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BRITANNIA
LOSS PREVENTION INSIGHT

ISSUE NUMBER 6 // OCTOBER 2023

# FUMIGATION
## AN OVERVIEW FOR THE MARITIME SECTOR



### ABOUT OUR PARTNER

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**CWA FOOD & AGRICULTURAL COMMODITIES DEPARTMENT**

The CWA Food & Agricultural Commodities department provides expert advice on a range of food, feed and other dry agricultural commodities, across the entire supply chain from field to consumer and especially relating to the shipment of these commodities as bulk, break-bulk, bagged, bottled, drummed, refrigerated, frozen and containerised cargoes.

The department applies scientific and commercial expertise to quality management in the international trade of food, feed and other agricultural commodities, with particular regard to damage causation, quantum, food safety and loss prevention. The department also assists in loss mitigation by applying its scientific, operational and commercial experience to advice on cargo utilisation, salvage and disposal.

## INTRODUCTION

FUMIGATION IS AN EFFECTIVE APPROACH TO ERADICATE LIVING ORGANISMS, SUCH AS INSECTS OR RODENTS, AND IS USED TO MITIGATE THE TRANSMISSION OF INVASIVE SPECIES OR PHYTOSANITARY RISKS WHEN TRANSPORTING AN AGRICULTURAL CARGO FROM ONE PORT TO ANOTHER. The benefit of using fumigant gas is that it can easily be dispersed to cover an extensive area in the cargo hold and the gas can eventually be diffused away with proper ventilation, thereafter leaving little to no active residue on the cargo. However, the use of fumigants comes with severe risks that need to be understood to avoid incidents with potentially fatal consequences.

Typically, the task of fumigating the cargo is undertaken by qualified fumigators and crew should not handle the fumigant. However, as vessels normally sail shortly after completing the fumigant application, there may not be enough time to complete the whole process, and for fumigation to achieve full effectiveness, prior to voyage. Therefore, in-transit fumigation is often utilised.

Fumigation normally starts at the load port and will continue for a defined period during the voyage, ending once the set number of days for fumigation has been completed. Once the holds are certified as gas-free, normal ventilation of the holds can resume.

In this article we highlight the importance of understanding the risks associated with fumigation on board vessels. The application for in-transit fumigation should be made with the agreement of the Port State Administration, either for the fumigation being intentionally continued in sealed cargo spaces during the voyage without aeration prior to sailing, or for in-port cargo fumigation.

FUMIGATION NORMALLY STARTS AT THE LOAD PORT AND WILL CONTINUE FOR A DEFINED PERIOD DURING THE VOYAGE, ENDING ONCE THE SET NUMBER OF DAYS FOR FUMIGATION HAS BEEN COMPLETED. ONCE THE HOLDS ARE CERTIFIED AS GAS-FREE, NORMAL VENTILATION OF THE HOLDS CAN RESUME.

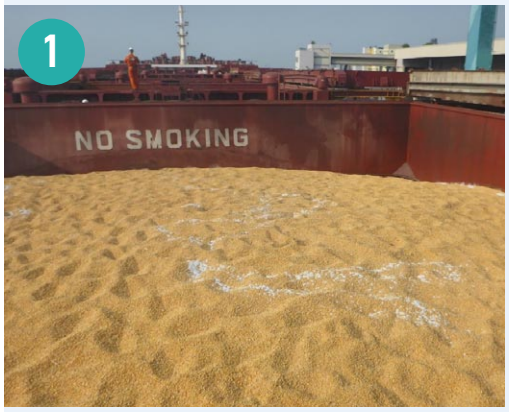


**Figure 1:** Fumigant can cover extensive area in the cargo hold with little active residue left behind


**Figure 2:** Infestations found on grain cargoes

## FUMIGATION IN GENERAL

Fumigation carried out in cargo spaces on board should be in accordance with the IMO's circulars on the issue: MSC.1/Circ.1264 *'Recommendations on the Safe Use of Pesticides in Ships Applicable to the Fumigation of Cargo Holds'*[1] as amended by MSC.1/Circ. 1396[2] and MSC.1/Circ.1358 *'Revised Recommendations on the Safe Use of Pesticides in Ships'*.[3] (Copies of all circulars can be found in the IMDG Code Supplement).

The IMO circulars clearly state that fumigation in-transit should only be carried out at the discretion of the master. Crew members can carry out small-scale or 'spot' treatment pest control if they adhere to the product manufacturer's instructions and cover the whole area of infestation. However, more extensive or hazardous treatments, including fumigation and insecticide spraying, should only be carried out by professional pest control operators in accordance with the IMO's recommendations.

The materials available for pest control on board vessels can broadly be divided into insecticides and fumigants. Insecticides are normally used to specifically target and kill the insects with direct contact, while fumigation is a pest control method achieved by filling the cargo spaces with toxic gaseous fumigants to neutralise the insects.

From a commercial perspective, fumigation, rather than contact insecticides, is the preferred method of removing potential infestations when shipping agricultural commodities. This is because it is easier for the fumigators to handle aluminum phosphide tablets or pellets. It is also relatively lower in cost and effective with the near absence of chemical residues on the cargo.

[1] MSC.1/Circ.1264: Recommendations on the Safe Use of Pesticides in Ships Applicable to the Fumigation of Cargo Holds, 2008
[2] MSC.1/Circ.1396: Amendment to the Recommendations on the Safe Use of Pesticides in Ships Applicable to the Fumigation of Cargo Holds (MSC.1/Circ.1264), 2011
[3] MSC.1/Circ.1358: Recommendations on the Safe Use of Pesticides in Ships, 2010

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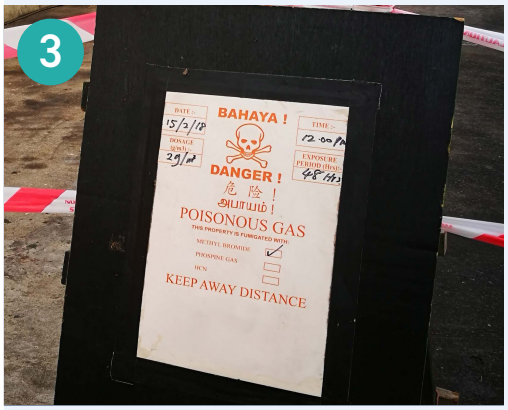



**Figure 3:** Notice of fumigation in progress

However, its popularity and associated risks have also resulted in the majority of marine fumigation incidents. Therefore, we will focus on fumigation rather than insecticides in this guidance.

According to the International Maritime Organization's (IMO) guidelines stipulated in MSC.1/Circ.1264, 'Recommendation on the Safe Use of Pesticides in Ships Applicable to the Fumigation of Cargo Holds', two of the most widely used fumigants are phosphine and methyl bromide.

Aluminum phosphide is available in solid tablets or pellets, mostly known by their brand names; QuickPhos, Phostoxin, Fumitoxin and Weevil-cide. These tablets or pellets react with moisture in the air to produce an active fumigant gas – phosphine ($PH_3$).

In contrast, methyl bromide is normally supplied in liquid form or as pressurised gas, known commercially sometimes as Bromomethane, Brom-o-gas or Celfume. However, methyl bromide is not permitted for in-transit fumigation and has been found to deplete the ozone layer. It is gradually being replaced by other fumigants.

Additionally, fumigation with methyl bromide must be carried out by qualified operators while the vessel remains at port with the ship's crew disembarked. There have been occasions when fumigation by methyl bromide has been conducted with the crew on board, but this should be avoided as it does not follow IMO guidance and can be extremely hazardous.

The choice of fumigant and the application method depends on the:

- type of commodity carried
- potential insects and rodents that may be present
- dosage and extent of coverage required by the cargo
- volumetric size of cargo holds
- location of infestation
- habits of pests found from the port of origin
- climate of the regions in-transit.

Given the complexity of these fumigants and wide variety of brand names, it is essential for the crew to review the Material Safety Data Sheets (MSDS) to understand the type of fumigant gas used and associated requirements, and the potential hazards and safeguarding measures required.

The reaction between aluminum phosphide tablets and moisture in the air is exothermic, meaning it releases heat, and disperses colorless phosphine gas into the atmosphere. Water moisture trapped in cargo spaces, either within a moist cargo or with high humidity within the hold, may accelerate this process, especially when fumigants are applied to the cargo surface. Ventilation flaps should be closed and hatch covers sealed to prevent any water ingress during precipitation or shipping seas, and to prevent the escape of toxic gas.


**Figure 4:** Fumigant residue on cargo of corn


**Figure 5:** Yellow pipes used for fumigation inside cargo hold


**Figures 6:** Examples of recirculation fans installed in manholes from different countries – USA and India


If necessary, additional prophylactic measures, such as the application of expanding foam to hatch cover joints, can be considered to achieve gas-tight holds.

It is essential for fumigant tablets/pellets to be spread evenly on the cargo surface and to ensure cargo is dry prior to application. When piled on a wet cargo surface, a rapid exothermic reaction could be sufficient to set fire to the cargo.

The molecular weights for both phosphine and methyl bromide gases are heavier than air and therefore the gas will slowly sink down through the cargo to achieve a good penetration within the stow depending on depth and exposure period. However, when the aluminum phosphide tablets or pellets do not fully react with moisture in the hold, an inert residual by-product, often a light, powdery, grey, ash-like substance, may be left behind. This residue creates an exposure risk if it is inhaled or comes into contact with the eyes. Exposure to the partially reacted residue may occur when the tablets/pellets are used in low humidity, low temperature environments or opening of the holds prematurely before the full exposure period is completed. Care should be taken when disposing of the aluminum phosphide residues due to the risk of toxic gas. There have been previous cases where residues, when collected in buckets or similar, have ignited spontaneously.

Methyl bromide supplied in gaseous form can achieve an effective fumigation coverage of the cargo within 24 to 48 hours, whereas a typical aluminum phosphide tablet may take more than two days to breakdown. With aluminum phosphide tablets, the required exposure period can take approximately five to twenty days depending on the coverage, temperature, and relative humidity of the air. Colder temperatures and drier atmospheric conditions reduce the rate of the fumigant's reaction and gas dissipation. In order to mitigate these effects, sub-surface probes are sometimes used to introduce the fumigant into the cargoes to speed up the process.

There are various methods for applying aluminum phosphide tablets and pellets to cargo:

- Standard fumigation by surface application of tablets in sleeves or blankets
- Sub-surface fumigation via trench application by placing fumigants in trenches dug into the cargo
- Fumigation with probes inserted into the cargo from around 0.3m to several metres
- Application via tubing with a safe fan circulating the fumigation gas within the cargo spaces.

The main method for applying methyl bromide gas is from cylinders connected to the pipework via a vaporiser. Crew will need to disembark whilst the operation is carried out.


# TOXICITY

## FOR AN EFFECTIVE FUMIGATION PROCESS, CARGO HOLD SPACES SHOULD BE MADE GAS TIGHT DURING THE EXPOSURE PERIOD.

This is to ensure the lethal concentration of fumigant is provided for an appropriate duration to effectively exterminate any pests within the cargo. If the hatch covers or ventilation flaps are leaking, it will reduce the efficacy of the procedures and pose additional risks to the crew. Sometimes additional hold sealing may be required to make all joints gas-tight.

When fumigants are deployed in a gaseous state, the most likely route of exposure to humans is through inhalation. Therefore, prior to opening holds, forced ventilation should be carried out to reduce gaseous residues to a concentration below the occupational exposure limit set by the Port and Flag State. For example, methyl bromide, a gas at ambient temperatures which is readily absorbed through the lung alveoli, is toxic to humans at 0.14 mg/litre in the air and reportedly lethal when inhaled for 1.5 hours at 30 mg/litre.[4]

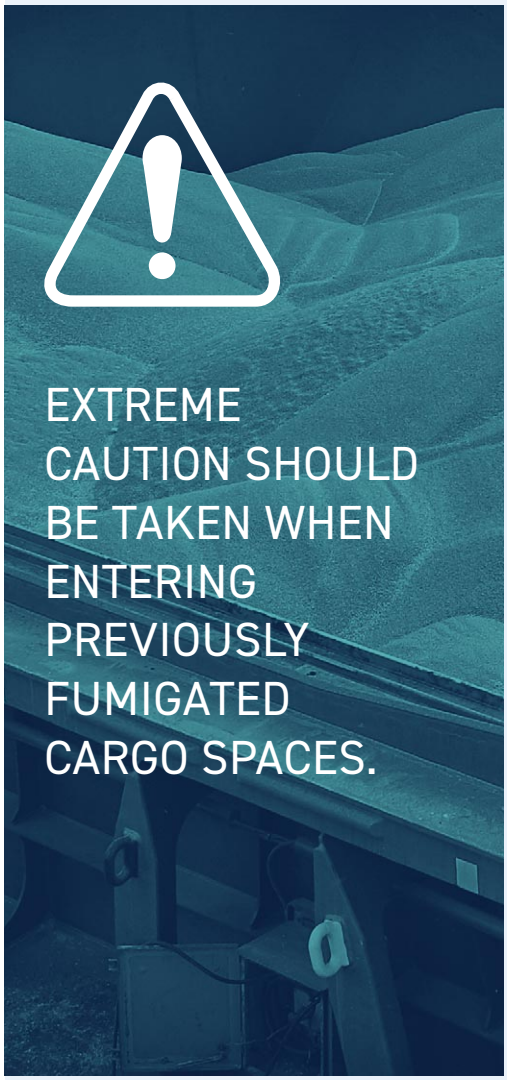
According to information published by the US Agency for Toxic Substances and Disease Registry (ATSDR), the Occupational Safety and Health Administration (OSHA) has recommended a safe limit for phosphine of 0.3 parts per million (PPM) of workroom air. This means that the long-term respiratory exposure limit to phosphine gas, on an eight-hour time weighted average (TWA), should not exceed 0.3.[5]

Both methyl bromide and aluminum phosphide are toxic to humans and to the intended targets of insects and rodents. Unfortunately, by the time fumigant gas is detected, it is sometimes too late to prevent poisoning, since the concentration of gas may be above the safe working limit. Additionally, there is typically a delay in the onset of symptoms following an exposure.

When phosphine gas, without the presence of any impurities, is released, it is colourless and odourless. However, when contaminants exist, phosphine gas may give off white-coloured smoke and/or the smell of decaying fish, garlic or carbide.

Methyl bromide is colourless but comes with a fruity or musty odour at high concentrations. These odours serve as good warning signs of gas leakage to people working in or near the cargo spaces. However, these indicators should never be solely relied upon as a means of determining whether a space is safe.

[4] Extension Toxicology Network Pesticide Information Profiles: Methyl Bromide; Bromomethane; **http://extoxnet.orst.edu/pips/methylbr.htm**
[5] US Agency for Toxic Substances and Disease Registry (ATSDR) – Occupational Safety and Health Administration (OSHA): **https://www.atsdr.cdc.gov/toxfaqs/tfacts177.pdf**



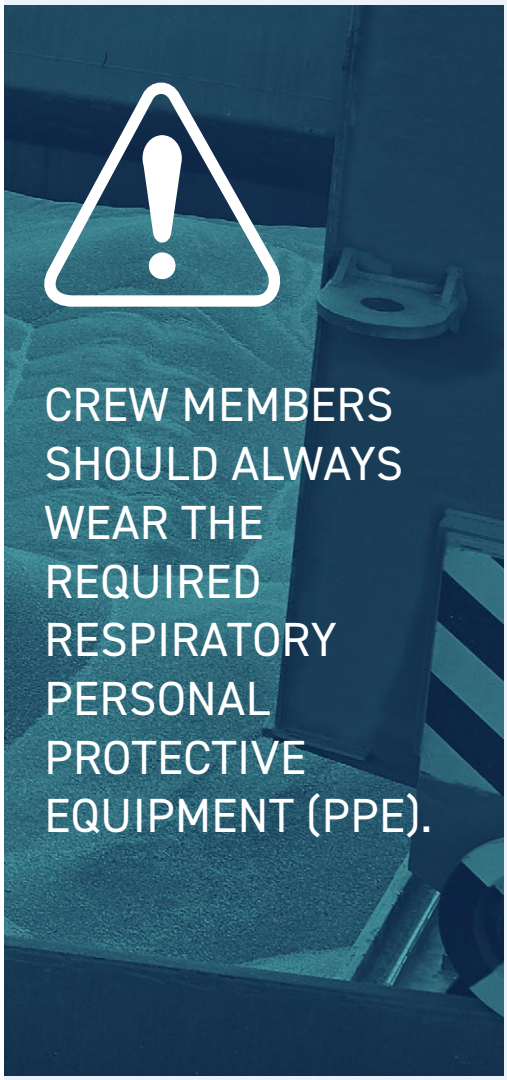

## SYMPTOMS

CREW MEMBERS SHOULD NEVER ENTER FUMIGATED CARGO SPACES UNTIL ENCLOSED SPACE ENTRY PROCEDURES HAVE BEEN COMPLETED. In a previous case, despite the holds being certified fumigant gas-free and the hatches opened, one crew member died and another was seriously injured after being exposed to phosphine gas under the hatch coaming above the cargo surface. Although phosphine gas is heavier than air and is meant to slowly penetrate the cargo from top to bottom, fumigant gases may sometimes remain in the cargo hold head space, even after the gas-freeing process is complete. Therefore, extreme caution should be taken when entering previously fumigated cargo spaces.

If a crew member feels any irritation to mucous membranes in their eyes, airways, and/or skin, it could be an early indication of gas exposure. Crew members should evacuate the area immediately and warn their colleagues. Subsequent symptoms may include headache, dizziness, nausea, breathing difficulties, vomiting, diarrhea, diaphragm pain, and limb numbness. There may be no life-saving antidote on board a vessel but respiratory aid and/or cardiovascular support can be provided. The most important thing is to get the victim(s) into fresh air and away from the source.

Higher levels of phosphine gas inhalation can cause body weakness, bronchitis, pulmonary edema (abnormal build-up of fluid in the lungs), shortness of breath, and convulsions (seizure or muscle spasms). The longer the exposure period, the higher the chances of acute phosphine intoxication, which primarily damages the lungs and affects the nervous system. Chronic exposure may cause damage to the central nervous system, kidneys and lungs, nasal cavities, adrenal glands, and the testes. High levels of exposure to fumigant gases have led to numerous seafarer fatalities.


**Figure 7:** Crew collecting damaged cargo from a cargo hold after gas-freeing




## FIRE AND EXPLOSION RISK

AS NOTED ABOVE, ALUMINUM PHOSPHIDE REACTS WITH MOISTURE IN AN EXOTHERMIC REACTION TO PRODUCE PHOSPHINE GAS.

When aluminum phosphide tablets are unevenly distributed in the cargo spaces, reactions can possibly produce localised heating. Some of these heat spots could be sufficient to start a smoldering cargo fire.

A smoldering fire can result in latent thermal decomposition within the cargo which might not be visible from the top of the cargo. Another issue arising from such smoldering fires is smoke tainted grains or oilseeds, which causes problems for human or animal consumption. It is essential that the fumigator distributes the fumigant evenly on the surface or subsurface of the cargo to decrease the chances of concentrated gas or heat generation.

Methyl bromide is not ordinarily combustible, but in the presence of a high-energy ignition source, it may become a flammable gas. When it catches fire, toxic gases such as hydrogen bromide are produced.

According to the International Maritime Dangerous Goods (IMDG) Code, aluminum phosphide is classed under Class 4.3 - 'Substances which, in contact with water, emit flammable gas' with a subsidiary Class 6.1 – 'Toxic and infectious substances'. The National Institute for Occupational Safety and Health (NIOSH) also states that phosphine gas has a lower explosive limit (LEL) in the air of approximately 1.79 %.[6] Therefore, if pellets of aluminum phosphide are clustered in a few areas, this may lead to an increased rate of phosphine evolution, that generates sufficient gas within the cargo spaces to present a fire hazard.


**Figure 8:** Cargo surface after fumigation explosion and recirculation pipe used

Given that phosphine gas has an auto-ignition temperature of about 38°C,[7] the potential heat generated by decomposing aluminum phosphide tablets may increase the risk of explosions. Additionally, a small amount of gas known as diphosphine is also generated during this thermal decomposition reaction and is more spontaneously flammable than phosphine gas.

Consequently, when fumigation gas is released into the cargo holds' headspaces it creates a potential explosion risk, particularly when coupled with ignition sources such as unsafe cargo hold lighting, fans or portable equipment, exposed electrical circuits, and sparks from opening hatch covers, all of which could ignite an explosive gas concentration inside the cargo spaces. Such incidents could occur several days after the fumigation was conducted as concentration of the gas increases. Potential sources of ignition should be removed from cargo spaces or suitably isolated and naked flames should be prohibited on the main deck and surrounding areas until fumigation is complete. It is also important that the fumigator correctly calculates the dosage based on the volumetric space and that the holds are free from excess moisture.

[6] The National Institute for Occupational Safety and Health (NIOSH) published Phosphine : Lung damaging agent, https://www.cdc.gov/niosh/ershdb/emergencyresponsecard_29750035.html
[7] Product information from Internationally Peer Reviewed Chemical Safety Information (INCHEM), https://www.inchem.org/documents/icsc/icsc/eics0694.htm


**Figure 9:** Fumigation carried out onboard by professional

To monitor for signs of fire or fumigation issues in a hold, an infrared handheld thermometer may be useful to detect hotspots on hatch covers and coamings. When phosphine burns, it produces a dense white cloud (phosphorus pentoxide) which severely affects respiration. Crew members should always take precautions when approaching these areas and wear the required respiratory personal protective equipment (PPE).

If a cargo hold fire alarm has been activated and/or smoke is seen coming from the hatches, crew members should activate the company's contingency plan and follow in-transit safety guidelines provided by the fumigator. Crew members should also comply with the Emergency Response Procedures for Ships Carrying Dangerous Goods (EmS Guide) in the IMDG Code.

If the fire develops further, crew and the ship management company should consult with experts and seek advice on how to prevent an increase in pressure within the cargo hold headspace. An increase in pressure could result in a volumetric explosion, which may lift and damage the hatch covers and bulkheads.

Normally, the best fire-fighting agents would be carbon dioxide or dry extinguishing chemicals instead of water. However, these methods may not be suitable for use on grain or oilseed cargoes. Extinguishing the fire safely should always be the priority but the effects of the fire-fighting method on the cargo should also be considered.


**Figure 10:** Shore labour cleaning damaged cargo from side coaming in a hold


**Figure 11:** Enclosed space rescue training

# PREVENTIVE MEASURES

## FUMIGATORS SHOULD ASSESS THE VESSEL'S CONDITION AND CARGO SPACES TO ENSURE THEY ARE SUITABLE FOR FUMIGATION.

A checklist can be drafted according to the MSC.1/Circ.1264 - Appendix 3 'Model Checklist for In-Transit Fumigation'[8] or as per the 'Fumigation checklist' in the Fumigation Handbook published by the United States Department of Agriculture (USDA).[9]

Fumigant gas may leak from the holds and enter air inlets adjacent to the accommodation and other spaces. This is due to lack of maintenance on cargo hatch seals, booby hatches, rubber packing, ventilator trunks or ventilator flaps. In one tragic incident, corrosion holes on the bulkhead between the accommodation and the adjacent hold resulted in the spread of phosphine gas into crew cabins, with one crew member regrettably losing his life.

Fatal levels of phosphine gas can still be found above the surface of the cargo after opening hatch covers and venting. Therefore, it is important that crew follow guidelines for enclosed space entry and check phosphine gas levels before entry. One of the most important, yet often neglected hazards as demonstrated in a recent fatality case, is the presence of toxic gas pockets underneath the hatch coaming, even with the hatch covers being opened.

There are also possibilities of gas diffusing through the duct keel, adjacent ballast tanks or even through the pipes of the fire warning system after the aeration process. The fumigator should provide guidelines on how the fumigant fumes should be dispersed safely at the end of the exposure period.

The fumigation company should provide fumigation guidelines in the form of a safety plan drawn up during the initial meeting. These guidelines should be used when conducting training for the ship's crew before any fumigation starts. Training should include, but not be limited to, the safety procedures in the safety booklet, the provisions of the material safety data sheet (MSDS), information on the fumigant product, gas detection methods, emergency procedures, and gas-freeing procedures.

The recommended safety plan should also cover the required detection equipment specific to the fumigant used, as different kinds of gas detection tubes are used to detect different gas types and concentrations. For instance, low level detecting tubes should be used for gas concentrations from 0.15 to 5 PPM. Tubes are available for detecting either phosphine or methyl bromide and a configured multigas monitor can be used to detect levels of oxygen, lower explosive limits of explosive gases and carbon monoxide, phosphine and methyl bromide.

All gas detectors should be regularly calibrated regardless of the gases they detect and it is recommended that sufficient detectors are provided to allow for redundancy.

[8] MSC.1/Circ.1264 - Appendix 3 'Model Checklist for In-Transit Fumigation', 2008
[9] USDA – Fumigation Handbook, Chapter 2.7 : Fumigation Checklist

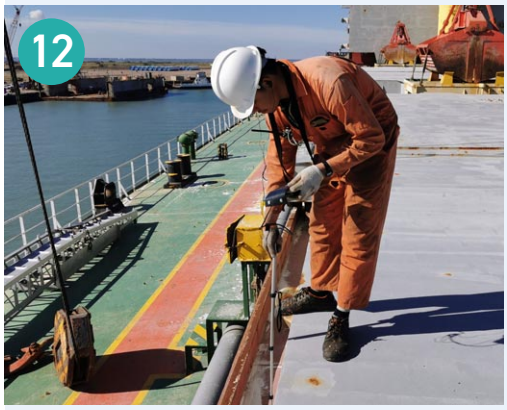



**Figure 12:** Ship crew conducting ultrasonic testing to check for leakage


**Figure 13:** Ship crew training with proper PPE for enclosed space entry

## BELOW ARE SOME OF THE PRACTICAL PREVENTIVE MEASURES THAT SHOULD BE UNDERTAKEN DURING OR BEFORE THE VOYAGE:

• Before reaching the loading port, maintenance should be carried out on the weathertight integrity of the cargo hold, such as hatch cover seals, hatch cleats, ventilators, cement ports and booby hatches. It is recommended that, as the hatch covers and other access points have to be gas tight to ensure their integrity. Prior to arrival, any necessary repairs should be conducted in good time and their effectiveness verified.

• Records of inspection and maintenance should be kept on board for a suitable period prior to fumigation.

• The fumigator should conduct inspections of all access points to the cargo holds to ensure they are suitably gas-tight for the fumigation process. This should be done when the hold is empty and in accordance with the requirements in the countries of loading and discharging. The master should sign off the pre-fumigation inspection report.

• The fumigator should ensure the formulation of fumigant is used at the correct dosage and is applied evenly to the cargo surface/subsurface. The application areas should be free from excessive moisture.

• To avoid fires it should be ensured that tablets and pellets on surfaces cannot roll and be collected at the hold plating.

• The master and ship's crew should carry out a thorough onboard search to confirm there are no stowaways or unauthorised personnel in the cargo spaces. All of the ship's crew should be accounted for before starting fumigation.

• The master and crew should also familiarise themselves with the fumigation procedures and precautions required when working near fumigated cargo areas and be aware of any warning notices posted at the entrances to holds on deck.

• The master may appoint at least two crew members to maintain safe conditions in the fumigated spaces on board, including testing the atmosphere. These crew members should be trained to use the gas detecting equipment.

• Upon completion of the fumigation process in each hold, all access points should be padlocked and ideally sealed with a customs seal or similar (and the seal number recorded). This means it should be easily seen if an access hatch has been opened. Keys for padlocks should be carefully secured by the chief officer.

• The treatment or exposure period for fumigation at sea, and in particular when the cargo spaces should remain sealed, should be made clear in writing to the ship's crew by the fumigator.



**Figure 14:** Professional examining fumigated cargo in the hold

• Aeration and ventilation after the exposure period should be performed according to the guidelines specified by the fumigator.

• When determining the period required to ventilate the cargo holds, a number of factors should be considered including type of fumigants used, method and rate of fumigant application, voyage duration, weather and temperature conditions, likely risks of gas desorption, and gas readings.

• It should be ensured that the aeration and ventilation processes do not result in the fumigant gases being blown into air duct intakes for enclosed accommodation spaces, the engine room, deck lockers or routine working spaces.

• The master should ensure regular checks are carried out at the specified intervals recommended by the fumigator to detect gas leakage within spaces occupied by crew, or whenever and wherever there is any suspicion that fumigant gas may be present. This is particularly the case when crew members shows signs of feeling uncomfortable. This should not be taken lightly and mistaken for motion sickness at sea. If there is any doubt, the atmosphere should be tested.

• In the event that the ship's crew shows any signs of poisoning, the master should take immediate action to evacuate crew from the affected spaces whilst using PPE.

• Gas detection equipment suitable for the intended fumigant should be provided, such as tube gas test equipment, photo-ionisation gas testing and monitoring equipment with the correct sensors.

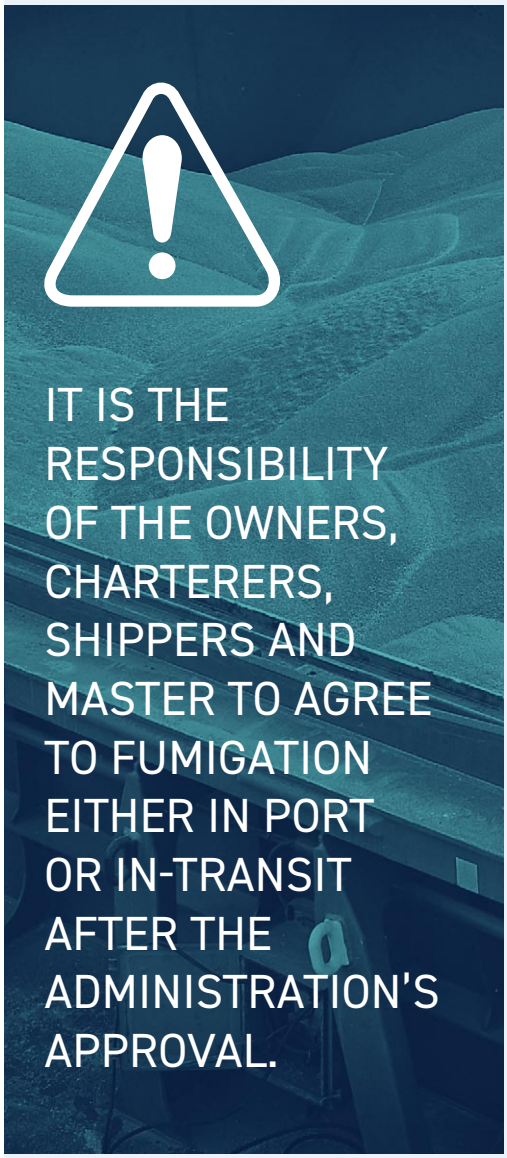
• Proper protective respiratory breathing equipment (a minimum of four sets is recommended) should be provided for the vessel prior to starting the voyage.

• Disposal of the sleeves/residue should be performed by the approved fumigator's representatives[10] in accordance with local and international regulations, with the use of appropriate PPE.

• After gas freeing and removal of residues, the fumigator's representatives should test the environment inside the cargo spaces with the gas detection equipment to confirm fumigant concentrations are below the threshold limit value (TLV). The ship's crew should verify that the gas-free testing is physically carried out up to the recommended maximum allowable PPM concentration as per the fumigator's instructions.

• A gas-free certificate for the vessel can only be issued by the fumigator in-charge when the cargo spaces are tested to show all residual fumigant has been dispersed from the cargo spaces and adjacent working spaces, the residual fumigant materials removed, and found safe for entry.

[10] Examples drawn from GAFTA Approved Registers of Fumigators, https://www.gafta.com/Search-Approved-Registers




# CONCLUSION

IT IS THE RESPONSIBILITY OF THE OWNERS, CHARTERERS, SHIPPERS AND MASTER TO AGREE TO FUMIGATION EITHER IN PORT OR IN-TRANSIT AFTER THE ADMINISTRATION'S APPROVAL.

The procedures should be followed by all parties involved through incorporating suitable terms in the contract of carriage (charterparty terms).

A company's safety management system (SMS) should set out the guidelines on fumigation and the procedures for fumigation in-transit, detailing the suitability of each vessel, risk assessments, and permits to work. This includes informing crew of the fumigation plan and educating them in relation to the associated risks, together with contingency plans for tackling emergencies related to fumigation.

Moreover, the management team should ensure they are familiar with the relevant regulations from the Flag Administration and satisfy themselves that all the on board preventive measures, before and after the fumigation process, have been carried out.

Although open hatches may not be categorised as enclosed spaces in most cases, it is recommended that the crew treat previously fumigated opened holds as enclosed spaces and follow the procedures for entering such spaces as detailed in the SMS, until they are proven to be gas-free.

If access to fumigated spaces is essential for safety purposes and they have not been proven safe for entry, then full PPE and respiratory protection equipment is required and all enclosed space entry and permit to work requirements should be followed.

IF ACCESS TO FUMIGATED SPACES IS ESSENTIAL FOR SAFETY PURPOSES, THEN FULL PPE AND RESPIRATORY PROTECTION EQUIPMENT IS REQUIRED.

# APPENDIX

## SOME OF THE KEY POINTS THAT A FUMIGATION SAFETY PLAN/BOOKLET SHOULD COVER ARE:

- fumigation plan
- pre-fumigation inspection report
- safety recommendations for vessels with fumigated cargoes
- risk assessment plans
- contingency plans for fumigation-related incidents
- voyage safety checklist
- statement of handover responsibility for maintaining safe conditions
- precautions and procedures during voyage
- instructions for calibration of gas detection equipment
- periodical and systematic atmosphere testing procedures
- instructions for aeration and ventilation
- gas-freeing test procedures and minimum requirements
- precautions during discharge
- information on fumigant residue hazards and disposal procedures
- list of safety detection and respiratory protection equipment, such as self-contained breathing apparatus (SCBA)
- first aid and medical treatment instructions
- emergency Response Procedures for Ships Carrying Dangerous Goods (EmS Guide)
- necessary medicines and medical equipment the vessel should carry in accordance to the Medical First Aid Guide for use in Accidents involving Dangerous Goods (MFAG) and the procedures to follow
- example of fumigation gas-free certification
- example of MSDS
- record keeping
- competency requirement of the fumigator.

FOR FURTHER INFORMATION REGARDING THE RISKS ASSOCIATED WITH FUMIGATION, THE CLUB HAS ISSUED A BSAFE CASE STUDY ON 'CARGO FUMIGANT POISONING LEADING TO A FATALITY'.[11]

[11] Britannia Club – BSAFE publication : **https://britanniapandi.com/2021/11/bsafe-incident-case-study-13-cargo-fumigant-poisoning-leading-to-a-fatality/, 2021**

# THE CLUB'S LOSS PREVENTION DEPARTMENT IS ALWAYS AVAILABLE TO SUPPORT MEMBERS AND RESPOND TO THEIR QUESTIONS.





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