove thoroughly all cargo residues from deckhead frames and longitudinal deck girders at the time of discharge, preferably when the cargo level is suitable for convenient cleaning. Where available, industrial vacuum cleaners are of value for the cleaning of cargo spaces and fittings.

2.1.3 The material collected during cleaning should be disposed of, or treated, immediately so that the insects cannot escape and spread to other parts of the ship or elsewhere. In port it may be burnt or treated with a pesticide, but in many countries such material may only be landed under phytosanitary supervision. Where destruction ashore is not practicable, the sweepings should be jettisoned well out to sea. If any part of the ship is being fumigated the material may be left exposed to the gas.

## **2.2 Main sites of infestation**

2.2.1 Tank top ceiling: if, as often happens, cracks appear between the ceiling boards, food material may be forced down into the underlying space and serve as a focus of infestation for an indefinite period. Insects bred in this space can readily move out to attack food cargoes and establish their progeny in them.

2.2.2 Tween-deck centre lines, wooden feeders and bins are often left in place for several voyages and because of their construction are frequent sources of infestation. After unloading a grain cargo, burlap and battens covering the narrow spaces between the planks should be removed and discarded before the holds are cleaned or washed down. These coverings should be replaced by new material in preparation for the next cargo.

2.2.3 Transverse beams and longitudinal deck girders which support the decks and hatch openings may have an L-shaped angle-bar construction. Such girders provide ledges where grain may lodge when bulk cargoes are unloaded. The ledges are often in inaccessible places overlooked during cleaning operations.

2.2.4 Insulated bulkheads near engine-rooms: when the hold side of an engine-room bulkhead is insulated with a wooden sheathing, the air space and the cracks between the boards often become filled with grain and other material. Sometimes the air space is filled with insulating material which may become heavily infested and serves as a place for insect breeding. Temporary wooden bulkheads also provide an ideal place for insect breeding, especially under moist conditions, such as when green lumber is used.

2.2.5 Cargo battens: the crevices at the sparring cleats are ideal places for material to lodge and for insects to hide.

2.2.6 Bilges: insects in accumulations of food material are often found in these spaces.

2.2.7 Electrical conduit casings: sometimes the sheet-metal covering is damaged by general cargo and when bulk grain is loaded later, the casings may become completely filled. This residual grain has often been found to be heavily infested. Casings that are damaged should be repaired immediately or, where possible, they should be replaced with steel strapping, which can be cleaned more easily.

2.2.8 Other places where material accumulates and where insects breed and hide include:

- .1 the area underneath burlap, which is used to cover limber boards and sometimes to cover tank top ceilings;

- .2 boxing around pipes, especially if it is broken;
- .3 corners, where old cereal material is often found;
- .4 crevices at plate landings, frames and chocks;
- .5 wooden coverings of manholes or wells leading to double-bottom tanks or other places;
- .6 cracks in the wooden ceiling protecting the propeller shaft tunnel;
- .7 beneath rusty scale and old paint on the inside of hull plates;
- .8 shifting boards;
- .9 dunnage material, empty bags and used separation cloths; and
- .10 inside lockers.

### **3 CHEMICAL CONTROL OF INSECT INFESTATION**

#### **3.1 Methods of chemical disinfestations**

##### **3.1.1 Types of pesticides and methods of insect control**

3.1.1.1 To avoid insect population becoming firmly established in cargo spaces and other parts of a ship, it is necessary to use some form of chemical toxicant for control. The materials available may be divided conveniently into two classes: contact insecticides and fumigants. The choice of agent and method of application depend on the type of commodity, the extent and location of the infestation, the importance and habits of the insects found, and the climatic and other conditions. Recommended treatments are altered or modified from time to time in accordance with new developments.

3.1.1.2 The success of chemical treatments does not lie wholly in the pesticidal activity of the agents used. In addition, an appreciation of the requirements and limitations of the different available methods is required. Crew members can carry out small-scale or "spot treatments" if they adhere to the manufacturer's instructions and take care to cover the whole area of infestation. However, extensive or hazardous treatments including fumigation and spraying near human and animal food should be placed in the hands of professional operators, who should inform the master of the identity of the active ingredients used, the hazards involved and the precautions to be taken.

##### **3.1.2 Contact insecticides**

3.1.2.1 Space treatments – insecticides may be discharged into the air as fine particles of liquid or solid. There are a number of types of equipment for producing and distributing such particles. This method of treatment kills flying insects and deals with superficial infestation where exposed insects come into contact with the particles, whilst there may be limited residual pesticidal effect on surfaces on which the particles settle.

3.1.2.2 For use in cargo spaces, space sprays and fogs can be produced in several different ways. These include fog generators in which an insecticide in the form of a liquid or coarse spray is vaporized. Such vaporized insecticides may condense into fine particles on reaching cool air. Alternatively, fine particles may be produced mechanically from suitable formulations by

dispersing nozzles, venturi systems or centrifugal force. Insecticidal smokes are evolved from generators simply by igniting the material and such generators are a convenient form of application for use by ships' personnel.

3.1.2.3 Tests have shown that these insecticidal smokes and sprays can be very effective against insects moving freely in the open, in spaces such as holds. However, no appreciable penetration or control of insects can be obtained in deep crevices, or between or under deck boards, tank top ceilings and limber boards, places where infestation commonly occurs. Where insects are deep seated, it is usually necessary to use a fumigant.

3.1.2.4 Surface sprays – spraying with a suitable insecticide can also be used to control residual infestation. Within the limitations of the technique this is a convenient way to control insects as it does not require evacuation of spaces not being treated. Various formulations are available:

- .1 emulsifiable concentrates and water-dispersible powder concentrates for dilution with water; and
- .2 oil concentrates for dilution with a suitable carrier oil and, for small-scale use, ready-to-use formulations, usually in a light oil.

3.1.2.5 Hand-operated or mechanically-operated sprayers may be used according to the size of the job to be done. To reach the heights of some ships' holds, power equipment is required which will develop enough pressure to get the spray material where it is needed. Hand sprayers are rarely adequate; "Knapsack" sprayers which develop enough pressure to reach infested areas may be used. Such surface sprays produce a deposit toxic to insects present at the time and also to those that subsequently crawl over or settle on treated surfaces.

3.1.2.6 As with fogging, a disadvantage of spraying is that the insecticide does not kill insects hidden in inaccessible parts of cargo spaces. Insecticidal sprays applied in oil solutions or water emulsions take some time to dry and may be hazardous to persons moving about the ship. No cargo should be loaded until spray deposits have dried.

3.1.2.7 In addition to methods described above, insecticidal lacquers may be painted on to boundary junctures in accommodation and galley areas in accordance with the manufacturers' instructions, to provide control of pests. Hand sprayers and hand-held aerosols may also be effective in these areas.

3.1.2.8 During the application of contact insecticides by any method all personnel not directly involved should be evacuated from the areas being treated for a period of time not less than that recommended by the manufacturer of the specific pesticide used on the label or package itself.

### **3.1.3 Fumigants**

3.1.3.1 Fumigants are used where contact insecticides will not give control. Fumigants act in a gaseous phase even though they may be applied as solid or liquid formulations from which the gas arises. Effective and safe use requires that the space being treated be rendered gas-tight for the period of exposure, which may vary from a few hours to several days, depending on the fumigant type and concentration used, the pests, the commodities treated and the temperature. Additional information is provided on two of the most widely used fumigants, methyl bromide and phosphine (hydrogen phosphide) in the annex, paragraph 5.

3.1.3.2 Since fumigant gases are poisonous to humans and require special equipment and skills in application, they should only be used by specialists and not by the ship's crew.

3.1.3.3 Evacuation of the space under gas treatment is mandatory and in some cases it will be necessary for the whole ship to be evacuated (see 3.1.4 and the annex, paragraph 5).

3.1.3.4 A fumigator-in-charge should be designated by the Fumigation Company, Government Agency or appropriate authority. He should be able to provide documentation to the master proving his competence and authorization. The master should be provided with written instructions by the fumigator-in-charge on the type of fumigant used, the hazards involved, and the precautions to be taken, and in view of the highly toxic nature of all commonly used fumigants these should be followed carefully. Such instructions should be written in a language readily understood by the master or his representative.

### **3.1.4 Fumigation with aeration (ventilation) in port**

3.1.4.1 Fumigation and aeration (ventilation) of spaces on board a ship should always be carried out in port (alongside or at anchorage). Ships should not be permitted to leave port until gas-free certification has been received from the fumigator-in-charge.

3.1.4.2 Prior to the application of fumigants to spaces, the crew should be landed and remain ashore until the ship is certified "gas-free", in writing, by the fumigator-in-charge or other authorized person. During this period a watchman should be posted to prevent unauthorized boarding or entry, and warning signs should be prominently displayed at gangways and at entrances to accommodation.

3.1.4.3 The fumigator-in-charge should be retained throughout the fumigation period and until such time as the ship is declared gas-free.

3.1.4.4 At the end of the fumigation period the fumigator will take the necessary action to ensure that the fumigant is dispersed from the space. If crew members are required to assist in such actions, for example in opening hatches, they should be provided with adequate respiratory protection and adhere strictly to instructions given by the fumigator-in-charge.

3.1.4.5 The fumigator-in-charge should notify the master in writing of any spaces determined to be safe for re-occupancy by essential crew members prior to the aeration of the ship.

3.1.4.6 In such circumstances the fumigator-in-charge should monitor throughout the fumigation and aeration periods, spaces to which personnel have been permitted to return. Should the concentration in any such area exceed the occupational exposure limit values set by the flag State regulations or by the regulations of the port State where the fumigation is carried out, crew members should be evacuated from the area until measurements show re-occupancy to be safe.

3.1.4.7 No unauthorized persons should be allowed on board until all parts of the ship have been determined gas-free, warning signs removed and gas-free certificates issued by the fumigator-in-charge.

3.1.4.8 Gas-free certificates should only be issued when tests show that all residual fumigant has been dispersed from empty cargo spaces and adjacent working spaces and any residual fumigant material has been removed.

3.1.4.9 Entry into a space under fumigation should never take place except in the event of an extreme emergency. If entry is imperative the fumigator-in-charge and at least one other person should enter, each wearing adequate protective equipment including respiratory protection appropriate for the fumigant used and safety harness and lifeline. Each lifeline should be tended by a person outside the space, who should be similarly equipped.



### **3.2 Disinfestation of empty cargo spaces**

3.2.1 An empty cargo space may be treated by any of the methods described, excepting the use of insecticidal lacquers. Care should be taken to avoid contamination and taint to subsequent cargoes. Examples of some commonly used pesticides are listed in the annex. (For precautions see 3.1.4.)

### **3.3 Disinfestation of food stores, galleys, and crew and passenger accommodation**

3.3.1 In general only those insecticides suitable for use in cargo spaces should be used in dry food stores in ships. A wider range of insecticides may be needed for treatments in galleys and in passenger and crew accommodation, especially against pests such as cockroaches, ants, flies and bed-bugs. Examples of some commonly used pesticides are listed in the annex.

### **3.4 Disinfestation of cargoes and surrounds**

3.4.1 The recommendations applicable to the fumigation of loaded or partially loaded cargo holds are contained in MSC.1/Circ.1264.

### **3.5 Carriage of fumigated freight containers, barges and other cargo transport units on a ship**

3.5.1 The recommendations applicable to the fumigation of cargo transport units are contained in MSC.1/Circ.1265.

## **4 CONTROL OF RODENT PESTS**

### **4.1 General**

4.1.1 With regard to rodent control, ships are subject to the provisions of the WHO's International Health Regulations.

4.1.2 Rodents may be controlled by fumigation, by the use of a bait incorporating a poison which acts within a few minutes (acute poison), or one which acts over a period (chronic poison), or by trapping.

### **4.2 Fumigation and baiting**

4.2.1 Fumigation against rodents is normally done at dosages and periods of exposure much less than those required for insect control. It follows that an insect fumigation also controls rodents in areas that are treated. However, rodent control often requires fumigation of accommodation and working spaces that may not normally be treated for insect control.

4.2.2 Fumigation against rodents alone should be undertaken in port and ventilation completed in port. The precautions in 3.1.4 should be observed.

4.2.3 Methods involving fumigation or the use of acute poisons should be employed only by qualified personnel of pest control servicing firms or appropriate authorities (e.g., Port Health Authorities). Baits containing acute poisons should be collected and disposed of by such personnel when the treatment is completed. Chronic poisons should be used strictly in accordance with the manufacturer's instructions contained on the label or on the package itself.

### **4.3 Rodents baits – chronic poisons permitted for use by ship's personnel**

4.3.1 Careless use may cause injury to ship's personnel.

4.3.2 For rodenticides to be efficient, they should be placed where the rodents are moving. Runways are usually detected by evidence of marking, debris and dirt. The use of rodenticides, however, is no substitute for high standards of hygiene and the rodent proofing of equipment whenever possible.

4.3.2.1 Baits should be protected from accidental consumption by humans or domestic animals and from contact with human and animal food.

4.3.2.2 Where practicable, cereal baits should be replaced within 30 days to avoid providing a source of insect infestation.

4.3.3 A record should be kept of the locations in which baits are set, particular care being taken to search for and remove all baits from cargo spaces prior to the loading of bulk foodstuffs and livestock cargoes.

## **5 REGULATIONS FOR THE USE OF PESTICIDES**

### **5.1 National and international controls on pesticides usage**

5.1.1 In many countries the sale and use of pesticides are regulated by governments to ensure safety in application and prevention of contamination of foodstuffs. Among the factors taken into account in such regulations, are the recommendations made by international organizations such as the FAO and the WHO, especially in regard to maximum limits of pesticide residues in food and foodstuffs.

5.1.2 Examples of some commonly used pesticides are listed in the annex. Pesticides should be used strictly in accordance with the manufacturer's instructions as given on the label or package itself. National regulations and requirements vary from one country to another, therefore particular pesticides which may be used for treatment of cargo spaces and accommodation in ships may be limited by the regulations and requirements of:

- .1 the country where the cargo is loaded or treated:
- .2 the country of destination of the cargo, especially in regard to pesticide residues in foodstuffs; and
- .3 the country of registration of the ship.

5.1.3 Ships' masters should ensure that they have the necessary knowledge of the above regulations and requirements.

## **6 SAFETY PRECAUTIONS – GENERAL**

### **6.1 Pesticide materials**

6.1.1 Pesticides are often at least as poisonous to humans as to the pests against which they are used. The instructions given on the label or package itself, particularly those relating to safety and disposal of residual material, should be strictly followed.

6.1.2 Pesticides should be stored in strict compliance with national regulations and requirements or the manufacturers' instructions.

6.1.3 Smoking, eating or drinking while using pesticides should always be avoided.

6.1.4 Empty pesticide receptacles and packaging should never be re-used.

6.1.5 Hands should always be washed after applying pesticides.

## **6.2 Space and surface spraying** (see also 3.1.2 above)

6.2.1 When spraying is being carried out by professional operators they are responsible for taking the necessary safety precautions. If operations are carried out by the crew, the master should ensure that the following safeguards are observed, both in the preparation and the application of the pesticides:

- .1 wear protective clothing, gloves, respirators and eye protection appropriate to the pesticides being used;
- .2 do not remove clothes, gloves, respirators or eye protection whilst applying pesticides, even under hot conditions; and
- .3 avoid excessive application and run-off on surfaces and avoid contamination of foodstuff.

6.2.2 If clothing becomes contaminated:

- .1 stop work immediately and leave area;
- .2 remove clothing and footwear;
- .3 take a shower and wash skin thoroughly;
- .4 wash clothing and footwear, and wash skin again; and
- .5 seek medical advice.

6.2.3 After work:

- .1 remove and wash clothing, footwear and other equipment; and
- .2 take a shower using plenty of soap.

## **6.3 Fumigation**

6.3.1 Ships' personnel should not handle fumigants and such operations should be carried out only by qualified operators. Personnel allowed to remain in the vicinity of a fumigation operation for a particular purpose should follow the instructions of the fumigator-in-charge implicitly.

6.3.2 Aeration of treated spaces on board a ship should be completed and a gas-free certificate should be issued as described in 3.1.4 before personnel are permitted to enter.

#### **6.4 Exposure to pesticides resulting in illness**

6.4.1 In the case of exposure to pesticides and subsequent illness, medical advice should be sought immediately. Information on poisoning by specific compounds may be found in the IMO Medical First Aid Guide for use in Accidents Involving Dangerous Goods (MFAG), or on the package (manufacturer's instructions and safety precautions on the label or the package itself).

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## ANNEX

### PESTICIDES SUITABLE FOR SHIPBOARD USE

#### 1 INTRODUCTION

1.1 The materials listed should be used strictly in accordance with the manufacturers' instructions and safety precautions, given on the label or package itself, especially in respect of flammability and with regard to any further limitations applied by the law of the country of loading, destination or flag of the ship, contracts relating to the cargo, or the shipowner's instructions.

1.2 Materials may be used by ship's personnel unless the contrary is indicated. A space-application insecticide may be used in conjunction with a residual insecticide.

1.3 It should be especially noted that some materials listed may taint sensitive commodities, e.g., coffee and cocoa, and special care should be taken when stowing these commodities in order to prevent this. The reason for naming purified grades in the list below is to minimize tainting.

#### 2 CONTACT INSECTICIDES IN A CARGO SPACE

2.1 Fast-acting insecticides for space application, e.g., against flying insects:

- .1 Pyrethrins (with or without synergist);
- .2 Bioresmethrin; and
- .3 Dichlorvos.

2.2 Slower-acting residual insecticides for surface application:

- .1 Malathion (premium grade);
- .2 Bromophos;
- .3 Carbaryl;
- .4 Fenitrothion;
- .5 Chlorpyrifos-methyl; and
- .6 Pirimiphos-methyl.

#### 3 CONTACT INSECTICIDES AND BAITS IN ACCOMODATION

3.1 Fast-acting insecticides for space application, e.g., against flying insects:

- .1 Pyrethrins (with or without synergist);
- .2 Bioresmethrin; and
- .3 Dichlorvos.

3.2 Slower-acting residual insecticides:

- .1 Malathion (premium grade);
- .2 Diazinon;
- .3 Fenitrothion;
- .4 Propoxur;
- .5 Bendiocarb; and
- .6 Permethrin.

3.3 Insecticides for use against particular pests and as an additional treatment:

- .1 Diazinon, as an aerosol spray or lacquer against ants, cockroaches and flies;
- .2 Dieldrin and Aldrin, in lacquers for control of ants and cockroaches;
- .3 Methoprene bait, for control of Pharaoh's ants; and
- .4 Chlorpyrifos-ethyl, as a bait and as a lacquer.

4 RODENTICIDES

4.1 Chronic poisons in baits:

- .1 Calciferol; and
- .2 Any Anticoagulant in the following two classes:
  - .2.1 Hydroxycoumarins (e.g., Warfarin, Fumarin, Coumatetralyl, Difenacoum, Brodifacoum); and
  - .2.2 Indandiones (e.g., Pival, Diphacinone, Chlorphacinone).

4.2 Acute poisons in baits or liquids:

TO BE USED ONLY IN PORT AND BY QUALIFIED OPERATORS

- .1 Barium fluoroacetate;
- .2 Fluoroacetamide;
- .3 Sodium fluoroacetate; and
- .4 Zinc phosphide.

## 5 FUMIGANTS

### TO BE APPLIED ONLY BY QUALIFIED OPERATORS

Additional information on methyl bromide and phosphine (hydrogen phosphide) to be read in conjunction with 3.1.3.

#### **Methyl bromide**

Methyl bromide is used in situations where a rapid treatment of spaces or commodities is required. Fumigation with methyl bromide should be **permitted only when the ship is in the confines of a port** (either at anchor or alongside) and to disinfest the spaces after the crew members have disembarked (see 3.1.3.3). Prior to re-embarkation of the crew, ventilation of the treated spaces should be completed and a gas-free certificate should be issued as described in 3.1.4 before personnel are permitted to enter.

#### **Phosphine (Hydrogen phosphide)**

A variety of phosphine-generating formulations are used for at-berth fumigations and also for in-ship in-transit fumigations. Application methods vary widely and include surface only treatment, probing, perforated tubing laid at the bottom of spaces, recirculation systems and gas-injection systems or their combinations. Ventilation of the treated spaces should be completed and a gas-free certificate should be issued as described in 3.1.4 before personnel are permitted to enter. **All safety recommendations related to the fumigation of cargo in cargo holds under in-ship in-transit fumigation are laid down in MSC.1/Circ.1264.**

5.1 Fumigants against insects in empty cargo spaces and against rodents anywhere aboard ship:

Carbon dioxide

Nitrogen

Methyl bromide and carbon dioxide mixture

Methyl bromide

Hydrogen cyanide

Phosphine (Hydrogen phosphide)

5.2 Fumigants against insects in loaded or partially loaded cargo spaces and cargo transport units:

Refer to MSC.1/Circ.1264 and MSC.1/Circ.1265

**CARE IS NEEDED IN SELECTING TYPES AND AMOUNTS OF FUMIGANTS FOR TREATMENT OF PARTICULAR COMMODITIES**

.1 Carbon dioxide;

.2 Nitrogen;

- .3 Methyl bromide and carbon dioxide mixture;
  - .4 Methyl bromide; and
  - .5 Phosphine (Hydrogen phosphide).
-