MARS

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In this bulletin…

In this edition – Fulminations on Fumigation

The hazards of confined spaces are well known, but add a poisonous substance to the mix and you have a clear and present danger to mariners.

Fumigation is a necessary step in the transport of cereals and other foodstuffs in bulk. But if procedures are not strictly followed, or if the vessel is not maintained to high standards or has structural flaws, the consequences are often fatal. A consolidated casualty analysis carried out by IMO found that:

- at least 49 seafarers and shore workers have lost their lives in fumigant-related accidents;
- a further 86 have been seriously injured after being exposed to hazards associated with the fumigation of cargo holds since MSC.1/Circ.1264 was approved in 2008 (MSC 111/19/3).

There have been at least three deaths due to fire or explosion, and several deaths associated with oxygen depletion, but the predominant cause of death is exposure to fumigant gas. This includes at least 25 seafarers that have died when fumigant entered the accommodation during the voyage.

This edition of MARS has some tragic but informative examples of accidents involving fumigation.

MARS 202616

Pin holes leak fumigation gas into crew cabin

A bulk carrier loaded feed wheat into the vessel's two holds. Once loading was complete, a specialised fumigation contractor applied aluminium phosphide pellets, loose, into the cargo. The fumigation process was intended to continue during the voyage to the discharge port as the tablets decomposed and gave off phosphine gas.

Before departing the ship, the fumigator-in-charge provided a brief to the chief officer, as well as leaving some gas detection equipment.

The voyage was uneventful, but the weather deteriorated and the ship encountered force 7-8 wind on the port bow. During the same day a crew member noticed a smell in the corridor outside his cabin but attributed this to some vomit he found in the laundry sink.

The following morning, another crewman was found deceased in his cabin, lying on the floor next to his day bed. The cabin was sealed and the agent in the arrival port was contacted.

The fumigator appointed to meet the vessel in the arrival port found a very high concentration of phosphine gas in the deceased crewman's cabin and in the hospital next door. Both these spaces were adjacent to the aft bulkhead of the hold. The cabin deck also overlapped into the hold by half a metre.

No obvious leakage path for the fumigant gas was located, even after smoke testing the hold and stripping back the bulkhead linings. However, following de-scaling of the area, some pin holes were discovered in the underside of the cabin deck that overhung the cargo hold. All indications are that the crewman died of phosphine poisoning from phosphine gas migration from the hold through the pin holes and into his cabin.

Lesson learned

- Phosphine gas is extremely effective for its intended purpose. It is also potentially fatal to humans at very low concentrations.
- There is no antidote to phosphine poisoning. Treatment consists solely of supportive

respiratory and cardiovascular care. Prevention is critically important for crew safety. (Ref. Marinepublic.com)
- Vessels with common bulkheads between cargo holds and crew accommodation require extra scrutiny, as these configurations have been involved in multiple fatalities.
- Safe in-transit fumigation requires proper crew training, including gas detection equipment operation, safety procedures, and emergency response protocols. At least two crew members, including one officer, must demonstrate competency with all safety equipment.

As edited from MAIB (UK) report published 23 January 2015

MARS 202617
In-transit fumigation fatality

[Editor's note; this report initially appeared as MARS 202210, but is repeated here as it is in line with the theme of this issue]

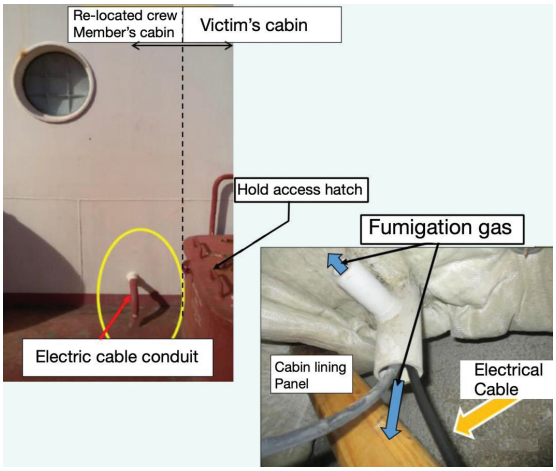
A handy-sized bulk carrier was loaded with wheat, and the cargo was fumigated after completion of loading. When the fumigation procedure was undertaken, the hatch covers, ventilators and access hatches to all five cargo holds were sealed. The vessel then departed for a trans-oceanic voyage. The crew had been briefed on the dangers of fumigation gas, and the Master told the crew to stay alert for the smell of garlic or decaying fish as this scent had been added to the gas to allow easy detection.

During the first three days of the voyage, phosphine gas readings were taken at regular intervals at the upper deck accommodation and the forecastle deck. All readings were zero ppm. On the fourth day, the gas test results showed that the accommodation on upper deck contained 0.1 ppm of phosphine gas. (According to best practices, an eight-hour average respiratory exposure to phosphine gas should not exceed 0.3 ppm and a short-term exposure should not exceed 1ppm.) On the same day, a crew member remarked that he had noticed a bad odour inside his cabin. A test in the cabin showed no phosphine gas but the crew member was relocated to another cabin.

The next day, a phosphine gas reading of 2 ppm was measured at the upper deck alleyway. The Master called muster stations and instructed all crew to evacuate their cabins at once. The engine cadet did not appear at muster, so two crew went to his cabin where he was found in a state of partial paralysis. The victim was taken outside for care. A phosphine gas reading of 9 ppm was measured in his cabin, which was next to the cabin of the crew member who had been relocated the previous day.

Over the next hour, the victim's vital signs deteriorated. A request for radio medical advice was sent and cardio-pulmonary resuscitation was carried out, but the crew were unable to revive the victim. His body was brought ashore at a port of refuge two days later.

The official investigation found, among other things, that a permanent access light for the aft access ladder of No. 5 cargo hold had been installed during construction. A conduit was used to run the electric cable between the accommodation and No. 5 cargo hold. The conduit ends were not sealed, contrary to best practices and classification rules. This defect allowed the phosphine gas to infiltrate the accommodation area and enter the crew cabins.



Lessons learned
- The suitability of a vessel for fumigation is a critical factor and could mean the difference between life or death. The timeworn critique that old, unsuitable vessels were the weak link in the fumigation system does not always apply. In this case a 'man-made' defect rendered the vessel unsuitable for fumigation.
- Deadly fumigation gases can take several days to infiltrate accommodation areas, even when a clear passage exists, as in this case. Continuous or very frequent testing is the best defence against this danger.

As edited from official MAISSPB (Hong Kong/SAR) report published 2019

MARS 202618

Crew poisoning from fumigant with two fatalities

The crew and stevedores had completed loading a cargo of shea nuts on a general cargo vessel. Before departure, two persons arrived on board to distribute fumigating agent (a phosphine emitting agent). The fumigators explained that the fumigating agent would begin to work after around 15 minutes from its distribution in the cargo hold. With their face masks on, they began to lay out the bags with fumigant and sprinkle them with liquid. The bags were placed on the surface of the cargo.

During the distribution of the fumigant, the crew smelled an unidentified sharp odour. The crew were advised to avoid inhaling the substance when closing the hatches. The crew then completed the closing of hold covers and prepared the ship for sea. When the hatches were closed and the hooks tightened, the odour was not present anymore. The chief officer did not receive any information or warning leaflets about the effects of the fumigant from the fumigators.

The day after departure, from about midnight, the crew began experiencing stomach pains and vomiting, with an accompanying feeling of cold and generalised weakness. Later that day, the condition of individual crew members began to deteriorate and symptoms started to worsen. The Master, who exhibited similar symptoms, consulted other officers and notified the shipowner, and then a physician from a coast radio station.

The Master suspected food poisoning and the attending radio physician suggested going to the nearest port. A local physician arrived by motorboat and prescribed various medicines which were distributed according to his recommendations.

The next night, the condition of the crew deteriorated further. The chief officer, who would normally stand the 4/8 watch, called the OOW at around 3am and asked him to remain on watch past 4am since he felt very bad. Sometime after 4am, a crew member went to the chief officer's cabin and found him lifeless. Resuscitation was started and emergency medical assistance was requested. During the resuscitation of the chief officer, the condition of the third officer also deteriorated. He had breathing problems and was given oxygen. Resuscitation began, but he was declared deceased after 40 minutes.

The rest of the crew (15) were disembarked to undertake testing, and were diagnosed with phosphine gas poisoning.

The investigation explained, among other things, the effects of exposure to an atmosphere containing phosphine, depending on its concentration:

- 0.3 ppm – exposure for up to 8 hours a day;
- 1.0 ppm – exposure for less than 15 minutes without any effects;
- 5.0 ppm – exposure for up to 1 hour without life-threatening effects;
- 100 – 190 ppm – exposure for 30–60 minutes results in serious consequences for health;
- 290 – 430 ppm – exposure for 30–60 minutes causes a threat to life;
- 400 – 600 ppm – exposure for 30–60 minutes causes death.

The investigation found, among other things, that leaks in the ventilation trunk of the air conditioning system allowed poisonous gas from the fumigated cargo hold to get to the A/C control room and on to the crew living quarters. This was a major contributing factor to the crew poisoning.

The chief officer had carried the same cargo of shea nuts on his previous voyage, but the cargo was not fumigated. On the ill-fated voyage, he did not expect fumigation and did not know how to proceed.

Lessons learned

- Specialised fumigators are required to leave instructions and procedures for crew to follow. If they have not done so, do not proceed to sea.
- If you are unfamiliar with fumigation procedures and are required to carry such cargo, call a stop work until all the information is available.
- If you are transporting fumigated cargo and there is general sickness on board amongst the crew, assume the worst – that it is fumigant poisoning.
- A vessel carrying fumigated cargo should carry fumigant gas-detection equipment, instructions on disposal of residual fumigant material, at least four sets of adequate respiratory protective equipment and a copy of the latest version of the *Medical First Aid Guide for Use in Accidents Involving Dangerous Goods*, as well as appropriate medicines and medical equipment.
- If fumigation is ongoing, perform gas concentration safety checks in such spaces as accommodation, engine-room, navigation bridge and frequently visited working areas. The checks should be performed at least at eight-hour intervals, and the readings should be recorded in the ship's logbook. **In some cases eight hours is probably too long an interval.**

As edited from State Marine Accident Investigation Commission (Poland) report WIM 14/15

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