

ASPHYXIATION IN CARGO HOLD DUE TO OXYGEN DEPLETION

AN UNEXPECTED INCIDENT OCCURRED ON BOARD A BULK CARRIER NEARING THE COMPLETION OF LOADING CORN CARGO, CAUSING TWO FUMIGATION CONTRACTORS TO ASPHYXIATE AND RESULTING THE DEATH OF ONE CONTRACTOR. BEFORE THE INCIDENT, THE CARGO HOLDS HAD BEEN CLOSED FOR SIX DAYS, LEADING TO DEPLETED OXYGEN LEVELS INSIDE.

THIS INCIDENT HIGHLIGHTS THE DANGERS OF CLOSED CARGO HOLDS, THE LACK OF AWARENESS ABOUT HAZARDOUS CONDITIONS, AND THE HUMAN TENDENCY TO HELP OTHERS IN DISTRESS WITHOUT CONSIDERING PERSONAL SAFETY.

WHAT HAPPENED

On 3 December 2021, a 33,000 GT bulk carrier arrived in Chennai, India, to load 53,000 tonnes of yellow corn. Fumigation contractors boarded to install ducting for fumigating the cargo. Loading began that day but was intermittently halted due to rain. By 15 December 2021, cargo hold four was loaded and its hatches and accessways were sealed. Loading continued in other holds as weather allowed.

On 21 December 2021, as loading neared completion, 21 fumigation contractors boarded at 0948. While their equipment was being loaded using the ship's crane, a team of four contractors prepared to fumigate cargo hold four. At 1212, two workers entered the booby hatch of hold four with gas masks and a phosphine gas detector. Shortly afterwards, worker A emerged onto deck feeling breathless and noticed that worker B had fallen over within the cargo hold. He re-entered to assist.

Other team members, realising the danger, attempted to help but quickly retreated due to breathlessness. One team member then informed the ship's crew at the gangway. At 1217, the officer of the watch alerted the master, who then called for an enclosed space rescue via the public address system. The chief officer, upon hearing the call, rushed to the booby hatch. Upon seeing the two collapsed workers inside the hold, he donned an emergency escape breathing device (EEBD) and entered the hold, retrieving worker A at 1222. He re-entered (still wearing the EEBD) and, using a rope, retrieved worker B onto the deck.

Both workers were given first aid and oxygen until 1240 when they were transported to a local hospital by car. Worker A was declared dead at 1425, while worker B recovered. Toxicology reports indicated no gaseous poison in the blood or lungs of either worker.



FIGURE 1 BOTTOM OF THE LADDER WHERE CASUALTY WAS FOUND

BRITANNIA COMMENTARY ON INCIDENT

THE INVESTIGATION AND CASE STUDY IDENTIFIED SEVERAL CONTRIBUTING FACTORS AND LESSONS LEARNED. THESE ARE BASED ON THE INFORMATION AVAILABLE IN THE INVESTIGATION REPORT AND ARE NOT INTENDED TO APPORTION BLAME ON THE INDIVIDUALS OR COMPANY INVOLVED.

THE CARGO HOLD WAS NOT CONSIDERED AS DANGEROUS SPACE

An enclosed space is defined in the International Maritime Organization (IMO) 'Resolution A.1050(27) Revised Recommendations for Entering Enclosed Spaces Aboard Ships' as follows:

"Enclosed space means a space which has any of the following characteristics:

1. Limited openings for entry and exit;
2. Inadequate ventilation; and
3. Is not designed for continuous worker occupancy,

and includes, but is not limited to, *cargo spaces*, double bottoms, fuel tanks, ballast tanks, cargo pump-rooms, cargo compressor rooms, cofferdams, chain lockers, void spaces, duct keels, inter-barrier spaces, boilers, engine crankcases, engine scavenge air receivers, sewage tanks, and adjacent connected spaces. This list is not exhaustive and a ship-specific list should be produced to identify enclosed spaces."

As per Section 10.5 of Resolution A.1050(27), grain cargoes (e.g. corn) can cause oxygen depletion. Corn kernels absorb oxygen and excrete carbon dioxide, which can cause oxygen depletion in a cargo hold that is closed for a long time. The Occupational Safety and Health Administration (OSHA) considers any atmosphere with an oxygen content below 19.5% by volume to be oxygen-deficient and immediately dangerous to life or health. After the incident, tests of the atmosphere in cargo hold 4 showed an oxygen content of 2.6% by volume.

UNAUTHORISED ENTRY INTO CARGO HOLD

The cargo hold had been shut for six days, and the oxygen in the hold had been depleted by the corn cargo. Therefore, the cargo hold should have been considered an enclosed space. The involved parties did not recognise the danger of the cargo hold, loaded with grain and closed for a long time, so they did not consider it an enclosed space. Entry into an enclosed space should only occur after the ship's master authorises it and completes the entry permit system. Although the booby hatch for accessing the hold could be locked to prevent unauthorised entry, it was not locked, possibly because the final loading was incomplete, and they did not anticipate oxygen depletion or unauthorised entry. Since 21 fumigation contractors boarded the ship, the crew could not monitor every action of the contractors.



FIGURE 2 EXAMPLE OF WARNINGS ON BOOBY HATCHES

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BRITANNIA COMMENTARY ON INCIDENT (CONTINUED)

IMPULSIVE RESCUE

Enclosed space incidents regularly involve a person entering or re-entering a dangerous space to rescue a fallen colleague, and then subsequently becoming unwell and also requiring rescue. Worker A's attempt to help his colleague cost him his life. The chief officer's action to rescue contractors was brave, and he managed to save the life of one worker, but he jeopardised his own safety. As per paragraph 8.5 of Resolution A.1050(27), 'only properly trained and equipped personnel should perform rescue operations in enclosed spaces.' The chief officer was not properly equipped to enter the space for rescue as the EEBD worn by him supplies only 10-15 minutes of air and is designed to be used for escape from a compartment with a hazardous atmosphere. It should not be used for fighting fires, entering oxygen-deficient voids or tanks, or worn by firefighters. Instead, a self-contained breathing apparatus (SCBA) should be used.

EQUIPMENT AND TRAINING FOR FUMIGATION CONTRACTORS

The fumigator's unauthorised entry into the cargo hold suggests they were not trained on the hazards of cargo holds and general conduct on board. Due to the nature of their work, fumigators should have been trained on the dangers of oxygen deficiency and the presence of other toxic gases that can be present in cargo holds. External visitors should not have entered any cargo space or other space on board without authorisation from the ship's crew. They should ensure that the atmosphere is tested, safe to enter, and that all necessary precautions are in place. The contractors were carrying a phosphine detector and a gas mask, anticipating hazards relating to phosphine; however, all contractors tasked with entering the cargo hold to set up fumigation arrangements should have been provided with a personal multi-gas detector. This would have enabled them to swiftly identify the lack of oxygen in the hold and exit quickly.

ENCLOSED SPACE TRAINING AND DRILL

The circumstances that led to this incident and the shortcomings in the rescue operation highlight the need for continuous and ongoing training on enclosed space entry, emphasising the points from IMO 'Resolution A.1050(27)'. SOLAS Ch III regulation 19 states, 'crew members with enclosed space entry or rescue responsibilities shall participate in an enclosed space entry and rescue drill to be held on board the ship at least once every two months.' Regular enclosed space rescue drills should be conducted in a safe and realistic manner. The master should conduct drills in all enclosed spaces on the ship to practice and address the specific procedures and equipment needed for each space.



FIGURE 3 CORRECT WAY OF ENCLOSED SPACE RESCUE

BRITANNIA COMMENTARY ON INCIDENT (CONTINUED)

CONCLUSION

Enclosed space related accidents on board ships are mostly caused by insufficient knowledge or disregard for necessary precautions, rather than a lack of guidance. Shortcomings in the attempt to rescue and the use of improper equipment highlight the need for more awareness, training and drills. When a large number of shore workers board, it is difficult for the ship's crew to monitor all their actions. However, this should be discussed with the person in charge of the shore workers and a system should be agreed for control of work. Access control to all dangerous spaces on board is paramount. In an emergency rescue, the atmosphere of an enclosed space should be considered unsafe unless confirmed otherwise, and proper procedures should be followed. Rescue operations should only be conducted by properly trained and equipped personnel.

CONTACT

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

THIS CASE STUDY IS DRAWN FROM THE MARINE SAFETY INVESTIGATION REPORT PUBLISHED BY THE BAHAMAS MARITIME AUTHORITY.
<https://www.bahamasmaritime.com/wp-content/uploads/2024/03/BMA-Magic-Striker-Report-final.pdf>

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.

REFLECTIVE LEARNING MATERIAL ON NEXT PAGE

REFLECTIVE LEARNING MATERIAL - ASPHYXIATION IN THE CARGO HOLD

THE QUESTIONS BELOW WILL HELP YOU TO REVIEW THE INCIDENT CASE STUDY EITHER INDIVIDUALLY OR IN SMALL GROUPS. IF POSSIBLE, DISCUSS YOUR CONCLUSIONS WITH OTHERS, AS THIS IS AN EFFECTIVE WAY OF THINKING ABOUT THE ISSUES IN MORE DEPTH.

PLEASE USE THE INFORMATION PROVIDED IN THE CASE STUDY TOGETHER WITH YOUR OWN EXPERIENCES AND THOUGHTS, TO REFLECT ON THE INCIDENT AND HOW THE ISSUES IDENTIFIED MIGHT RELATE TO YOUR OWN SITUATION.

WHAT DO YOU BELIEVE WAS THE IMMEDIATE CAUSE OF THE INCIDENT?

WHAT OTHER FACTORS DO YOU THINK CONTRIBUTED TO THE INCIDENT?

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WHAT DO YOU BELIEVE WERE THE BARRIERS THAT SHOULD HAVE PREVENTED THIS INCIDENT FROM OCCURRING?

WHY DO YOU THINK THESE BARRIERS MIGHT NOT HAVE BEEN EFFECTIVE ON THIS OCCASION?

WHAT WERE THE CIRCUMSTANCES SURROUNDING THE FUMIGATION CONTRACTOR'S EXPERIENCE, TRAINING AND EQUIPMENT LEADING TO THIS INCIDENT ?

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WHAT IS YOUR COMPANY'S PROCEDURE FOR ENTRY INTO ENCLOSED SPACES AND ENCLOSED SPACE RESCUE IN THE SMS?

HOW IS ACCESS CONTROL ACHIEVED ON BOARD YOUR SHIP? ARE ALL ENTRANCES TO ENCLOSED SPACES MARKED WITH WARNING SIGNS?

WHAT CHANGE IN CREW TRAINING, CONDUCT OF DRILLS, OR PROCEDURE FOR ENTERING ENCLOSED SPACES OR PROCEDURE FOR RESCUING FROM ENCLOSED SPACES IS NEEDED ON BOARD YOUR SHIP OR IN THE COMPANY SMS?

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