



Carefully to Carry

Fumigation of ships and their cargoes

Introduction

Fumigation is a procedure that is used throughout the world to eradicate pests that infest all types of goods, commodities, warehouses, processing factories and transport vehicles including ships and their cargoes.

1. What are fumigants and how do they work?

Fumigants are gases, which are toxic to the target infestation. They can be applied as gas, liquid or in solid formulations, but after vaporisation from liquids or reaction products from solids, always act in the gaseous phase. They act either as respiratory poisons, or as suffocants in the case of controlled or modified atmospheres. On release, they mix with air at a molecular level. They are capable of rapidly diffusing from one area to another and through commodities and buildings.

Fumigants should not be confused with smokes, which are solid particles in air, or with mists, aerosols or fogs, which are liquid droplets, of various sizes, in air. Smokes, mists, aerosols or fogs are not fumigants as they are unable to diffuse (i.e. they do not mix with air at a molecular level) and do not reach deep-seated infestations in commodities or structures.

The fumigant gases used to carry out the fumigation process are numerous, but the most commonly used currently for the treatment of ships cargoes are phosphine and methyl bromide. Others used are carbon dioxide and more recently sulfuryl fluoride, which is starting to replace the use of methyl bromide.

1.1 How does a fumigant gas work effectively?

The critical parameters, which need to be considered for fumigants to be effective are:

- Nature of infestation (type of pest, e.g. rodent, insect or beetle, and stage of its life cycle).
- Type of fumigant applied.
- Concentration and distribution of gas.
- Temperature.
- Length of time fumigant must be applied.
- Method by which fumigant is administered.
- Containment of fumigant. Nature of commodity.
- Nature of commodity packaging.
- Monitoring system.
- Ventilation system.

1.2 Aim of fumigation

Fumigation aims to create an environment, which will contain an effective concentration of fumigant gas at a given temperature, for a sufficient period of time to kill any live infestations. Both the time measured (hours or days) of exposure and concentration of gas is critical to fumigation efficiency. Dosages applied are usually expressed as grams per cubic metre, concentrations measured during the fumigation are usually expressed in parts per million (PPM) or grams per cubic metre, and total concentrations actually achieved, as concentration-timeproducts (CTPs). The fumigation process is not completed until ventilation has been effectively carried out, and removal of any residues is completed.



“The carrier shall properly and carefully load, handle, stow, carry, keep, care for and discharge the goods carried.”

Hague Rules, Articles iii, Rule 2

Carefully to Carry Advisory Committee

This report was produced by the Carefully to Carry Committee – the UK P&I Club's advisory committee on cargo matters. The aim of the Carefully to Carry Committee is to reduce claims through contemporaneous advice to the Club's Members through the most efficient means available.

The committee was established in 1961 and has produced many articles on cargoes that cause claims and other cargo related issues such as hold washing, cargo securing, and ventilation.

The quality of advice given has established Carefully to Carry as a key source of guidance for shipowners and ships' officers. In addition, the articles have frequently been the source of expertise in negotiations over the settlement of claims and have also been relied on in court hearings.

In 2002 all articles were revised and published in book form as well as on disk. All articles are also available to Members on the Club website.

Visit the Carefully to Carry section in the Loss Prevention area of the Club website www.ukpandi.com for more information, or contact the Loss Prevention Department.

2 When can ships' cargoes be fumigated?

The ship's cargo can be fumigated and ventilated:

- In warehouse or storage silos before loading.
- In freight containers before loading.
- In the hold of the ship with fumigation and ventilation completed before sailing.

or

- In the hold prior to sailing with fumigation continued during the voyage (intransit).
- In freight containers before loading with fumigation continuing during the voyage (intransit).

In these situations the fumigation continues during the voyage and is not finished until the ventilation and removal of residues is completed, which is normally at the first discharge port.

3. Rules, regulations and guidelines that affect the fumigation process

3.1 The United Nations International Maritime Organisation (IMO) Safety of Life at Sea (SOLAS) Convention places an obligation on all governments to ensure all shipping activities are carried out safely.

3.2 The Recommendations on the Safe Use of Pesticides in Ships (IMO Recommendations) published by the IMO (revised 2002) are intended as a guide to all those involved in the use of pesticides and fumigants on ships and are recommended to governments in respect of their legal obligations under the SOLAS Convention.

These recommendations are referred to throughout this document as within the IMO Recommendations.

3.3 Individual countries (e.g. US and Canadian Coastguard) have their own requirements, but some governments have chosen to make the IMO Recommendations mandatory on all vessels in their territorial waters (e.g. UK).

3.4 The IMO International Maritime Dangerous Goods (IMDG) Code, which is mandatory in many parts of the world under SOLAS, specifically relates to the fumigation of packaged goods only and will be referred to under section 8 on freight container fumigation.

The fumigation of packaged goods and freight container recommendations, are referred to throughout this document as within the IMDG Code.

3.5 The International Maritime Fumigation Organisation (IMFO) Code of Practice (COP) provides clear guidance to fumigators and ships' masters in respect of bagged and bulk cargoes, in addition to packaged goods.

IMFO is an organisation of independent maritime fumigation servicing companies with members in many countries. See Annex 2.

4. Fumigants that can be used for intransit fumigation of bulk and bagged cargoes in ships' holds

4.1 The most widely used fumigant for intransit fumigation is phosphine (PH₃). The gas is normally generated from

aluminium phosphide or sometimes magnesium phosphide, but can also be applied direct from cylinders.

4.2 Methyl bromide should never be used for fumigation intransit (IMO Recommendations, Annex 1D).

4.3 Insecticides such as dichlorvos, pirimiphos-methyl, malathion, permethrin and others may be sprayed on to the grain during loading. These are not fumigants and should be allowed provided data is provided to the master as set out in IMO Recommendations 6.2 and 6.4 and Annex 1A.

5. Intransit fumigation of bulk and bagged cargoes with phosphine gas

5.1 Phosphine is only fully effective if a lethal concentration is maintained for a period of time that can be as little as 3 days or as much as 3 weeks.

The actual time needed will vary according to the cargo temperatures, insect species that may be present, and the system of fumigation (refer to Annex 1 of this article for brief details of the types of system).

This is the reason why fumigation with phosphine is almost always carried out during the voyage (intransit) so that the voyage time can be used to ensure a fully effective treatment.



Probing aluminium phosphide in retrievable sleeves into a bulk cargo

5.2 When the owners/charterers/master agree to fumigation being carried out intransit with phosphine, the master should ensure he is familiar with the requirements of IMO Recommendations 3.4.3.1. - 3.4.3.20. This will enable the master to be clear what the obligations of both fumigator and master are. A checklist of these obligations is as follows:

5.2.1 Fumigator

To provide written documentation in respect of the following:

- Pre-fumigation inspection certificate.
- Standard safety recommendations for vessels with fumigated grain cargoes.
- Gas tightness statement.
- Statement of vessel suitability for fumigation and fumigant application compliance.
- Manufacturers information or safety data sheet.
- First aid and medical treatment instructions.
- Fumigation certificate.
- Fumigation plan.



Ventilating the cargo prior to discharge



Checking the gas concentrations in the cargo prior to discharge

- Instructions for the use of the phosphine gas detecting equipment.
- Precautions and procedures during voyage.
- Instructions for aeration and ventilation.
- Precautions and procedures during discharge.
- Also to provide sufficient additional respiratory protective equipment (RPE) where necessary to the vessel, to ensure the requirements of IMO in respect of RPE are available for the duration of the voyage. (Note; the RPE may consist of SCBA or canister respirators or a combination of both but the minimum requirement is for 4 sets of RPE).

Refer also to IMO Recommendations Annex 4.

5.2.2 Master

- Appoint a competent crewmember to accompany the fumigator during the inspections/testing of empty holds prior to loading to determine whether they are gas tight, or can be made gas tight and, if necessary, what work is to be carried out to ensure they are gas tight.
- Ensure the crew is briefed on the fumigation process before fumigation takes place.
- Ensure the crew search the vessel thoroughly to ensure there are no stowaways or other unauthorised personnel onboard before fumigation takes place.
- Appoint at least two members of the crew to be trained by the fumigator to act as representatives of the master during the voyage to ensure safe conditions, in respect of the fumigations, are maintained onboard the ship during the voyage.
- After the fumigant has been applied and appropriate tests have been completed, the master should provide

his representative to accompany the fumigator, to make a check that all working spaces are free of harmful concentration of gas (IMO Recommendations 3.4.3.11).

- When the fumigator has discharged his responsibilities, the fumigator should formally hand over in writing responsibility to the master for maintaining safe conditions in all occupied areas, which the master should accept (IMO Recommendations 3.4.3.12).
- It must be clearly understood by the master that, even if no leakage of fumigant is detectable at the time of sailing, this does not mean that leakage will not occur at some time during the voyage due to the movement of the ship or other factors. This is why it is essential the master ensures regular checks are carried out during the voyage.
- During the voyage, the master should ensure that regular checks for gas leakage should be made throughout all occupied areas and the findings recorded in the ships log (IMO Recommendations 3.4.3.13). If any leakage is detected appropriate precautions to avoid any crew being exposed to harmful concentrations must be taken. If requested to do so by the fumigator, the master may, prior to arrival at the first discharge port, start the ventilation of the cargo spaces.
- Prior to arrival at the first discharge port the master should inform the authorities at the port that the cargo has been fumigated intransit. (IMO Recommendations 3.4.3.16).
- On arrival at the discharge port the master should not allow discharge of the cargo to commence until he is satisfied that the cargo has been correctly ventilated and aluminium phosphide residues that can be removed have been removed, and that any other requirements of the discharge port have been met (IMO Recommendations 3.4.3.17). Refer also to IMO Recommendations, Annex 4.

6. Fumigation of bulk and bagged cargo with ventilation in port

This procedure can be used either after loading and prior to sailing (6.1) or on arrival at the discharge port prior to discharging (6.2).

6.1 After loading and prior to sailing

Phosphine fumigation is the only fumigant that should be accepted for this procedure, as methyl bromide (though frequently used) is not recommended (IMO Recommendations, Annex 1D). Phosphine fumigation and ventilation in port, prior to sailing, will normally take from 1-2 weeks to complete and therefore is only occasionally specified. All procedures as for intransit fumigation should be followed to ensure a safe and effective fumigation.

6.2 At discharge port prior to discharge

Methyl bromide is the most common fumigant used for this purpose as it is normally possible to achieve an effective fumigation of the cargo in 24-48 hours. The crew should be landed and remain ashore until the ship is certified 'gas free' in writing by the fumigator in charge. The fumigator is responsible for the safety and efficiency of the fumigation, though crewmembers may remain in attendance to ensure the safety of the ship provided they adhere to safety instructions issued by the fumigator in charge.

The ventilation of methyl bromide from cargoes can be a very slow process if sufficient powered ventilation is not available and the master (or his representative) should ensure that the fumigator has ensured that residues of gas are below the TLV (IMO Recommendations, Annex 2) throughout all parts of the cargo and holds. Phosphine fumigation and ventilation in port, prior to discharge, will normally take from 1-2 weeks to complete and therefore is only occasionally specified. All procedures as for intransit fumigation should be followed to ensure a safe and effective fumigation.

7. Fumigation of empty cargo holds and/or accommodation to eradicate rodent or insect infestation

7.1 Methyl bromide is the most common fumigant used for this purpose (although hydrogen cyanide (HCN) or sulfuryl fluoride may be used in some countries) as it is normally possible to achieve an effective fumigation of the empty spaces in 12-24 hours.

7.2 The crew should be landed and remain ashore until the ship is certified 'gas free' in writing by the fumigator in charge as for 6.2 above.

8. The intransit fumigation of freight containers

8.1 The reason for the fumigation of containers is normally to try to ensure that when the goods arrive at the discharge port they are free of live pests/ insects.

8.2 Containers are normally fumigated and subsequently ventilated prior to being loaded onboard the ship. Containers that have been fumigated and subsequently ventilated and where a 'certificate of freedom from harmful concentration of gas' has been issued, can be loaded onboard ships as if they had not been fumigated (IMO Recommendations 3.5.2.1).

8.3 Frequently containers are fumigated but not ventilated prior to loading and these containers are therefore

fumigated intransit, as the ventilation process will not take place until after they have been discharged from the ship. The carriage of containers intransit under fumigation is covered by the IMDG Code whereby these containers are classified in Section 3.2 Dangerous Goods List as 'Fumigated unit Class 9 UN 3359'. Also refer to the IMDG Code Supplement Section 3.5.1 and 3.5.2 of chapter called 'Safe use of pesticides in ships'.



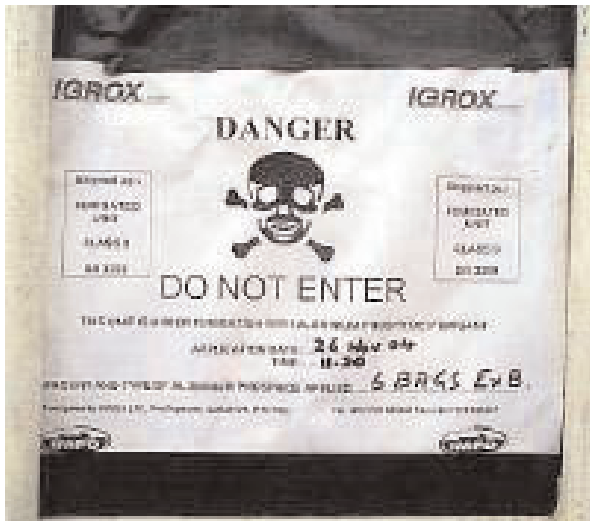
WARNING - Containers are still sometimes shipped under fumigation with no warning notices attached and no accompanying documentation stating they have been fumigated. This process is in direct contravention of the IMDG Code. There may be dangerous levels of fumigant gas inside the container when it arrives at its destination which is both illegal and dangerous.

8.3.1 Obligations on the fumigator

- The fumigator must ensure that, as far as is practicable, the container is made gas tight before the fumigant is applied.
- The fumigator must ensure that the containers are clearly marked with appropriate warning signs stating the type of fumigant used and the date applied and all other details as required by the IMDG Code and IMO Recommendations Annex 3.
- The fumigator must ensure the agreed formulation of fumigant is used at the correct dosage to comply with the contractual requirements.

8.3.2 Obligations on the exporter

- The exporter must ensure that the containers are clearly marked by the fumigator with appropriate warning signs stating the type of fumigant used and the date applied and all other details as required by the IMDG Code and IMO Recommendations Annex 3.
- The exporter must ensure that the master is informed prior to the loading of the containers.
- The exporter must ensure that shipping documents show the date of fumigation and the type of fumigant and the amount used all as required in the IMDG Code, volume 1, page 35 and specifically section 9.9.



8.3.3 Obligations on the master

- The master must ensure that he knows where containers under fumigation are stowed.
- The master must ensure he has suitable gas detection equipment onboard for the types of fumigant present, and that he has received instructions for the use of the equipment.
- Prior to arrival of the vessel at the discharge port the master should inform the authorities at the discharge point that he is carrying containers under fumigation.
- If the master (or his representative) suspects that unmarked containers may have been fumigated and loaded onboard they should take suitable precautions and report their suspicions to the authorities prior to arrival at the discharge port.

8.3.4 Obligations on the receivers

- The receiver (or his agent) must ensure that any fumigant residues are removed, and the container checked and certificated as being free from harmful concentrations of fumigant by a suitably qualified person before the cargo in the container is removed.

For further information: International Maritime Organisation, 4 Albert Embankment, London, SE1 7SR
Tel: 0207 735 7611. Fax: 0207 587 3210
Website: <http://www.imo.org>

International Maritime Fumigation Organisation, Friars Courtyard, 30 Princes Street, Ipswich, Suffolk, IP1 1RJ or any member worldwide. See - <http://www.imfo.com>.

Annex 1

A summary of the various methods of phosphine application methodology that can be considered for intratransit fumigation of bulk or bagged cargoes in ships' holds.

1. **Application of tablets or pellets to cargo surface (or into the top half metre).**
High concentrations of gas build up in the head space, potentially resulting in a lot of leakage through the hatchcovers unless they are very well sealed. Very little penetration down into the cargo. Powdery residues cannot be removed. Good kill of insects in top part of

cargo but negligible effect on eggs or juvenile or even adults in lower part of cargo.

2. **Application of tablets or pellets by probing into the cargo a few metres.**
Less loss of gas through hatchcovers than in 1. Better penetration of gas than when applied on surface only but unlikely to be fully effective unless holds are relatively shallow and voyage time relatively long. Powdery residues cannot be removed.
3. **Application of tablets or pellets by deep probing into the full depth of the cargo.**
This is difficult to achieve and currently practically impossible if the cargo is more than 10 metres deep. Ensures effective fumigation provided voyage time is relatively long to allow gas to distribute. Powdery residues cannot be removed.
4. **Application of aluminium phosphide in blankets, sachets or sleeves, placed on the surface of the cargo (or into the top half metre).**
All points the same as 1, except that with this method powdery residues can be removed prior to discharge.
5. **Application of tablets or pellets by probing into the cargo a few metres in retrievable sleeves.**
All points as for 2, except that with this method powdery residues can be removed prior to discharge.
6. **Fitting of an enclosed powered re-circulation system to the hold and application of aluminium phosphide tablets or pellets to the surface.**
This will ensure the gas is distributed throughout the cargo evenly and rapidly making maximum use of the fumigant in the shortest possible time. Powdery residues cannot be removed.
7. **Fitting of an enclosed powered re-circulation system to the hold and application of aluminium phosphide in blankets, sachets or sleeves on the surface or probed into the top one or two metres.**
As for 6, except that with this method, powdery residues can be removed. Also gaseous residues can be removed more easily than with other methods, as once the powdery residues have been removed the re-circulation system can be used to assist this to happen rapidly.
8. **Deep probing into the full depth of the cargo (however deep) with tablets or pellets (in retrievable sleeves when required).**
This is being developed in Canada but is not yet available. Also deep probing using pre-inserted pipes. Will enable good distribution of gas to be achieved without the requirement for a powered recirculation system, provided the voyage is long enough.
9. **Use of powered re-circulation system with phosphine from cylinders.**
This is not yet available but could be in the future and will enable phosphine fumigation to be carried out without using aluminium phosphide. This will mean no powdery residues to deal with and therefore residue and safety problems at the discharge port will be minimised. A powered re-circulation system will be needed to enable this system to work with maximum efficacy.

Annex 2

References

International Maritime Organisation *Recommendations on the Safe Use of Pesticides in Ships* revised 2002. Published by IMO, 4 Albert Embankment, London, SE1 76R

International Maritime Organisation *The International Maritime Dangerous Goods Code (IMDG Code) Volumes 1, 2 and Supplement* (which includes the *Recommendations on the Safe Use of Pesticides in Ships* referred to above). Published by IMO London as above. Refer to Dangerous Goods List under entry UN 3359.

The International Maritime Fumigation Organisation (IMFO) *Code of Practice (COP)* Obtainable from the IMFO website <http://www.imfo.com>

