

Marine Safety Investigation Report

VERY SERIOUS MARINE CASUALTY | March 2024

The Bahamas
Maritime Authority

Magic Striker

Dangerous space fatality on 21 December 2021

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What happened

On the morning of 21 December 2021, the Bahamas registered bulk carrier Magic Striker had nearly completed loading a cargo of corn in Chennai, India, when a team of fumigation contractors arrived onboard.

In the early afternoon, two contractors entered cargo hold 4, wearing gas masks along with a phosphine gas detector. Shortly afterwards, one of them climbed back out, feeling breathless. He then noticed his colleague had fallen and went back down the ladder to help him. He too collapsed.

After the alarm was raised, the chief officer ran to the hatch and saw the two workers motionless at the bottom of the ladder. He then fetched an emergency escape breathing device which he wore to enter the hold and retrieve both contractors. One of the workers recovered but his colleague did not survive.

Why it happened

Oxygen levels in the cargo hold had been depleted by the corn cargo inside – in the six days that the hatches had been shut, oxygen levels had fallen well below that needed to support life. Dangerous levels of phosphine were also found but toxicology showed no gaseous poison in the blood or lungs of the victim or survivor.

The fumigation workers entered cargo hold 4 without the knowledge of the crew and without effective protection - the cargo holds were not considered dangerous spaces and therefore there was no safe system of entry or access control in place.

The attempt to help a colleague in distress cost the victim his life. The uncoordinated rescue attempt by the chief officer using unsuitable equipment could have resulted in more victims.

What we can learn

Organic cargoes, such as corn, can deplete oxygen (and raise carbon dioxide) to dangerous levels in enclosed spaces rapidly.

The fumigation contractors' protective equipment – gas masks and phosphine detector - offered no protection from the other hazard that they were exposed to. The risk of oxygen depletion was not considered by those onboard or ashore.

The human drive to help those in distress is incredibly strong but can prove fatal: the importance of realistic drills to prepare for these scenarios and imprint an appropriate response cannot be underestimated. Shoreside personnel that are subject to the same risks would benefit from similar training.

The evidence used in this investigation - including witness testimonies, scene examination and documentation - was gathered by the India's Mercantile Marine Department in Chennai, acting as a Substantially Interested State.

Narrative

On 3 December 2021, the Bahamas registered bulk carrier Magic Striker arrived in Chennai, India, ready to load a cargo of 53,000 tonnes of Indian yellow corn. As part of the preparation for loading, fumigation contractors boarded the vessel to install ducting within the cargo holds to enable effective fumigation of the cargo once loaded. Loading commenced that day and continued intermittently, with stops due to rain.

At 13:15 on 15 December, loading was complete in cargo hold 4. The hatches and accessways were shut. Loading continued in the remaining holds as weather allowed.

Six days later, on the morning of 21 December, cargo loading was nearing completion and, at 09:48, 21 contractors arrived onboard to fumigate the cargo. Whilst their equipment was being loaded onboard, using a ship's crane (No.1, forward) a team of four contractors were waiting at the forward booby hatch of cargo hold 4.

At around 12:12, the team set about arranging the fumigant circulation equipment for cargo hold 4, two workers entered the booby hatch, wearing gas masks and taking with them a phosphine gas detector. Shortly afterwards, worker A climbed back out, feeling breathless. He then noticed worker B had fallen and went back down the ladder to help him.

On deck, the other members of the team realised that their colleagues were in difficulty and attempted to enter but quickly returned to the deck when they too felt breathless. One then ran to inform the ship's crew at the gangway. At 12:17 the officer of the watch alerted the master by handheld radio and shortly afterwards the master made an announcement on the public address system to muster for an enclosed space rescue.

Having heard the initial call on the radio, the chief officer ran to the booby hatch and saw the two workers motionless at the bottom of the ladder. He then fetched an emergency escape breathing device and at 12:22 the chief officer, wearing the emergency escape breathing device, entered the hold and retrieved worker A.

The chief officer then re-entered (still wearing the emergency escape breathing device) and retrieved worker B with the help of a rope being hauled from deck. Both casualties were given first aid (including oxygen) until 12:40, when they were taken to hospital by car.

Worker A was declared dead at 14:25. Worker B recovered. Toxicology showed no gaseous poison in the blood or lungs of the victim or survivor.

Vessel and People

Magic Striker was a Bahamian registered bulk carrier with five cargo holds and a cargo capacity for 71,634 tonnes of grain. The vessel's 22 Ukrainian and Filipino crew all held appropriate qualifications for their respective roles on board.

The chief officer was a 27 year old Ukrainian. He held a chief mate certificate of competency and had been onboard for two months.

Worker A was a 42 year old Indian National. He was employed by Fumigation Services Private Ltd. Chennai. He did not hold any formal qualifications.



Previous similar cases

The industry has suffered an unacceptable number of deaths in “enclosed” or “confined” spaces for decades but deaths in these spaces are not always due to the hazards that might be expected. The Bahamas Maritime Authority has recorded four other instances of deaths in dangerous spaces or due to oxygen deficient or toxic atmosphere in the last five years.

Jupiter (2022) [Bahamas](#)

Two crew had entered a cargo hold containing a soy bean cargo when one was overcome by residual fumigant gas. The chief officer, who entered the hold to facilitate a rescue, was also overcome. The crew member died and chief officer was seriously injured.

The cargo had been fumigated on passage but the holds were not considered to be dangerous as the vessel was in possession of a gas free certificate, issued by fumigant removal contractors, and the hatches had been open and ventilated for some time.

Navigator of the Seas (2020) [Bahamas](#)

Three crew were working inside a feedwater tank onboard a Bahamas flagged passenger vessel when there was a sudden release of steam. One person died and another was seriously injured.

Confined space entry paperwork had been completed and the team had discussed the hazards and control measures identified in the job safety analysis but the risk of steam release was unknown to those completing the work so it was not considered and effective controls were not put in place.

Diane (2020) [Saudi Arabia](#) (IMO GISIS reference C0013148)

During discharge of a soy bean cargo from a Bahamas flagged bulk carrier, the crew identified a stevedore lying at the bottom of a booby hatch. Having mustered, and in appropriate protective equipment, the rescue team recovered the victim but he could not be revived.

Legislation and guidance

International Maritime Organisation (IMO) Regulation A.1050(27) *Revised recommendations for entering enclosed spaces aboard ships*¹ contains recommendations aimed at preventing casualties to persons entering spaces where there may be an oxygen-deficient, oxygen-enriched, flammable and/or toxic atmosphere. It highlights that investigations into casualties have shown that accidents on board ships are

¹ At the time of publishing, work was ongoing at the International Maritime Organization to finalise new *Recommendations for Entering Enclosed Spaces Aboard Ships*

in most cases caused by an insufficient knowledge of, or disregard for, the need to take precautions rather than a lack of guidance.

Particularly relevant excerpts:

- Section 6.1 Entry doors or hatches leading to enclosed spaces should at all times be secured against entry, when entry is not required.
- Section 8.5 In the event of an emergency, under no circumstances should the attending crew member enter the space before help has arrived and the situation has been evaluated to ensure the safety of those entering the space to undertake rescue operations. Only properly trained and equipped personnel should perform rescue operations in enclosed spaces.

Analysis

The purpose of the analysis is to determine the contributory causes and circumstances of the casualty as a basis for making recommendations to prevent similar casualties occurring in the future.

Atmosphere

Measurements of the atmosphere in the holds were taken by the Indian Mercantile Marine Department four days after the casualty. They recorded the following²:

	Oxygen	Phosphine
Cargo Hold #1	2.6%	31 ppm
Cargo Hold #2	9.4%	21 ppm
Cargo Hold #3	19.4%	0 ppm
Cargo Hold #4	2.6%	35 ppm
Cargo Hold #5	7.8%	18 ppm

Oxygen makes up 20.9% of air and there is a threat to human life if levels fall below 19.5%. Breathing air that contains less than 6% oxygen produces convulsions, then apnea (cessation of breathing), followed by cardiac standstill. These symptoms occur immediately. Even if a person survives exposure, their organs may be irreversibly damaged³.

Phosphine is a poisonous gas commonly used as a pesticide in agriculture. The effects of exposure are usually rapid and there is no antidote - treatment is to provide oxygen. The Bahamas does not have any regulations identifying occupational exposure limits for phosphine but exposure to levels above 1 part per million (ppm) is considered dangerous - even for a short time.

Toxicology analysis did not identify any poisoning associated with fumigants in the blood or organs of the victim or survivor: the gas masks they were wearing may have protected them from the exposure to phosphine - unconsciousness and further deterioration of their condition was due to lack of oxygen.

Oxygen depleting cargoes

Recent work presented to the International Maritime Organization⁴ has highlighted how quickly the oxygen level can deplete to a dangerous level in holds that contain organic cargoes such as barley, wheat

² There was no hydrogen sulphide or methane detected. There were increased levels of carbon monoxide measured but levels were well below concentrations that would have a physiological effect. There were no measurements taken of carbon dioxide.

³ Occupational Safety and Health Administration Respiratory Protection Rules: www.govinfo.gov/content/pkg/FR-1998-01-08/pdf/97-33843.pdf

⁴ Sub-Committee on Carriage of Cargoes and Containers, Session 9. Papers INF.8 & INF.10

and timber. Experiments were not conducted on corn but other organic cargoes were found to reduce oxygen and increase carbon dioxide from the moment hatches were sealed, with some cargoes reducing oxygen below 19.5% (or raising carbon dioxide to dangerous levels) in under an hour. Higher temperatures and moisture content increased the speed of development of fatal atmospheric conditions.

The findings of the study are mirrored in the atmosphere readings taken in the cargo holds of Magic Striker post-casualty – the holds that had been shut longest had the lowest levels of oxygen.

Fumigation

The plan was for the cargo to be fumigated using methyl bromide on completion of loading. Methyl bromide is applied as a gas from cylinders which connect to the holds via pipework installed prior to loading. Methyl bromide fumigation is not allowed during transit and requires the crew to be disembarked whilst it is carried out. Fumigation operations had not yet started at the time of the casualty (or when atmosphere was sampled post-casualty), therefore the dangerous levels of phosphine found in the cargo were present in the cargo prior to loading.

The cargo declaration and related documents did not identify the corn as being fumigated prior to loading and the vessel did not have means to detect the presence of, or protect the crew from, phosphine gas. Whilst the fumigation contractors were aware of the potential risk of the presence of phosphine – reflected in the wearing of gas masks on entry - this information was not shared with the crew and they were at increased risk during the entire cargo operation.

Access control

The fumigation workers entered cargo hold 4 without the knowledge of the crew. Whilst access to the ship was controlled at the gangway in practice it did not extend beyond the gangway watchkeeper: there was not enough crew to monitor and control the 21 person fumigation team plus the other stevedores and shore workers onboard at the time of the casualty. The booby hatches that provided access to the cargo holds were lockable but were not secured at any point during cargo operations.

Regardless of potential for controlling access, the cargo holds were not considered dangerous spaces in the context of requiring a permit to work to enter. No steps had been taken by the crew or the fumigation contractors to ensure that the entry that needed to occur to conduct the fumigation operation was safe.

Rescue

Worker A's attempt to help his colleague cost him his life. The other fumigation contractors that entered the hold to assist were fortunate to make it back to fresh air when they became breathless. The chief officer's decision to enter and the hold to facilitate rescue wearing only an emergency escape breathing devices was incredibly risky.

Emergency escape breathing devices provide a constant flow of air to the wearer to facilitate exit from a space where the breathing air is unsafe: it is not suitable equipment for entering a space to facilitate a rescue – they have a limited duration (approximately 10 minutes) and it is possible for a wearer to require a greater flow of air than the equipment supplies - this can result in the wearer breathing the atmosphere that has created the casualty and being overwhelmed.

The importance of realistic drills for rescues from an enclosed space cannot be overstated. A measured and coordinated rescue, using appropriate protective and retrieval equipment is essential. Regardless of the effectiveness of the vessel's emergency response plan, the fumigation contractors were not aware of appropriate actions to be taken when a colleagues became incapacitated in the cargo hold.

Conclusions

- A fumigation contractor died and another was seriously injured when they entered a cargo hold that did not have sufficient oxygen to support life.
- Oxygen levels in the cargo hold had been depleted by the corn cargo inside – in the six days that the hatches had been shut, oxygen levels had fallen below that needed to support life.
- The cargos holds were not treat as dangerous spaces and therefore there was no control of access or any safe system of entry in place.
- Contrary to the cargo documentation and specification, the corn had been fumigated prior to loading – significantly increasing risk to the health of all onboard for the duration of cargo operations.
- The fumigation contractors protective equipment – gas masks and phosphine detector - offered protection from the phosphine but not to the other hazard that they were exposed to. The risk of oxygen depletion was not considered.
- The victim re-entered and the cargo hold to help his colleague and was overcome. He was followed by two further colleagues who managed to exit before becoming casualties themselves.
- The chief officer entered the hold to rescue the victims using unsuitable protection for himself and with insufficient support. The rescue operation was fortunate not to have resulted in further fatalities.

Action taken and Recommendations

As a result of the casualty, Enterprises Shipping & Trading S.A has:

- Circulated a QHSE alert to its fleet, sharing lessons learned from the casualty including the importance of keeping all entrances to unattended dangerous areas secured against entry. The alert restated that no rescue attempts should be made without wearing breathing apparatus and safety harness and reinforced that the crew has the authority to stop any unsafe activity or behaviour by visitors or contractors that could potentially lead to an incident.
- Revised procedures for fumigation, emphasizing charterer’s and fumigation team’s responsibilities.

The Bahamas Maritime Authority has:

- Continued to work with member States through the auspices of IMO sub-committee on Carriage of Cargoes and Containers (CCC) to revise on Resolution A.1050(27) to improve the recommended practices for entering enclosed spaces aboard ships.

Due to the nature of the investigation, the BMA cannot issue recommendations to Fumigation Services Private Ltd. Chennai. Considering the actions taken (and ongoing), there are no further recommendations.

Vessel particulars

Vessel name	Magic Striker
Vessel type	Bulk carrier
Flag / IMO number	Bahamas / 9493664
Registered owner	Maggiore Marine Limited
Manager	Enterprises Shipping & Trading S.A.
Classification Society	Bureau Veritas
Built	China, 2010
Length / breadth / moulded depth (m)	189.99 / 32.26 / 18.0
Gross / net tonnage	33,044 / 19,231
Minimum safe manning	14

Voyage Particulars

Load port	Chennai, India
Discharge port	Various in Vietnam
Distance / duration	N/A
Cargo information	Approx. 53,000 tonnes Indian yellow corn
Crew	22

Marine Casualty Information

Severity of casualty	Very serious marine casualty
Date / time	21 December 2021, 12:21LT (UTC +5:30)
Geographical location	Chennai, India
Place onboard	Forward access to cargo hold 4
Injuries / fatalities	1 serious injury / 1 fatality
Damage / environmental impact	None
Ship operation	Loading cargo
Stage of passage	Alongside
External environment	Wind: Northeast force 3. No precipitation, natural light, air temperature 30°C