

OVERVIEW AS PART OF THE CASE STUDY MATERIAL, THE FOLLOWING COMMENTARY HAS BEEN PREPARED TO FURTHER CONSIDER SOME OF THE KEY ISSUES IN ORDER TO SUPPORT REFLECTIVE LEARNING.

The first two pages of this commentary discuss some of the contributory factors and lessons learned in more detail with particular reference to best practices. The final page graphically illustrates some of the barrier control measures that could have potentially mitigated against the risks associated with the hazards by making use of Britannia's interpretation of the Hierarchy of Barrier Controls triangle as a framework.

CARGO FUMIGANT POISONING LEADING TO A FATALITY

THE CONTRIBUTING FACTORS AND LESSONS LEARNED IN THIS CASE STUDY ARE DISCUSSED BELOW. THIS INCIDENT APPEARS TO BE THE RESULT OF ABSENT AND/OR INEFFECTIVE SAFETY BARRIERS, WHICH IN THIS PARTICULAR CHAIN OF EVENTS FAILED TO PREVENT THE FUMIGANT FROM REACHING LETHAL EXPOSURE LIMITS INSIDE THE ACCOMMODATION AREA.

GUIDANCE, PROCEDURES AND RISK ASSESSMENT

The company's Safety Management System (SMS) did not contain any guidance on the carriage of fumigated cargo.

The ISM Code introduces a mandatory requirement for a company to assess all identified risks to their ships and personnel and to establish adequate safeguards, which should be based on a risk assessment. Even if the risks associated with fumigation had not been identified in advance, for example, because the ship had not been previously engaged in this activity, the charterers requirement to fumigate the cargo on board should have prompted a consideration and resulted in an ad-hoc risk assessment.

This in turn should have resulted in identifying appropriate risk mitigants, as well as contingency planning in the event of fumigant ingress to the accommodation space.

The following IMO circulars provide safety recommendations with regard to carrying out fumigation on board ships:

- General MSC.1/Circ.1358 "Recommendations on the Safe Use of Pesticides in Ships"
- Fumigation in cargo holds: MSC.1/Circ.1264 "Recommendations on the Safe Use of Pesticides in Ships Applicable to the Fumigation of Cargo Holds", amended by MSC.1/Circ.1396
- Fumigation in cargo transport units: MSC.1/Circ.1361 "Revised Recommendations on the Safe Use of Pesticides in Ships Applicable to the Fumigation of Cargo Transport Units"

SUITABILITY FOR FUMIGATION AND INSPECTION OF GAS TIGHT INTEGRITY

No procedures had been established to ensure the ship was suitable for in-transit fumigation, and no inspection was carried out by the ship's staff or fumigators to confirm the gas tight integrity of the hold. The fumigators did not arrive at the ship until after loading was complete, which made the inspection of the gas tight integrity impossible.

IMO Circ.1264 recommendations require that empty cargo holds should be inspected and/or tested for leakage, so that they can be sealed properly. According to IMO Recommendations 3.3.2.4, the fumigator-in-charge, accompanied by a trained representative of the master or a competent person, should determine whether the cargo holds are or can be made sufficiently gas tight to prevent leakage of the fumigant to the accommodation space, engine-rooms and other working spaces in the ship.

It is therefore necessary to identify all spaces within the accommodation (as well as enclosed work spaces) to which the fumigant can leak from the cargo hold(s) and, thoroughly check the boundary between them and seal it as required.

Following a procedure established to comply with IMO Recommendations would have resulted in the identification and sealing/removing of leaks prior to loading and fumigation, and as a result prevented the incident from occurring.

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PREVENTING INGRESS OF THE FUMIGANT TO ACCOMMODATION

It is advisable to maintain a slight over-pressure in the accommodation to prevent a potential fumigant gas leak from penetrating the area – otherwise, even a relatively small opening/hole may result in fumigant ingress to the accommodation space.

Once the fumigating compound in the cargo holds had been fully hydrolysed, a positive pressure balance of phosphine gas (PH₃) was created in the cargo hold. The fumigant entered the accommodation space via the sanitary ventilation system and unsealed stubs of pipe when positive pressure in the accommodation, provided by the ventilation system, was stopped.

Due consideration of the implications of shutting down the accommodation ventilation system while laden with fumigated cargo could have resulted in maintaining the positive pressure balance and in consequently could have prevented the incident.

Masters of ships which carry out in-transit fumigation should be aware that changing ventilation arrangements through the adjustment of closing devices, flap settings, air conditioning and closed loop ventilation may potentially result in sub-pressure and the drawing in of the fumigant gas to the accommodation space or engine room.

PLANNED MAINTENANCE

The fumigant penetrated into the accommodation area through the hydraulic room. The main issue which contributed to the incident was with the door to the cargo hold, which could not be made gas- or water-tight. The misalignment of the door was visibly noticeable. The remaining issues (ventilation fan and trunking not being air-tight) were not readily visible, although they should have been detected through routine checks.

None of the above issues had been identified as part of the vessel's planned maintenance schedule, which indicates that the periodical tests/checks and maintenance routines had not been effective. No maintenance records were available for the hydraulic room door or the sanitary ventilation system. This points to gaps in technical and safety management processes combined with an ineffective safety culture, which enabled these issues to remain unrectified.

DETECTING OF THE FUMIGANT INSIDE ACCOMMODATION

The periodic monitoring of the accommodation and engine room atmosphere was not conducted at the specified frequency. In any event, periodic monitoring did not detect the fumigant in time to avert lethal levels of exposure. It should also be noted that the carbide additive did not provide sufficient olfactory warning to the presence of the fumigant.

The fumigators provided the ship with a manual pump gas detection equipment and 20 gas detection tubes. The tubes could be used in multiple locations in each test period if no gas was detected. No equipment for the continuous monitoring for the presence of PH₃ was available onboard.

According to the instructions received by the ship, testing should have been conducted every eight hours in the accommodation space, engine room and other working areas. In reality, the C/O tested twice a day, after his watch. The manual testing process was complex and time-consuming, taking up to half an hour to test on both accommodation decks and in the engine room.

No assessment was made if or when an increased frequency of testing would be required, e.g. in heavy weather. An increased frequency of testing could have identified the fumigant earlier. However, it is worth pointing out that once exposed to the fumigant, several members of the crew became immobilised in minutes.

Periodic testing did not therefore ensure that the presence of the fumigant would be detected in time to avert lethal levels of exposure. Such protection would only realistically be possible with a continuous monitoring system, which is rarely encountered in cargo ships, or with personal monitoring devices which produce an alarm once the user's exposure to the fumigant reaches a set level.

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IDENTIFICATION OF SAFE LEVEL OF EXPOSURE

The fumigator's guidance on maximum exposure limits was not in line with the thresholds established in the country of loading or discharge and did not take in to account that the Flag State (The Bahamas) did not have any regulations identifying occupational exposure limits for phosphine.

According to IMO Recommendations (MSC.1/Circ.1264), the gas detection equipment should be provided along with the occupational exposure limit values set by the Flag State regulations for safe working conditions. Regulatory limits vary significantly between States.

Although instructions provided by the fumigators identified a threshold limit value (TLV) of 0.3 parts per million (ppm), they did not specify if it referred to the short term exposure limit (STEL), or the time weighted average (TWA).

While the investigation did not consider this to be a contributory factor to the outcome of the incident, the instructions to the ship should be unambiguous and correct.

TRAINING AND BRIEFING

According to IMO Recommendations, at least two members of the crew (including one officer) who have received appropriate training should be designated as the master's trained representatives responsible for ensuring that safe conditions in the accommodation, engine-room and other working spaces are maintained after the fumigator-in-charge has handed over that responsibility to the master. The trained representatives of the master should brief the crew before a fumigation takes place.

The fumigator-in-charge provided training to one crew member (the C/O). In turn, the C/O provided a fumigation briefing to the available crew. However, at least two members of the crew were not present. Members of the crew who were not present did not receive any further information on the fumigation or related risks. With no records kept, it was unclear whether the deceased crew member was present at the briefing.

For those who did attend, the content of the briefing turned out to be insufficient to highlight the risks of fumigation, or the symptoms of poisoning, to sufficiently alert them when taken ill. For anyone who actually smelled it, the carbide/garlic additive did not trigger any action. Poor quality of air in the accommodation was associated it with the ingress of exhaust gases, sewage or other unknown issues.

Structured and well organised training is key in delivering safety-related information to crew members. It is an opportunity to discuss the risks and mitigants, reflect on one's personal safety and embed knowledge which may prevent injury or loss of life.

SEE NEXT PAGE FOR HIERARCHY OF BARRIER CONTROLS DIAGRAM.

For more information on this incident, email: lossprevention@tindallriley.com

THE SOURCE OF THIS CASE STUDY IS DRAWN FROM THE INVESTIGATION REPORT PUBLISHED BY THE BAHAMAS MARITIME AUTHORITY: <https://www.bahamasmartime.com/downloads/investigation-reports/bma-investigation-report-cargo-fumigant-poisoning-resulting-in-one-fatality-on-board-the-fri-dolphin/>

THE PURPOSE OF THIS CASE STUDY IS TO SUPPORT AND ENCOURAGE REFLECTIVE LEARNING. THE DETAILS OF THE CASE STUDY MAY BE BASED ON, BUT NOT NECESSARILY IDENTICAL TO, FACTS RELATING TO AN ACTUAL INCIDENT. ANY LESSONS LEARNED OR COMMENTS ARE NOT INTENDED TO APPORTION BLAME ON THE INDIVIDUALS OR COMPANY INVOLVED. ANY SUGGESTED PRACTICES MAY NOT NECESSARILY BE THE ONLY WAY OF ADDRESSING THE LESSONS LEARNED, AND SHOULD ALWAYS BE SUBJECT TO THE REQUIREMENTS OF ANY APPLICABLE INTERNATIONAL OR NATIONAL REGULATIONS, AS WELL AS A COMPANY'S OWN PROCEDURES AND POLICIES.