BSAFE

INCIDENT **CASE STUDY**

BRITANNIA P&I

Cargo Fumigant Poisoning Leading to a Fatality

Cargo Fumigant Poisoning Leading to a Fatality

BACKGROUND

- **A small ship was chartered to carry a cargo of corn on a short haul voyage in Europe. The cargo required in-transit fumigation.**
- **Before loading, the cargo hold was inspected by cargo interests for the suitability for cargo, however the hold's gas tight integrity was not assessed by the charterers or ship's crew.**
- **On completion of loading, technicians from a fumigation company visited the ship and made preparations for fumigation. After verbally confirming with the master that the hold was suitable for fumigation, three bags of aluminium phosphide were placed in the hold. The hatches were then closed.**
- **The master was given a briefing document pack and equipment for testing for the presence of the fumigant. The chief officer (C/O) was given training in the use of the gas detection equipment provided.**

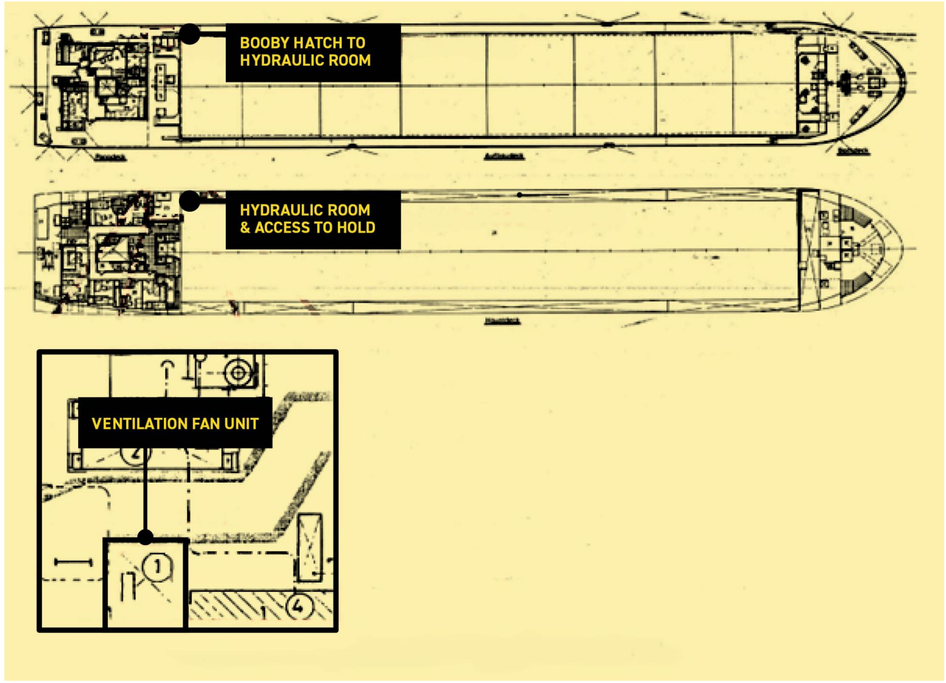
The ship
Source: Investigation report by The Bahamas Maritime Authority

BACKGROUND (continued)

- **The ship had a single box-shaped cargo hold. The accommodation consisted of two decks, of which the lower was below the main deck level. The forward bulkhead of this deck was next to the cargo hold.**

- **Access to the cargo hold was gained through a booby hatch at the front and through a hydraulic room aft. The hydraulic room shared two bulkheads with the accommodation space. The ventilation of the cargo hold was arranged via ducts forward and aft. The aft ventilation duct passed through the accommodation space and was adjacent to the engine room air intakes.**

- **After the incident an investigation using pressure checks and smoke testing revealed that the door leading from the hydraulic room to the cargo hold was misaligned and could not be made gas-tight. In addition, the ventilation fan and trunking for the accommodation's sanitary spaces running through the hydraulic room were not airtight. There were also two uncapped stubs of pipe between the hydraulic room and the accommodation space.**



Aft access to cargo hold through the hydraulic room
Source: Investigation report by The Bahamas Maritime Authority

BACKGROUND (continued)

- **During smoke testing after the incident with the ventilation fans stopped, a smoke generator located in the hydraulic room filled the accommodation space in under a minute.**

- **The compound used to fumigate the cargo was aluminium phosphide, which creates the fumigant, phosphine gas (PH_3). For in-transit fumigation, the compound is placed on top of the cargo on completion of loading. Phosphine gas is heavier than air, flammable, colourless and odourless. However, the addition of chemicals to the compound gives the gas the odour of garlic to provide a warning.**

- **In the case of exposure to phosphine gas, there is no antidote; the treatment is to provide oxygen.**

THE INCIDENT

- **The fumigation compound was placed in the cargo hold after the loading was completed at around 2145. The ship remained alongside overnight waiting for the tide and departed at 0600 the next morning (12 February).**
- **An initial check for the presence of the fumigant was conducted by the C/O at 0800 at two locations in the accommodation space and one in the engine room. These checks were then repeated at 2000 and 0800 the following day (13 February).**
- **Meanwhile the weather deteriorated and the master adjusted the passage plan accordingly. At approximately 1030 on 13 February, a wave entered the ventilation trunking which resulted in water flooding the galley and a store room. The ventilation system was then stopped and the accommodation's ventilation flaps were shut.**
- **For a period in the early afternoon, the combination of the apparent wind direction and the openings on the bridge and accommodation resulted in exhaust gas being funnelled into the accommodation.**
- **After lunch the crew who were not working retired to their cabins. By 1245 several of the crew were experiencing headaches, fatigue and severe nausea which they attributed to seasickness, reaction to the food served at lunch or the presence of exhaust gas in the accommodation.**

THE INCIDENT

- **With the exception of the chief engineer (C/E), who went to the engine room, the crew affected either remained in their cabins, went to the bridge or went on to the boat deck to get fresh air.**

- **It was not until around 1800 when the master became aware that at least three of the crew were unwell and the possibility of fumigation poisoning was raised. The information provided by the fumigation company was then re-checked and the master tested the atmosphere in the accommodation and confirmed the presence of the fumigant gas (PH_3).**

- **Local authorities were contacted to report the presence of the fumigant in the accommodation and request assistance. The crew were then moved to the ship's office and master's cabin where windows could be opened to increase the flow of fresh air. Sometime before 1900, the able bodied seaman/cook (AB/Cook) returned to his cabin for an unknown reason, which was unnoticed.**

- **A rescue helicopter reached the ship at 2019 and a winchman was lowered on to the deck. At 2059 the winchman reported to shore that three members of the crew were in a serious condition and that the AB/Cook had been found dead in his cabin. About an hour later a second helicopter arrived with a medical team and stabilised the three crew, who were finally evacuated by boat and later recovered in hospital.**

REFLECTIVE LEARNING

The questions below are intended to be used to help review the incident case study either individually or in small groups:

- **What do you think could have been the immediate cause of the incident?**
- **What other factors do you think contributed to the incident?**
- **What do you think were the barriers that should have prevented this incident?**
- **Why do you think these barriers might not have been effective on this occasion?**
- **What are the risks associated with in-transit fumigation?**
- **What guidance does your Safety Management System (SMS) provide for fumigation? Does it include any advice on ventilation arrangements in the accommodation, engine room and other working spaces?**
- **How do you ensure that cargo spaces are suitable for in-transit fumigation? Are small holes and penetrations dangerous?**
- **How do you detect the presence of fumigant inside the accommodation space and what actions need to be taken in case of a leak?**

LESSONS LEARNED

The following lessons learned have been identified based on the available information in the investigation report and are not intended to apportion blame on the individuals or company involved:

- **Guidance and risk control measures**: The SMS did not contain any relevant guidance, or any procedures to ensure the ship was suitable for in-transit fumigation, maintain gas tight integrity of the cargo hold, or conduct a pre-loading inspection. No risk assessment was conducted and no contingency plans had been developed in the event of fumigant ingress in to the accommodation.

- **Pre-loading inspection:** No inspection was conducted by the ship's staff. The fumigators arrived after loading was complete and by then the inspection to confirm the gas tight integrity of the hold could not take place as required. Checks were limited to a verbal confirmation with the master and C/O. In fact, the hydraulic room was not gas or watertight, which had not been identified as part of the ship's planned maintenance schedule.

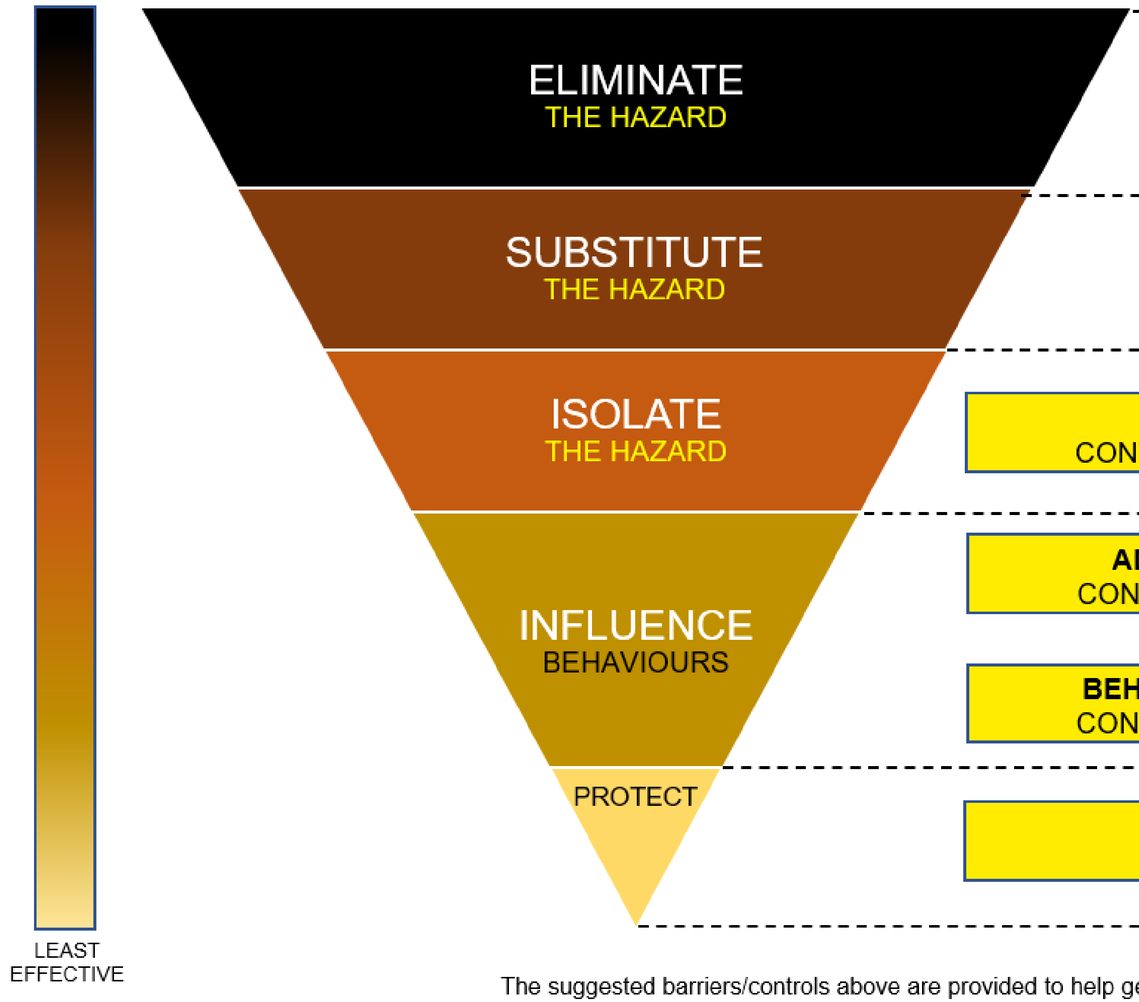
- **Training:** Only one crew member (the C/O) was provided with training by the fumigator-in-charge. In turn, the C/O's briefing for the crew did not adequately highlight the risks or the symptoms of poisoning to sufficiently alert the crew when taken ill.

- **Loss of positive pressure:** When the accommodation's ventilation was stopped and the flaps closed, no consideration was given to the potential effects of this action or the additional risk posed by the fumigated cargo. Stopping the accommodation's forced ventilation resulted in the positive pressure being lost in the accommodation and allowed the fumigant to enter.

- **Atmosphere monitoring** was not conducted at the specified frequency. An increased periodic testing frequency may have identified the fumigant earlier. In addition, the olfactory additive did not provide sufficient warning and did not alert the crew to the presence of the fumigant in the accommodation space.

Cargo Fumigant Poisoning Leading to a Fatality

HIERARCHY OF BARRIER CONTROLS



PHYSICAL CONTROLS/BARRIERS

ADMINISTRATIVE CONTROLS/BARRIERS

BEHAVIOURAL/SKILL CONTROLS/BARRIERS

PPE CONTROLS

EXAMPLES OF POSSIBLE RISK MITIGATION CONTROL MEASURES RELATED TO THE CASE STUDY

Consider **EXCLUDING** in-transit fumigation in fixture terms

Fumigate cargo **PRIOR TO LOADING** if practicable

Not applicable: fumigation typically cannot be substituted with less toxic processes

GAS-TIGHT barriers inspected, well maintained and leak-free
POSITIVE PRESSURE to prevent drawing the fumigant in
DETECTION adequate and frequent enough

RISK ASSESSMENT to identify and mitigate fumigation risks
PROCEDURE to monitor the implementation of risk controls
MAINTENANCE planned and controlled to ensure gas-tightness

BRIEFING all crew to advise of risks, symptoms and actions
TRAINING to ensure safe conditions are maintained

PPE always to be provided and carried as appropriate for the activity and risk. However, PPE is not likely to have been able to prevent this incident

The suggested barriers/controls above are provided to help generate reflective discussions, and should not be considered as conclusive/definitive or comprehensive for the provided case study. The risk and control measures relating to any similar scenario or activity must always be appropriately assessed based on the specific onboard arrangement and circumstances.

CONCLUSIONS

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.

The ship's SMS did not provide guidance or adequate safeguards for fumigation despite the available IMO safety recommendations in this regard. An ad-hoc risk assessment should have identified appropriate risk controls and resulted in contingency planning in the event of the fumigant ingress to the accommodation space.

The periodic monitoring of the atmosphere did not detect the fumigant in time to avert lethal levels of exposure, and the carbide additive did not provide sufficient warning to the presence of the fumigant. A timely assessment whether increased testing was required, e.g. in heavy weather, could have prevented this incident.

Although some of the defects such as misaligned hydraulic room doors were easily noticeable, they had not been rectified in good time. The periodical checks and maintenance routines had not been effective due to apparent gaps in technical and safety management combined with an ineffective safety culture, which enabled these issues to remain uncorrected.

Finally, 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.

QUESTIONS