Chapter 46 – Agricultural Produce – Insect Infestation and Fumigation

Fumigant gases are poisonous to humans and should only be used by specialists, not by the ship's crew.

Insect and mite pests of plant products may be found within cargo spaces as:

- Introduced infestation (carried on board with the produce)
- cross infestation (moved across from one product parcel to another)
- residual infestation (remaining on board from a prior infested cargo to attack subsequent cargo).

The principal method of treating cargo spaces or their contents for the control of insects is by fumigation, which is the action of an insecticidal chemical in its gas phase. The chemical can be applied as a gas, liquid or in solid formulation, but after vaporisation from liquids or reaction from solids, will always act in the gaseous phase. Fumigants 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 and 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 (ie they do not mix with air at a molecular level) and do not reach deep-seated infestations in commodities or structures.

The most common fumigant is phosphine (PH_3), which is extremely toxic.

The effective and safe use of fumigants requires the space being treated to be rendered gastight for the period of exposure, which may vary from a few hours to several days, depending on the type of fumigant and concentration used, the pests, the commodities being treated and the ambient temperature.

The critical parameters that need to be considered for effective fumigation are:

- Nature of infestation (type of pest, eg rodent, insect or other invertebrate, and stage of its life cycle)
- type of fumigant applied
- concentration and distribution of gas
- ambient temperature
- length of time for which fumigant must be applied
- method by which fumigant is administered
- containment of fumigant
- nature of commodity
- nature of commodity packaging
- monitoring system
- ventilation system.

The other chemical used for fumigation on board ships is methyl bromide, also known as bromomethane.

Exposure to methyl bromide is highly irritating to the skin, eyes and airways. Irritation of the airways can cause coughing, chest tightness and a burning sensation in the nose and throat. It may also cause nausea, vomiting and abdominal pain if it is inhaled in large volumes. As of 2010, this chemical was banned within the EU due to its adverse effects on humans, health and the environment (it is also a greenhouse gas). However, as only the EU has banned its use, it may still be found in use as a fumigant in other parts of the world, or in cargoes loaded outside of the EU.

46.1 Aim of Fumigation

The aim of fumigation is to create an environment that 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 the concentration of gas are 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 time products (CTPs). The

fumigation process is not completed until ventilation has been effectively carried out and the removal of any residues is completed.

Evacuation of the space under gas treatment is essential and, in some cases, it will be necessary for the whole ship to be evacuated.

The Master will require the fumigator to provide written information on the type of fumigant to be used, to include the hazards involved, the threshold limit values (TLV) and the precautions to be taken.

The fumigation of cargoes with phosphine gas is by the use of tablets, pellets or solid preparations in other physical forms which are supplied by the manufacturers in hermetically-sealed containers. The active ingredient of these preparations is either aluminium phosphide or magnesium phosphide. These substances are highly reactive with water and, as the preparations are removed from their sealed containers, the active ingredient comes into contact with atmospheric water vapour and yields phosphine gas into the cargo space under fumigation. Phosphine is extremely toxic, so the crew evacuation procedures should apply. However, shippers or charterers frequently supply phosphine-releasing fumigants and request the Master to arrange for them to be applied to the cargo by the ship's crew during the course (often towards the end) of the voyage. Such requests flagrantly contravene IMO recommendations.

As well as this serious issue (applying apparently different procedural standards to the fumigation of goods according to which fumigant is employed), two further important points should be made in relation to requests to fumigate the goods while on passage:

- To fulfil such a request, it would be necessary to open the weather-deck hatch covers while at sea to apply the fumigant and then to release and re-secure them. This may involve considerable risk and is contrary to good practice
- fumigation is incompatible with the need to ventilate the cargo as may be required by the prevailing climatic conditions. This will exacerbate ship's sweat, if the prevailing conditions are conducive to its formation, and may lead to an adverse effect upon the cargo.

As well as being highly toxic, phosphine gas is also highly flammable with a low flammability level of 1.8% by volume in air.

Therefore, it is likely that potentially explosive mixtures of air and phosphine are encountered during the first 12 to 24 hours of phosphine fumigations when the phosphine concentration in the cargo hold reaches its peak. The high concentrations of phosphine then disperse by diffusion, with the gas diffusing into the less accessible portions of the cargo hold, removing the explosion risk.

Reference should be made to the following IMO guidance:

- The IMDG Code (Reference 19). The IMDG Supplement includes copies of the following three Circulars in 'Recommendations on the Safe Use of Pesticides in Ships'
- *Revised Recommendations on the Safe Use of Pesticides in Ships* (MSC.1/Circ.1358) (Reference 1)

- *Recommendations on the Safe Use of Pesticides in Ships Applicable to the Fumigation of Cargo Holds* (MSC.1/Circ.1264) (Reference 51)
- *Revised Recommendations on the Safe Use of Pesticides in Ships Applicable to the Fumigation of Cargo Transport Units* (MSC.1/Circ.1361/Rev.1) (Reference 52).

The relevant sections should be studied very carefully by Masters, always bearing in mind the following recommendations (Reference 51):

- *"Fumigation in transit should only be carried out at the discretion of the master*
- *in-ship in-transit fumigations with Methyl Bromide should not be carried out. Fumigation with Methyl Bromide should be permitted only when the ship is in the confines of a port (either at anchor or alongside) ... once crew members have disembarked"*.

The IMO recommendations permit discretionary usage of phosphine in transit. It is possible that this has led to common misconception that phosphine gas is less toxic and that, consequently, non-specialists such as ships' crew may apply phosphine-releasing preparations prior to or during a sea voyage. It must be clear that this belief is incorrect and potentially dangerous. Masters should never agree to requests for the ship's crew to apply phosphine-releasing preparations in cargo spaces at any time, whether at sea or not.

46.2 Fumigation Continued in Transit

If fumigation that began in port is to be continued in transit, it is strongly recommended that the Master should have access to *Recommendations on the Safe Use of Pesticides in Ships* (Reference 1) and be familiar with all relevant sections. This will enable them to make suitably informed decisions as to whether or not to allow fumigation to be continued in transit and, if such fumigation is allowed, to be aware of and to implement the appropriate safety precautions that should be taken before the ship leaves port and during the course of the voyage.

When specialists apply phosphine in port with a view to the fumigation being continued in transit, they usually install flexible pipework in stows to circulate the phosphine gas better throughout the stow. This provides more effective fumigation of deep stows than would be achieved by applying the fumigant only to the surface of the stow and relying on diffusion alone to deliver the gas to the lower regions of the stow.

When the owners/charterers/Master agree to phosphine fumigation being carried out in transit, the Master should be clear both as to their own obligations and those of the fumigator:

Fumigator
The fumigator provides written documentation in respect of the following:

- Pre-fumigation inspection certificate
- standard safety recommendations for vessels with fumigated grain cargoes
- gastightness statement

- statement of vessel suitability for fumigation and fumigant application compliance
- manufacturer's information or safety data sheet
- first aid and medical treatment instructions
- fumigation certificate
- fumigation plan
- instructions for the use of the phosphine gas detecting equipment
- precautions and procedures during the voyage
- instructions for aeration and ventilation
- precautions and procedures during discharge.

Master

It is the Master's responsibility to:

- Appoint a competent crew member to accompany the fumigator during the inspections/testing of empty holds prior to loading, to determine whether they are gastight or can be made gastight and, if necessary, what work is to be carried out to ensure they are gastight
- ensure the crew is briefed on the fumigation process before fumigation takes place
- ensure that the crew search the vessel thoroughly to ensure there are no stowaways or other unauthorised personnel on board 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 that safe conditions in respect of the fumigation are maintained on board during the voyage
- provide, after the fumigant has been applied and appropriate tests have been completed, a representative to accompany the fumigator to check that all working spaces are free from harmful concentrations of gas
- accept responsibility for maintaining safe conditions in all occupied areas after the fumigator has discharged their responsibilities. The fumigator should formally hand over responsibility to the Master in writing
- fully understand 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 point during the voyage, due to the movement of the ship or other factors. This is why it is essential that the Master ensures that regular checks are carried out during the voyage
- ensure that during the voyage regular checks for gas leakage are made throughout all occupied areas and the findings recorded in the ship's log. 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 ventilation of the cargo spaces
- inform the Port Authorities, prior to arrival at the first discharge port, that the cargo has been fumigated in transit
- only allow discharge of the cargo to commence after they are satisfied that the cargo has been correctly ventilated, any aluminium phosphide residues that can be removed have been removed, and any other requirements of the discharge port have been met.

46.3 Compatibility between Fumigant and Cargo

It should be borne in mind that compatibility between the fumigant and the particular cargo being carried needs to be determined. Decisions on this point should be left to specialists. However, it should be noted that, while fumigants are suitable for many different cargoes, they are not suitable for all.

46.4 Charterparties

Charterparties may provide the charterer with an option to fumigate cargoes (usually cereal grains and oil seeds or similar agricultural produce) on board after loading has been completed. While it is convenient for the charterer or the shipper to fumigate cargoes on board instead of ashore, problems may well be experienced as a result of this practice. Before considering the most significant problems that may be encountered, it is worth remembering that, although the goods may have been fumigated prior to loading, this will not necessarily mean they are free of all live insects. Insects in one or other of their metamorphic stages of development may still be present in the products because no treatment against insects is permanent.

A standard sale contract usually requires cargoes such as cereal grains to be free from 'live infestation' at the time of shipment. However, rarely, if ever, will such a cargo be absolutely free from insects.

Although the terms of the contract of sale may only affect the relationship between the buyer and the seller, it makes little sense to expect a Master to adopt a standard that is at odds with the standards anticipated in standard forms of contract.

If the expectation of the standard contract of sale is that the goods should be 'free' of live infestation at the time of shipment but infestation is clearly apparent to the Master at that time, they are bound to conclude that the goods are not in apparent good order and condition.

If clearly infested goods are loaded on board, even though there is an intention to fumigate the goods upon completion of loading, it is advisable to clause the relevant mate's receipts and B/Ls in terms similar to the following:

"Some live insects detected at the time of shipment on board; cargo to be fumigated by shippers/charterers at their risk and expense upon completion of loading."

If the charterer intends to have the goods fumigated on board, it is also advisable to make a suitable provision in the charterparty in terms similar to the following:

"Charterers shall indemnify the owners in respect of any and all claims of whatsoever nature howsoever arising as a consequence of any infestation of the cargo at the time of shipment on board the vessel and/or the presence of dead insects in the cargo following the fumigation thereof."

Regulations applying in some countries will only allow the presence of limited numbers of dead insects in imported goods. In such circumstances, sale contracts will be drafted to reflect these limitations. However, the fumigation of goods on

board anticipates a residue of dead insects remaining within the cargo following the fumigation and it is, therefore, doubtful whether the issuance of clean B/Ls in such circumstances can be justified.

The Master may be told by a representative of the shipper or charterer that the presence of live insects in agricultural produce is quite normal, and that any insects present will be killed during the fumigation process on board after the completion of loading. This is usually the basis of the request for clean B/Ls, notwithstanding the visible presence of insects at the time of shipment. It is, therefore, important to consider this point further.

46.5 Recommendations on the Safe Use of Pesticides in Ships

IMO Circular MSC.1/Circ.1358 covers the use of insecticide sprays, smokes and gaseous fumigants, and it is recommended that it is carried on board all dry cargo ships (Reference 1). Insecticide sprays and smokes can be used effectively on clean empty holds. However, the eradication of either insect infestation or rodents in loaded holds can only be effected with fumigant gas treatment.

Owners' and Masters' attention is drawn specifically to the following sections:

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."

When a cargo or empty vessel is to be treated with gaseous fumigation, the following requirement must be observed:

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."

Fumigation in port is covered in Section 3.1.4 of the Circular, and particularly important sections are:

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."

3.1.4.5
"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."

It is common practice to fumigate ships, both empty and loaded, with crew still on board and in some instances this requirement is incorporated in charterparties. However, in some ports, the authorities will not allow fumigation with crew on board. While evacuation of crew provides the safest option, if a Master is prepared or required to allow fumigation with crew on board, it is imperative that the Master is satisfied that the fumigator-in-charge is equipped with proper gas detection and measuring equipment for the fumigant gas being employed. When Draeger tubes are used, the Master should ensure that adequate tubes are available, bearing in mind that each measurement requires the use of a separate tube. The Master should also insist that the fumigator-in-charge remains on board throughout the whole operation, ie from initial closing to completion of ventilation and the issue of a gas-free certificate. The Master should also be satisfied that the fumigator-in-charge regularly checks for gas leakages in areas where crew may be working or resting.

MSC.1/Circ.1264 covers in-transit fumigation of cargo holds, which is now a fairly common practice, particularly for bulk cargoes of agricultural products. With this type of operation, the Master is responsible for the safety of all on board their ship.

3.3.2 *"Fumigation continued in transit"*

3.3.2.1
"Fumigation in transit should only be carried out at the discretion of the master. This should be clearly understood by owners, charterers, and all other parties involved when considering the transport of cargoes that may be infested. Due consideration should be taken of this when assessing the options of fumigation. The master should be aware of the regulations of the flag State Administration with regard to in-transit fumigation. The application of the process should be with the agreement of the port State Administration. The process may be considered under two headings:

.1 fumigation in which treatment is intentionally continued in a sealed space during a voyage and in which no aeration has taken place before sailing; and

.2 in-port cargo fumigation where some aeration is carried out before sailing, but where a clearance certificate for the cargo hold(s) cannot be issued because of residual gas and the cargo hold(s) has been re-sealed before sailing."

3.3.2.2
"Before a decision on sailing with a fumigated cargo hold(s) is made it should be taken into account that, due to operational conditions, the circumstances outlined in 3.3.2.1.2 may arise unintentionally, eg a ship may be required to sail at a time earlier than anticipated when the fumigation was started. In such circumstances the potential hazards may be as great as with a planned in-transit fumigation and all the precautions in the following paragraphs should be observed."

3.3.2.3
"Before a decision is made as to whether a fumigation treatment planned to be commenced in port and continued at sea should be carried out, special precautions are necessary. These include the following:

.1 at least two members of the crew (including one officer) who have received appropriate training (see 3.3.2.6) should be designated as the trained representatives of the master responsible for ensuring that safe conditions in accommodation, engine-room and other working spaces are maintained after the fumigator-in-charge has handed over that responsibility to the master (see 3.3.2.12); and

.2 the trained representatives of the master should brief the crew before a fumigation takes place and satisfy the fumigator-in-charge that this has been done."

3.3.2.4
"Empty cargo holds are to be inspected and/or tested for leakage with instruments so that proper sealing can be done before or after loading. The fumigator-in-charge, accompanied by a trained representative of the master or a competent person, should determine whether the cargo holds to be treated are or can be made sufficiently gastight to prevent leakage of the fumigant to the accommodation, engine-rooms and other working spaces in the ship. Special attention should be paid to potential problem areas such as bilge and cargo line systems. On completion of such inspection and/or test, the fumigator-in-charge should supply to the master for his retention a signed statement that the inspection and/or test has been performed, what provisions have been made and that the cargo holds are or can be made satisfactory for fumigation. Whenever a cargo hold is found not to be sufficiently gastight, the fumigator-in-charge should issue a signed statement to the master and the other parties involved."

3.3.2.5
"Accommodation, engine-rooms, areas designated for use in navigation of the ship, frequently visited working areas and stores, such as the forecastle head spaces, adjacent to cargo holds being subject to fumigation in transit should be treated in accordance with the provisions of 3.3.2.13. Special attention should be paid to gas concentration safety checks in problem areas referred to in 3.3.2.4."

3.3.2.6
"The trained representatives of the master designated in 3.3.2.3 should be provided and be familiar with:

.1 the information in the relevant Safety Data Sheet; and

.2 the instructions for use, eg on the fumigant label or package itself, such as the recommendations of the fumigant manufacturer concerning methods of detection of the fumigant in air, its behaviour and hazardous properties, symptoms of poisoning, relevant first aid and special medical treatment and emergency procedures."

3.3.2.7
"The ship should carry:

.1 gas-detection equipment and adequate fresh supplies of service items for the fumigant(s) concerned as required by 3.3.2.12, together with instructions for its use and the occupational exposure limit values set by the flag State regulations for safe working conditions;

.2 instructions on disposal of residual fumigant material;

.3 at least four sets of adequate respiratory protective equipment; and

.4 a copy of the latest version of the Medical First Aid Guide for Use in Accidents Involving Dangerous Goods (MFAG), including appropriate medicines and medical equipment."

3.3.2.12
"Upon discharging his agreed responsibilities, the fumigator-in-charge should formally hand over to the master in writing responsibility for maintaining safe conditions in all occupied spaces. The fumigator-in-charge should ensure that gas-detection and respiratory protection equipment carried on the ship is in good order, and that adequate fresh supplies of consumable items are available to allow sampling as required in 3.3.2.13."

3.3.2.13
"Gas concentration safety checks at all appropriate locations, which should at least include the spaces as indicated in 3.3.2.5, should be continued throughout the voyage at least at eight-hour intervals or more frequently if so advised by the fumigator-in-charge. These readings should be recorded in the ship's log-book."

It has been noted that some fumigations are unsatisfactory due to three basic causes:

- Excessively heavy infestation or infestation with fumigant-resistant strains of various insect species
- inadequate initial dosing
- insufficient time allowed for total penetration of the fumigant gas.

It is impossible for Masters to have sufficient expertise to be able to decide whether a proposed fumigation operation should prove satisfactory. Although it is possible to obtain expert advice on this matter, it is difficult for anyone to advise other than in

general terms when they have not seen either the ship or the cargo. It is the fumigators' duty to perform proper fumigation and, if they are employed by shippers or charterers, it is the latter's duty to ensure that the fumigators are competent. However, to safeguard the shipowner's position, the Master must insist on receiving a certificate of fumigation from the fumigators which states:

- The fumigant used
- the dose level in terms of weight of fumigant per volume of hold, eg g/m^3
- the dates and times when fumigation commenced and ceased (ie when either ventilation fans were turned on or hatches were opened, whichever was the earlier).

If insects and/or mites are observed in or on any cargo, it is helpful to take specimens, transfer them to a small bottle with a secure closure, such as an aspirin bottle, and place it in a refrigerator. The specimens can be supplied to experts at a later date if there are complaints at the time of discharge.

If heavy infestation is observed, surveyors should be instructed to draw substantial samples of affected cargo (1 kg lots), which should be sealed and refrigerated pending expert examination to determine the level and nature of the infestation.

Shipowners are particularly warned that receivers in certain countries, particularly in the Middle East, may reject cargo, with the backing of their government authorities, if minimal live infestation is detected, or even if the cargo is contaminated with a very small quantity of dead insect residues. It follows that, if a Master detects any insect infestation when cargoes are being loaded for Syria, Egypt and some other eastern Mediterranean countries, they should inform the shipowners immediately so they may seek advice from the Club.

46.6 Fumigation of Bulk and Bagged Cargo with Ventilation in Port

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

After loading and prior to sailing
Phosphine fumigation and ventilation in port, prior to sailing, will normally take from 1 to 2 weeks to complete and therefore is only occasionally specified. All procedures as for in-transit fumigation should be followed to ensure safe and effective fumigation.

At discharge port prior to discharge
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, but crew members 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 fumigant from cargoes can be a very slow process if sufficiently powerful ventilation is not available. The Master (or their representative) should confirm that the fumigator has ensured that residues of gas are below the TLV throughout

all parts of the cargo and holds. All procedures as for in-transit fumigation should be followed to ensure safe and effective fumigation.

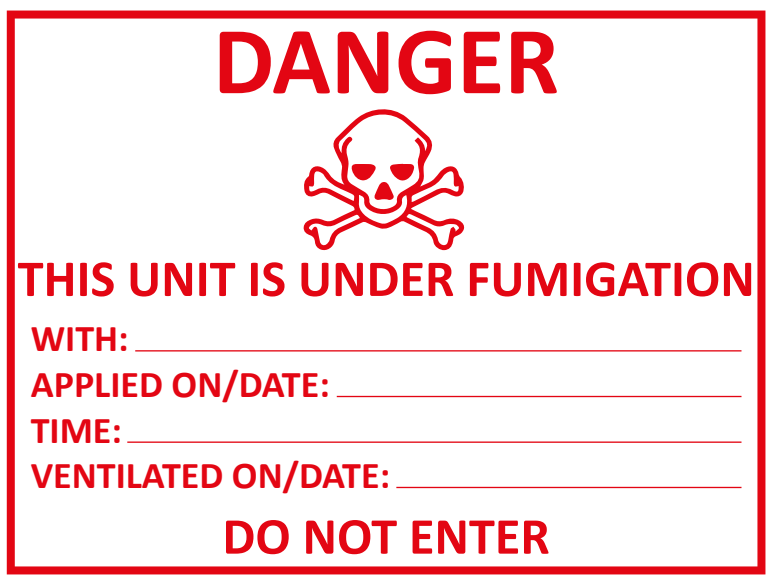
46.7 In-transit Fumigation of Freight Containers

Fumigation of containers is normally undertaken to ensure that, when the goods arrive at the discharge port, they are free from live pests/insects.

Containers are normally fumigated and then ventilated prior to being loaded on board the ship. Containers that have been fumigated and ventilated, and where a 'certificate of freedom from harmful concentration of gas' has been issued, can be loaded on board ships as if they had not been fumigated.

Frequently, containers are fumigated but not ventilated prior to loading and these containers are therefore fumigated in-transit, as the ventilation process will not take place until after they have been discharged from the ship. The carriage of containers in-transit under fumigation is covered by the IMDG Code (Reference 19) whereby these containers are classified in Section 3.2, Dangerous Goods List as *Fumigated Cargo Transport Unit Class 9 UN 3359*. Reference should also be made to MSC.1/Circ.1361/Rev.1 (Reference 52) which may be found in the IMDG Code Supplement in the chapter entitled *Recommendations for the safe use of pesticides in ships*.

WARNING – Containers are 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.



Obligations on the fumigator

- The fumigator must ensure that, as far as is practicable, the container is made gastight 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 MSC.1/Circ.1361/Rev.1 (Reference 52)
- the fumigator must ensure that the agreed formulation of fumigant is used at the correct dosage to comply with the contractual requirements.

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 MSC.1/Cric.1361/Rev.1 (Reference 52)
- the exporter must ensure that the Master is informed of the fumigation prior to the loading of the containers
- the exporter must ensure that shipping documents show the date of fumigation, the type of fumigant and the amount used all as required in the IMDG Code and MSC.1/Cric.1361/Rev.1, specifically Section 5.5.2.4.

Obligations on the Master

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

Obligations on the receivers

- The receiver (or their 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.

46.8 Phosphine Methodologies

The various methods of phosphine application that can be considered for in-transit fumigation of bulk or bagged cargoes in ships' holds include the following. The actual method to be used will be specified by an expert.

1. Application of tablets or pellets to the cargo surface (or into the top half metre).

   High concentrations of gas build up in the headspace, potentially resulting in a lot of leakage through the hatch covers unless these are very well sealed. There is very

little penetration down into the cargo and powdery residues cannot be removed. This method produces a good kill of insects in the top part of the cargo but has negligible effect on eggs or juveniles or even adults in the lower part of the cargo.

2. Application of tablets or pellets by probing into the cargo a few metres.

   There is less loss of gas through hatch covers than in method 1 and better penetration of gas than when applied on the surface only. However, it is 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 m deep. However, it ensures effective fumigation provided voyage time is long enough 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 are the same as for method 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 are the same as for method 2, except that, with this method, powdery residues can be removed prior to discharge.

6. Fitting of an enclosed, powered recirculation system to the hold and application of aluminium phosphide tablets or pellets to the surface.

   This method 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 recirculation system to the hold and application of aluminium phosphide in blankets, sachets or sleeves on the surface or probed into the top 1 or 2 m.

   All points are the same as for method 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 recirculation 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 method is being developed in Canada but is not yet available. Deep probing could also utilise pre-inserted pipes. It will enable good distribution of gas to be

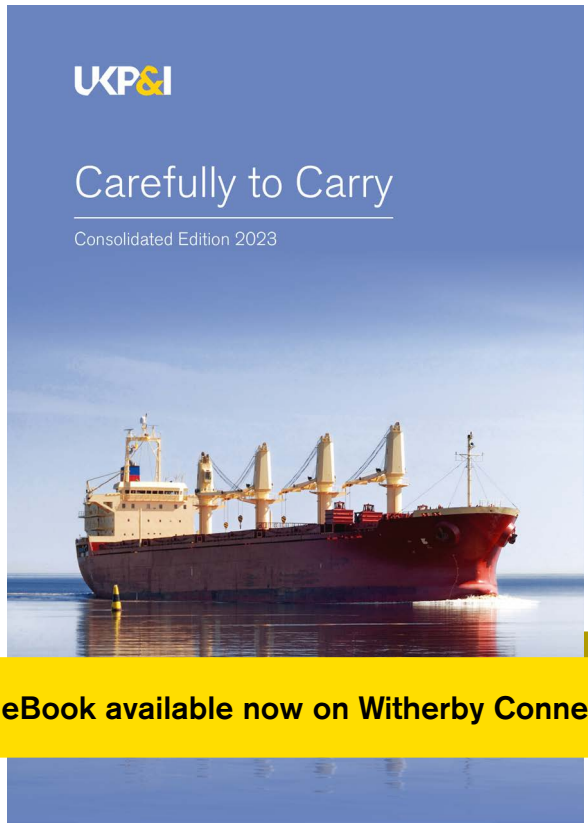
achieved without the requirement for a powered recirculation system, provided the voyage is long enough.

9. Use of powered recirculation system with phosphine from cylinders.

   This method 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 recirculation system will be needed to enable this system to work with maximum efficacy.

Carefully to Carry

Consolidated Edition 2023



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