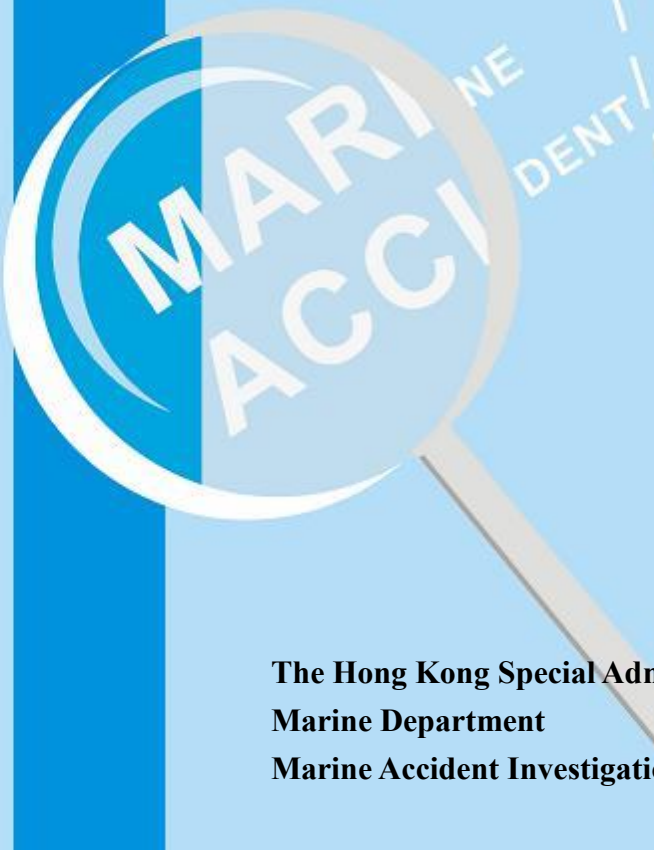
Report of investigation into the fatal accident on board the Hong Kong registered bulk carrier "*Darya Tapti*" at sea on 9 October 2020



The Hong Kong Special Administrative Region
Marine Department
Marine Accident Investigation Section

04 January 2022

Purpose of Investigation

The purpose of this investigation, conducted by the Marine Accident Investigation Branch (MAIB) of Marine Department, is to determine the circumstances and the causes of the incident with the aim of enhancing the safety of life at sea and avoiding similar incidents in future.

It is not intended to apportion blame or liability towards any particular organization or individual except so far as necessary to achieve the said purpose.

The MAIB has no involvement in any prosecution or disciplinary action that may be taken by the Marine Department resulting from this incident.

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Summary

On 9 October 2020, a fatal accident happened on board the Hong Kong registered bulk carrier "Darya Tapti" (*the vessel*) when she was at approximate position 20°39.57'S, 163°05.10'E, en route from Tauranga, New Zealand to Jiangdu, China for cargo discharging.

When *the vessel* was fully loaded with logs and a fumigation process remained in transit on board, the Bosun was assigned to top up fumigant in the cargo holds on the fifth day after the initial fumigant application into the cargo holds in transit at sea.

The top-up work was carried out smoothly from the ship forward No. 1 cargo hold. When the Bosun came to the forward access hatch of the No. 5 cargo hold, he noticed that the fumigant gas concentration indicator (dositube) was detached from the internal side of the access hatch cover. He then entered through the access hatch attempting to retrieve the detached dositube inside. The Third Officer (3/O), preparing for the top-up work close to the Bosun, suddenly heard a loud sound from the access hatch. He noticed that the Bosun slipped on the inclined ladder below the vertical ladder under the access hatch. The Bosun was rescued and taken out of the access hatch, his pulse was very weak and his heartbeat could not be detected. A few hours later, the Bosun was declared dead by the paramedics on their arrival on board.

The investigation revealed that the contributory factors causing the accident were: failure of following the safety procedures of permit to work and carrying out a proper risk assessment before entering cargo hold; lack of knowledge of enclosed space entry and insufficient safety awareness; and the inadequate and lack of comprehensive training on the fumigation procedures for the crew.

1. Description of the vessel

Ship name	:	*Darya Tapti* (Figure 1)
Flag	:	Hong Kong, China
Port of registry	:	Hong Kong
IMO number	:	9712462
Type	:	Bulk carrier
Year built, shipyard	:	2014, Shikoku Dockyard Co., Ltd. Takamatsu, Japan
Gross tonnage	:	21,801
Net tonnage	:	12,309
Summer deadweight	:	35,947 tonnes
Length overall	:	176.5 metres
Breadth	:	28.8 metres
Engine power, type	:	5,940kW, MAN B&W 6S46ME-B8.3
Classification society	:	Nippon Kaiji Kyokai
Registered owner	:	Tapti Shipping Limited
Management company	:	Chellaram Shipping (Hong Kong) Limited

Figure 1 *The vessel*

2. Sources of evidence

2.1 The information was provided by the crew and the management company of *the vessel* (the Company).

3. Outline of events

(All times were local time UTC +12 hours)

3.1 On 30 September 2020, *the vessel* arrived and berthed in Tauranga, New Zealand for loading cargo of logs. On 4 October 2020, the cargo holds were fully loaded with logs, and fumigation technicians from ashore carried out cargo hold fumigation.

3.2 At 0700 hours on 5 October 2020, after completing loading cargo and the initial fumigant application into the cargo holds, *the vessel* departed from Tauranga, New Zealand to the discharge port in Jiangdu, China.

3.3 At about 1200 hours, the Master and Chief Officer (C/O) held a safety meeting to brief the crew on the dangers of fumigation in transit on board. Afterwards, the C/O discussed with the Bosun about the safety measures for the fumigated cargo holds including the daily basic safety precautions to be carried out on the deck, the personal protective equipment (PPE) to be donned, and the areas to be avoided by the crew without proper PPE.

3.4 On 7 October 2020, the Master discussed with the designated person ashore (DPA) about the fumigant top-up process to be carried out by the crew on 9 October 2020 as per the instructions by the fumigation company.

3.5 On 9 October 2020, before commencing the fumigation top-up work, a toolbox meeting was carried out for the crew involved. The crew members were separated into two groups; team 1 consisted of the C/O, the Bosun, and an able seafarer deck (GPD1); team 2 consisted of the 3/O and two able seafarers deck (GPD2 and GPD3). In the meeting, the crew members had been reminded that none of them was allowed to enter the cargo holds under any circumstances.

3.6 At about 1500 hours, the Master was monitoring the fumigation work on the bridge. The crew members of team 1 wore the masks (Figure 2) which were the type of full-face mask with filter. The masks were provided by the fumigation company. Team 1 proceeded to the cross deck between No. 1 and No. 2 cargo holds. They opened the access hatch covers of No. 1 and No. 2 cargo holds and took a reading and

photograph of the dositube fitted on the internal side of the access hatch cover by magnet clamp. The reading shown on the dositube indicated the fumigant concentration inside the cargo hold. The crew members were required by the fumigation company to take photographs of the dositube for record purposes. They then opened the fumigation canisters and released the contents into the cargo holds. Upon the fumigant being completely discharged, the access hatch covers were closed. They came up onto the cargo of logs being stowed on the main deck (the deck cargo of logs) and passed the masks to team 2.

Filter attached to the full-face mask

Figure 2 The full-face mask and filter

3.7 The crew members of team 2 took over and wore the masks being passed from team 1. They then crossed the deck between the No. 2 and No. 3 cargo holds to carry out the fumigation work similar to team 1. Upon the operation was completed, they returned on the deck cargo of logs and passed the masks to team 1 again. Team 1 repeated the procedures on the cross deck between No. 3 and No. 4 cargo holds.

3.8 After team 1 completed the operation on the cross deck between No. 3 and No. 4 cargo holds, the masks should be handed over to team 2 according to the work plan. However, the Bosun of team 1 decided to continue the fumigation work instead of handing over the mask to GPD2.

3.9 At about 1630 hours, the team comprising the 3/O, the Bosun and GPD3 proceeded to cross deck between No. 4 and No. 5 cargo holds for the fumigation work. They completed taking reading and photographs of the dositube and discharging the contents in the fumigation canisters into the No.4 cargo hold through aft access without any problem.

3.10 At about 1645 hours, they proceeded to the forward access of the No. 5 cargo hold to continue fumigation work. After opening the No. 5 cargo hold forward access hatch cover, they failed to find the dositube on the internal side of the hatch cover. The Bosun instructed GPD3 to bring a cargo light to illuminate the cargo hold access trunk under the access hatch. After that, they found the dositube stuck on the access trunk about one metre below the access hatch. The 3/O and Bousn tried to take it out by hand but in vain.

3.11 The 3/O noticed that the Bosun stood on the vertical ladder in the access trunk and squatted down, trying to reach the dositube. The 3/O warned the Bosun not to go down and then continued to prepare for the fumigation work.

3.12 At about 1650 hours, *the vessel* was at approximate position 20°39.57'S, 163°05.10'E. When the 3/O was preparing to take photographs, he suddenly heard a loud sound from No. 5 cargo hold forward access. The 3/O quickly moved to the access hatch and spotted the Bosun slipping on the inclined ladder below the vertical ladder under the access hatch.

3.13 The 3/O immediately informed the C/O of the incident, who was nearby on top of the deck cargo of logs. The C/O rushed the access hatch assessing the situation of the Bosun and relayed the information to the Master. The emergency alarm was raised to summon the rescue team for the enclosed space rescue operation.

3.14 The 3/O, GPD2 and a crew member donned with self-contained breathing apparatus (SCBA) entered No. 5 cargo hold with an emergency escape breathing device (EEBD) ready for the Bosun. While the 3/O was putting the EEBD on the Bosun, he found the mask and safety helmet of the Bosun missing.

3.15 At about 1705 hours, the Bosun was taken out of the access hatch, his pulse was very weak and his heartbeat could not be detected. The Master called the fumigation company for medical advices and Noumea Maritime Rescue Coordinate Center (MRCC) to immediately evacuate the Bosun. *The vessel* was diverted the course heading for New Caledonia to evacuate the Bosun.

3.16 At about 0005 hours on 10 October 2020, the helicopter deployed by

the Noumea MRCC arrived at the meeting point with *the vessel.* Two paramedics were winched down from the helicopter to *the vessel* to check the vital signs of the Bosun. However, the Bosun was declared dead by the paramedics on their arrival on board.

4. Analysis

Certification, training and experience

4.1 The statutory trading certificates of *the vessel* were valid and in order. *The vessel* was manned by 18 crew members, including the Master.

4.2 The Master had worked in the Company for about 12 years and joined *the vessel* on 14 June 2020. He had about 7 years of experience as a master. He possessed a Class 1 Certificate of Competency issued by India valid until 28 June 2021.

4.3 The C/O had worked in the Company for about 16 years and joined *the vessel* on 14 June 2020. He had about 3 years of experience as a chief officer. He possessed a Class 1 Certificate of Competency issued by United Kingdom valid until 14 November 2021.

4.4 The 3/O had worked in the Company for about 6 years and joined *the vessel* on 14 June 2020. He had more than 1 year of experience as a third officer. He possessed a Class 3 Certificate of Competency issued by India valid until 31 January 2023.

4.5 The Bosun had worked in the Company for about 20 years and joined *the vessel on* 14 June 2020. He had about 4 years of experience as a bosun.

4.6 There were no abnormalities noted with regard to the certification and experience of the crew concerned.

Weather and sea conditions

4.7 The weather was cloudy with east south-easterly wind of Beaufort force 4. The sea was moderate swell and a visibility of 7 nautical miles. The weather should not be a contributory factor to the accident.

Fatigue, alcohol and drugs abuse

4.8 There was no evidence showing that any crew on board suffered from fatigue at work or abuse of alcohol and drugs.

Cause of death

4.9 According to the autopsy report, the cause of death probably was an acute intoxication by the phosphine contained in the cargo hold of *the vessel,* probable disturbance of the heart rhythm not macroscopically authenticated, or neurotoxic astonishment with asphyxiation which was consistent with the accident.

Fumigation

4.10 The cargo holds were fumigated by using aluminum phosphide tablets (the tablets). The tablets would slowly react with the atmospheric moisture inside the cargo holds by releasing the phosphine gas which was highly toxic and colourless with an unpleasant odour. Subject to the exposure time and gas concentration, inhalation of phosphine gas may cause bleeding and liquid form in the lungs leading to respiratory problems, nausea, and ultimately suffocation.

4.11 Phosphine gas is widely used as a fumigant by interfering the biological process of living organisms. The vaporization process to fumigate cargo holds required a few days after dispersing the tablets in the loaded cargo holds. Hence, the Master adopted the plan of commencing fumigation in port and continued in transit at sea.

4.12 The fumigator-in-charge (the fumigator) with other fumigation technicians from shore checked all the cargo holds after the initial fumigation and confirmed with the Master that they were all gastight. Upon receipt of the confirmation, the Master then decided to set sail *the vessel*. In accordance with Section 3.3.2.14 of the Annex to the International Maritime Organization's (IMO) circular MSC.1/Circ.1264 "Recommendation on the Safe Use of Pesticides in Ships Applicable to the Fumigation of Cargo Holds" (Circ.1264), the fumigator should not be allowed to leave *the vessel* and had to stay on board to take the lead of the fumigant top-up process in the cargo holds until *the vessel* was in a safe condition.

Fumigation in transit

4.13 The fumigation in transit requires the topping up of fumigant from time to time. The process involved opening the sealed hatch covers of cargo hold access and pouring the tablets down around the fifth day after the initial fumigation. It should be done by the fumigator on board according to Circ. 1264. As a general safety precaution, the crew

members should not handle fumigants and should follow the instructions of the fumigator implicitly.

Exception

4.14 However, due to the COVID-19 pandemic, the local authority of New Zealand permitted the fumigator to leave *the vessel* upon considering the fumigator not being able to return from *the vessel* in foreign ports.

Conditions for the crew to carry out fumigation top-up process

4.15 The conditions required by the local authority allowing the crew to be certified as competent persons for carrying out the fumigant top-up process on board, included the following:

(a) the fumigator to conduct an initial leak check prior to the departure of *the vessel*;

(b) record of gas detection to confirm fumigant gas in the cargo hold nearest the accommodation;

(c) crew to be trained to the same level as the fumigator and to be recorded on the competency register, to follow the same process with the appropriate protective equipment to conduct subsequent top-up process, daily leak checks and ventilation of cargo holds, and to keep the fumigation records sent to the fumigation company for review and advice;

(d) the fumigation company to monitor the records from the crew and to issue gas free top-up report, gas free certificate and clearance, and to provide advice correspondingly; and

(e) the fumigation company to be subject to the audit by the local authority on the performance of monitoring the fumigant top-up process on board, daily leak checks, and cargo holds ventilation and gas free.

4.16 The local authority approved the crew as competent persons after being trained to meet the local requirements to continue the remaining fumigation process in transit. Five crew members comprising the Master, the C/O, the Bosun, GPD1 and GPD2 were issued a certificate of competence by the fumigation company after receiving an one-hour training provided by the fumigator on 4 October 2020 that met the local regulations to be competent persons.

4.17 To obtain a gas free top-up report from the fumigation company for the permission of onward cargo operation in the discharge port, the crew had to record the reading on the dositube with photographs as supporting evidence and sent it to the fumigation company. According to the instructions from the fumigation company, the crew had to replace the detached dositube with the spares supplied on board and to repeat the work after additional administrative steps to be executed as follows:

(a) Place a tag to the new dositube and write the relevant manhole number on it.

(b) Make sure the tag or tape does not cover the port of the tube which must be read.

(c) Ensure the end of the tube is broken at the red line.

(d) Note the dositube replacement on the dositube form and the date the new one was placed.

(e) Place it back in the manhole internal surface.

Entry into enclosed space

4.18 According to the International Maritime Solid Bulk Cargoes Code (IMSBC Code), logs transported in bulk can cause oxygen depletion and increase carbon dioxide levels in the cargo hold and adjacent spaces. IMSBC Code also states that personnel should not enter such cargo hold until a test has been carried out to establish the oxygen level of 21% and an oxygen meter should be equipped and activated by the crew member when entering enclosed spaces. Indeed, cargo hold loaded with logs is hazardous and turns to a deadly space with fumigant inside.

4.19 After the fumigation technicians including the fumigator left *the vessel*, the fumigation process remained on board including the fumigant top-up process. Before reaching the discharge port, daily leak checks and involving cargo holds ventilation were to be carried out without any cargo hold entry. In case any imperative cargo hold entry arises, the entry procedures should be reviewed and done according to the instructions of the fumigation company. Nevertheless, the Master also had to follow basic guidance stated in Annex 14.1 "Permits to Work" to the Code of Safe Working Practices for Merchant Seafarers (the Code[1]),

[1] In accordance with Section 4 of Cap.478M "Merchant Shipping (Seafarers) (Code of Safe

as well as the General Checklist-07 of Enclosed Space Entry Permit in the Safety Management System (SMS) of *the vessel*, which stipulated the permit to work system and risk assessment for enclosed space entry.

Access trunks inside cargo holds

4.20 The access trunks under the cargo hold access hatches were part of the cargo holds. They were deficient in oxygen and contained highly toxic fumigants of phosphine gas. For safety reasons, the fumigation company required the crew to wear the masks and stand upwind during the fumigant top-up process in order to protect them from being affected by the phosphine gas when pouring the tablets into the access trunks. Nevertheless, cargo hold entry was strictly prohibited.

4.21 In the accident, the Bosun with the mask went into the access trunk with his lower body supported by the rungs of the vertical ladder under the access hatch. He tried to squat down to pick up the detached dositube stuck at about 1 metre from the access hatch beside the vertical ladder.

Figure 3 The dositube attached on internal side of the access hatch cover

Working Practices) Regulation", Hong Kong registered vessels are required to carry the "Code of Safe working Practices for Merchant Seafarers" onboard.

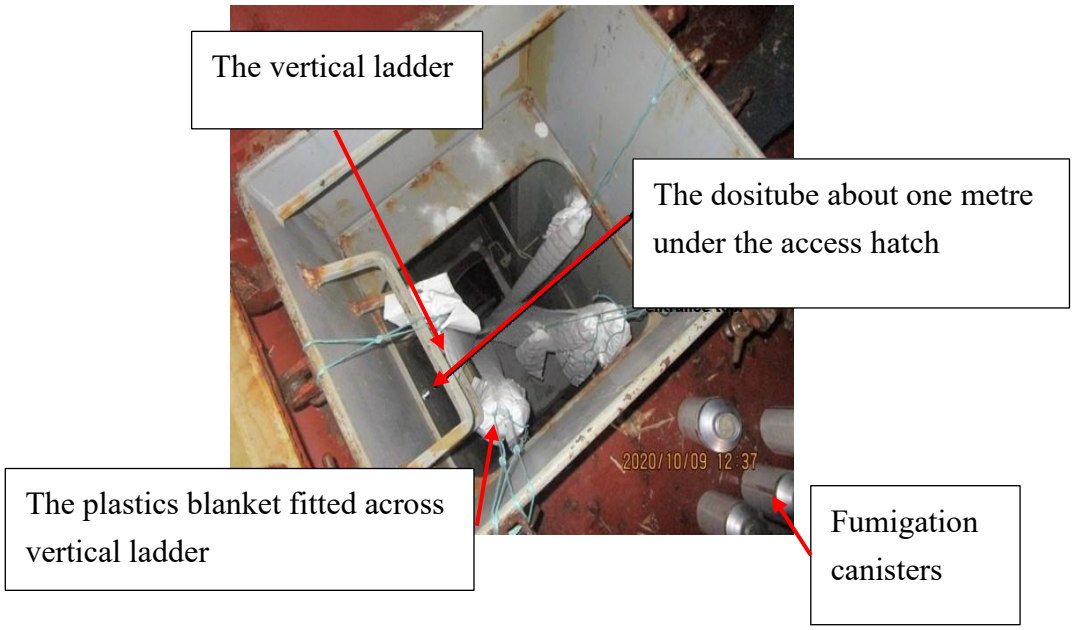

Figure 4 Top view of the No.5 cargo hold forward access

Not seeking advice from the fumigation company for cargo hold entry

4.22 The investigation revealed that the Bosun did not report to the fumigation company through the Master for advice on his entry to the cargo hold under fumigation. He also failed to follow permit to work safety procedure and risk assessment before entering the cargo hold. The Bosun was trained and certified by the fumigation company as a competent person to carry out the fumigant top-up process on board and yet he disregarded the required safety procedures. The negligent act of the Bosun might be the combination of the following:

(a) the Bosun was lack of knowledge of enclosed space entry as he was not aware that his lower body entering through the access hatch had exposed himself to full risks of entering a fumigated cargo hold space;

(b) the Bosun was lack of safety awareness by taking the shortcut to retrieve the detached dositube inside the access trunk without following the established replacement procedures and the safety advice of the 3/O; and

(c) the Bosun might believe that the mask he wore was appropriate for entering the access trunk to retrieve the detached dositube probably due to ineffective and inadequate training.

Improper personal protective equipment worn by the Bosun

4.23 The fumigation company had supplied three sets of full-face mask and 14 pieces of filter for the remaining fumigation process on board, as shown in Figure 2. The mask worn by the Bosun belonged to the air-purifying type rather than the air-supplied type which could supply breathable air to the wearer.

4.24 According to the Safety Data Sheet of the tablets provided by the fumigation company to *the vessel*, a close-fitting gas mask with self-contained breathing apparatus is required if the concentration inside cargo holds unknown. Therefore, the masks supplied on board were not suitable for the usage in either the unknown concentration of phosphine gas or the oxygen-deficient atmosphere inside cargo holds under fumigation. The mask supplied on board failed to protect the Bosun from entering the access trunk resulting in his death.

Training of fumigation procedures

4.25 According to the fumigation plan, the initial fumigation of the cargo holds was carried out by the fumigator when *the vessel* was in port. The fumigant top-up process should be conducted by the competent crew around the fifth day after initial fumigation.

4.26 Before topping up the fumigant in the cargo holds, the crew should take a reading of the phosphine gas level from the dositube clamped magnetically to the internal side of the hatch cover of each cargo hold access. The fumigation company had supplied extra 3 sets of magnetic clamp and dosibtube to *the vessel* for backup if any dosibtubes were missing or damaged.

4.27 The Master, the C/O, the Bosun, GPD1 and GDP2 had been trained on the fumigation procedures for an hour by the fumigator of the fumigation company before sailing. The 3/O and GPD3 were also trained by the Master and the C/O respectively.

4.28 The investigation revealed that the training on the fumigation procedures could further be enhanced due to the following findings:

(a) The training of using self-contained breathing apparatus (SCBA) in the fumigation process was not included. This is critical as it plays a role in fumigation process, as mentioned in Circ. 1264, the Safety Data Sheet of the tablets supplied by the fumigation

company, and the company procedure of fumigation in the SMS of *the vessel*.

In transit at sea, Circ. 1264 as well as the company procedure of fumigation in the SMS of *the vessel*, require the cargo holds sealed for fumigation should never be opened or entered, except in an extreme emergency. If entry is imperative, at least two persons should enter, wearing adequate protective equipment and a safety harness and lifeline tended by a person outside the space, similarly equipped with protective, SCBA. In other words, entering a fumigated cargo hold without SCBA is not allowed.

Circ. 1264 also requires competent persons to be familiar with the relevant Safety Data Sheet information. According to the Safety Data Sheet of the tablets, a close-fitting gas mask with SCBA is required if the concentration is unknown.

(b) The limitation of wearing the masks in giving protection to carry out the fumigation process was not included.

(c) The training did not cover the fatal consequence of the fumigation process to the crew. That might lead to Bosun to perceive that the fumigation procedures presenting to him in training were more administrative than safety resulting in his cargo hold entry disregarding the safety procedures. The Bosun also might not know that spare dositubes were supplied on board. Furthermore, the training also did not mention the risk of retrieving detached dositubes inside the access trunks.

5. Conclusions

5.1 On 9 October 2020, a fatal accident happened on board *the vessel* when she was en route from Tauranga, New Zealand to Jiangdu, China. In the voyage, the Bosun was assigned to top up fumigant in the cargo holds. The Bosun was also required to take photographs of dositubes that each was attached on the internal side of each access hatch cover. When the Bosun entered the No. 5 cargo hold forward access hatch to retrieve the detached dositube not far below, the 3/O heard a loud sound suddenly. The 3/O immediately turned around to the access hatch and saw the Bosun slipping on the inclined ladder below the vertical ladder under the access hatch. The Bosun was taken out of the access hatch, his pulse was very weak and his heartbeat could not be detected. Finally, the Bosun was declared dead by the paramedics on their arrival on board.

5.2 The investigation revealed that the contributory factors causing the accident were as follows:

(a) the failure of following the safety procedures of permit to work and carrying out a proper risk assessment before entering cargo hold;

(b) the lack of knowledge of enclosed space entry and insufficient safety awareness resulting in the underestimation of the risk of the job by wearing inappropriate PPE to enter fumigated cargo hold; and

(c) the training mainly designed for shore fumigation technicians on the fumigation procedures might not be comprehensive enough to cover ship crew, including the principle of cargo hold entry, the use of SCBA in the fumigation process, the limitation of wearing the mask, and the concept of a fatal consequence of the fumigation process.

6. Recommendations

6.1 The management company of *the vessel* should issue circulars informing all masters, officers and crew members of its fleet of the findings of the investigation and lessons learnt from this accident, and instruct them to:

(a) conduct work for fumigation strictly in accordance with the fumigating company's instructions and Circ. 1264; and

(b) enhance training plan on enclosed space entry, in particular fumigated cargo hold.

6.2 The management company should conduct an internal audit on *the vessel* to ensure that the crew members follow the safety requirements strictly when entering an enclosed space and in-transit fumigation are required.

6.3 A Hong Kong Merchant Shipping Information Note is to be issued to promulgate the lessons learnt from this accident.

7. Submission

7.1 The draft investigation report, in its entirety, was sent to the following parties for their comments:

(a) the management company and the master of *the vessel*;

(b) the fumigation company; and

(c) the local authority of New Zealand.

7.2 By the end of consultation, there was no comment received from the above-mentioned parties.