Report of investigation into the fatal accident on board the Hong Kong registered bulk carrier *"Golden Taurus"* at sea on 5 February 2017

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

29 October 2019

Purpose of Investigation

The purpose of this investigation conducted by the Marine Accident Investigation and Shipping Security Policy Branch (MAISSPB) 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 MAISSPB has no involvement in any prosecution or disciplinary action that may be taken by the Marine Department resulting from this incident.

Table of Contents **Page**

Summary

On 31 January 2017, the Hong Kong registered bulk carrier “Golden Taurus” (*the vessel*) completed loading of wheat at New Orleans, USA and commenced fumigation on the same day.

After completion of the fumigation, *the vessel* commenced her voyage to Oran, Algeria on 1 February 2017.

At 0730 hours on 5 February 2017, a phosphine gas reading of 2.0 parts per million (ppm) was measured at the upper deck alleyway of the accommodation. The master instructed the crew to vacate their cabins immediately, but the engine cadet did not come out from his cabin. He was later found lying on his bed and taken outside by the crew at once. Although revival had been attempted on board, the engine cadet was confirmed dead by the Centro Internationale Radio Medico (CIRM) at 1422 hours.

On arrival at Bermuda, the engine cadet’s body was lowered to a police boat and sent ashore at 1545 hours on 7 February 2017.

The investigation reveals the following contributory factors leading to the accident:

a) When *the vessel* was built, an electric cable conduit connecting No. 5 cargo hold and the accommodation was added at the request of the shipowner. This additional work had not been checked against the relevant rules and regulations of the classification society (CS) of *the vessel*. Both ends of the cable conduit were not sealed thus allowing the passage of phosphine gas from No. 5 cargo hold into the accommodation; and

b) the senior officers of *the vessel* were in lack of safety awareness. They did not inform the management company of the fumigation according to the company’s procedures. No immediate actions were taken to detect the cause of increasing phosphine gas concentration within the accommodation.

1. Descriptions of the vessel

Ship name	:	*Golden Taurus* (Figure 1)
Flag	:	Hong Kong, China
Port of registry	:	Hong Kong
IMO number	:	9699294
Type	:	Bulk carrier
Year built, shipyard	:	2015, Chengxi Shipyard Co. Ltd.
Gross tonnage	:	36,332
Net tonnage	:	21,626
Summer deadweight	:	63,657.7 metric tonnes
Length overall	:	194.90 metres
Breadth	:	32.26 metres
Engine power, type	:	8,050 kW, MAN B&W/5S60E-C 8.2 Tier II
Classification society	:	DNV GL
Registered owner	:	Golden Taurus Inc.
Management company	:	Bernhard Schulte Shipmanagement (Singapore) Pte. Ltd.

Figure 1 *the vessel*

2. Sources of evidence

2.1 The statements of the master and the crew of *the vessel*.

2.2 The information provided by the management company of *the vessel*.

3. Outline of events

(All times are local time UTC - 5 hours.)

3.1 On 31 January 2017, *the vessel* completed loading of wheat at New Orleans, USA. Fumigation was arranged and commenced on the same day after completion of loading.

3.2 On 1 February 2017, *the vessel*'s hatch covers, ventilators and access hatches of all five cargo holds were sealed upon completion of fumigation. *The vessel* then commenced her voyage to Oran, Algeria.

3.3 On 1 February, 2 February and 3 February 2017 respectively, phosphine gas readings were taken at the upper deck accommodation at 0730 hours, 1530 hours and 2330 hours and at forecastle deck at 0730 hours and 1530 hours and all readings were zero ppm.

3.4 On 4 February 2017, three phosphine gas readings were taken at 0730 hours, 1530 hours and 2330 hours at the accommodation on upper deck. The readings revealed that the accommodation on upper deck contained 0.1 ppm of phosphine gas. The readings taken at 0730 hours and 1450 hours at the forecastle deck remained zero ppm. On the same day, a motorman complained to the chief officer that he had smelled a bad odour inside his cabin. The chief officer carried out a test and revealed that there was zero ppm phosphine gas in the cabin. Nevertheless, the chief officer changed the cabin for the motorman.

3.5 At 0730 hours on 5 February 2017, a phosphine gas reading of 2.0 ppm was measured at the upper deck alleyway. The master instructed all crew to evacuate their cabins at once.

3.6 At 0747 hours, the engine cadet was found not coming out from his cabin. A motorman and an able seafarer entered his cabin and found him lying on his bed suffering from partial paralysis. The engine cadet was taken outside the cabin at once. At 0800 hours, a phosphine gas reading of 9.0 ppm was measured in the engine cadet's cabin.

3.7 From 0810 hours to 0900 hours, the body temperature, complexion, breathing and pulse of the engine cadet were monitored continually. At 0900 hours, engine cadet's vital signs worsened and his pulse and breathing were weak. The master sent request for medical advice from CIRM.

3.8 At 1010 hours, the engine cadet was taken to *the vessel*'s hospital and cardio-pulmonary resuscitation (CPR) was applied to him. At 1044 hours, medical advice was received from CIRM.

3.9 At 1227 hours, the master requested the Bahamas and Bermuda Marine Rescue Co-ordination Centre for assistance. At 1300 hours, CPR was stopped as no vital sign was detected.

3.10 At 1422 hours, CIRM advised that the engine cadet had passed away based on the reported symptoms.

3.11 At 0700 hours on 7 February 2017, *the vessel* arrived at Bermuda. At 1545 hours, the engine cadet's body was lowered to a police boat and then sent ashore.

4. Analysis

Certification and experience

4.1 The statutory trading certificates of *the vessel* were valid and in order. There were 22 crew including the master and the manning complied with the flag State's minimum safe manning requirements.

4.2 The master held a valid Class 1 Licence of the Deck Officer (Licence) issued by the Hong Kong Marine Department (HKMD). He has worked as master for about 14 years and was employed in the management company for about 2 years. He joined *the vessel* for about 5 months before the accident.

4.3 The chief officer held a valid Class 1 Licence issued by HKMD. He has worked as chief officer for about 9 years and was employed by the management company for 3 years. He joined *the vessel* on 22 October 2016.

4.4 The engine cadet worked on board *the vessel* for about 6 months and it was his first sea service.

Fatigue, drugs and alcohol abuse

4.5 The investigation did not reveal that the engine cadet was subject to fatigue. There was also no evidence that *the vessel*'s crew had been subjected to drug or alcohol abuse.

Weather and sea condition

4.6 The weather was cloudy with easterly wind force 6 and a rough sea. The weather or sea condition should not be a contributory factor in this accident.

Cargo fumigation process

4.7 Recirculation method prescribed by the United States Federal Grain Inspection Services Rules was used for cargo hold fumigation. A local contractor approved by the United States Department of Agriculture (USDA) carried out the job and the arrangement was shown in Figure 2. The fumigants were tablets containing aluminium phosphide, ammonium carbamate and covered with paraffin. The tablets were spread on top of the wheat. A blower was used to suck the phosphine gas evaporated from the tablets accumulated above the wheat through vertical tube to cargo hold bottom. Phosphine gas would pass through the perforated tubing to

circulate around the cargo hold bottom and make its way up running through the wheat so as to fumigate the wheat evenly.

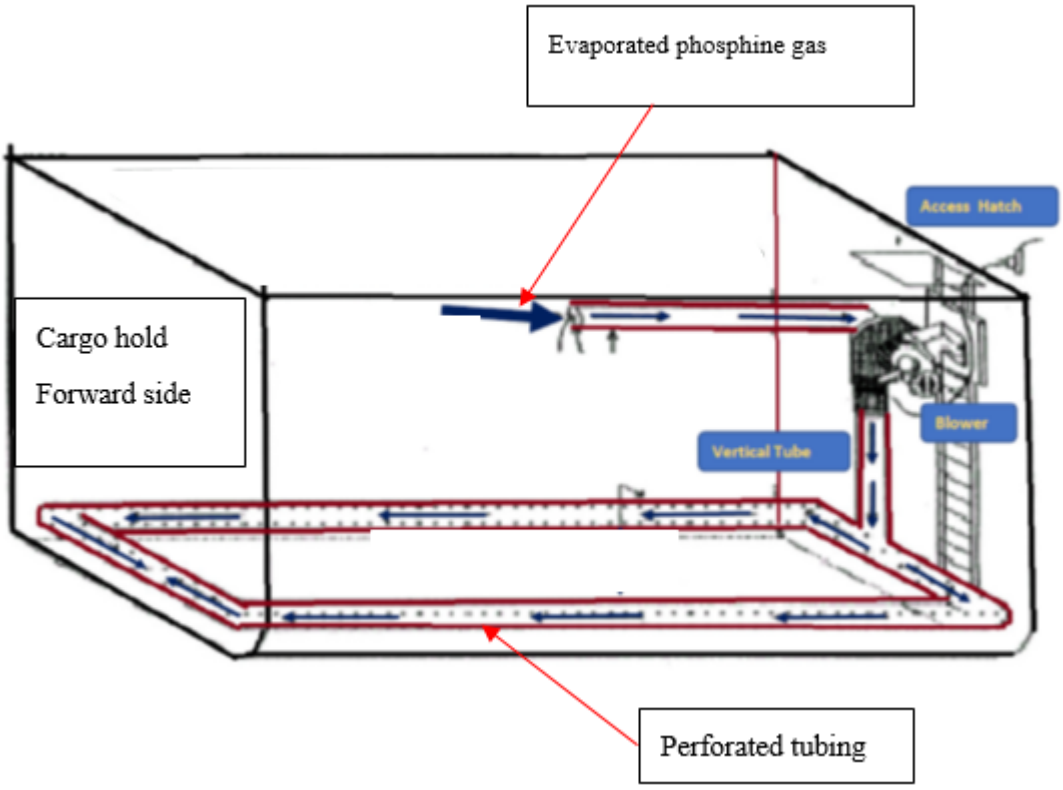

Figure 2 Fumigation of the cargo hold

Nature of phosphine gas and the monitoring

4.8 Pure phosphine gas is colourless, odourless and highly toxic. The unpleasant odour given out is due to a contaminant added to provide warning to people. According to the US National Institute for Occupational Safety and Health (NIOSH), an eight-hour average respiratory exposure to phosphine gas should not exceed 0.3 ppm and a short-term exposure should not exceed 1ppm.

4.9 In the Statement of Prefumigation Notice Compliance, the USDA approved contractor (the Applicator) of fumigation of *the vessel* remarked that the accommodation and the deck were considered safe in general during fumigation. However, the Applicator recommended to check ppm readings of phosphine gas in the accommodation and deck area 3 to 4 times for the first 5 days. The Applicator provided the crew with detection kits of phosphine gas which consisted of 20 gas detection tubes with a gas detection pump and two sets of gas mask with phosphine canisters. The Applicator also recommended

that 0.3 ppm was the safe exposure limit and advised that the detection tubes could be reset after use by exposing to fresh air.

4.10 On 31 January 2017, a brief on fumigation was delivered to the crew by the master and the Applicator. The master asked the crew to stay alert if smell of garlic or decaying fish was detected. The Applicator provided training on the application of the detection kit and advised the crew that the safe limit of phosphine gas concentration level was 0.3 ppm.

4.11 On the first three days after fumigation (i.e. from 1 February to 3 February 2017), all readings revealed in daily checks of phosphine gas at the accommodation and the forecastle deck were zero ppm.

4.12 For the three daily checks on 4 February 2017, 0.1 ppm concentration of phosphine gas was detected in the accommodation. Although there was an increase in the concentration level, the readings were within the 0.3 ppm safe limit as recommended by the Applicator. As such, senior officers did not take any further investigation or actions.

4.13 However, on the same day of 4 February 2017, a motorman complained to the chief officer that he had smelled a bad odour inside his cabin. The chief officer then tested for the presence of phosphine gas using a new detection kit. Although the test result was zero ppm of phosphine gas, the chief officer assigned another cabin to the motorman.

4.14 Despite the fact that a concentration of 0.1 ppm phosphine gas was detected in the accommodation on 4 February 2017 and a complaint of bad odour in the motorman cabin was received on the same day, no further investigation was carried out to ascertain the cause of the increase of phosphine gas level in the accommodation as compared to previous days. It suggested that the senior officers were in lack of safety awareness.

Communications and company procedures for fumigation

4.15 According to the management company's "BSM Bulk Carrier Manual" Section 11, the master of *the vessel* should report to the management company if there was fumigation conducted on board *the vessel*. However, the master failed to follow the company procedures to report the fumigation to the management company. It appeared that there was communications gap between the management company and *the vessel*.

The leak of phosphine gas into accommodation

4.16 *The vessel* was built at Chengxi Shipyard Company Limited, China in 2015. When she was under construction, the owner requested an additional work to fit a permanent access light for the aft access ladder of No. 5 cargo hold which was located about 10 cm forward of the accommodation bulkhead. A 60 mm diameter conduit was used to run an electric cable between the accommodation and No. 5 cargo hold (Figures 3 and 4).

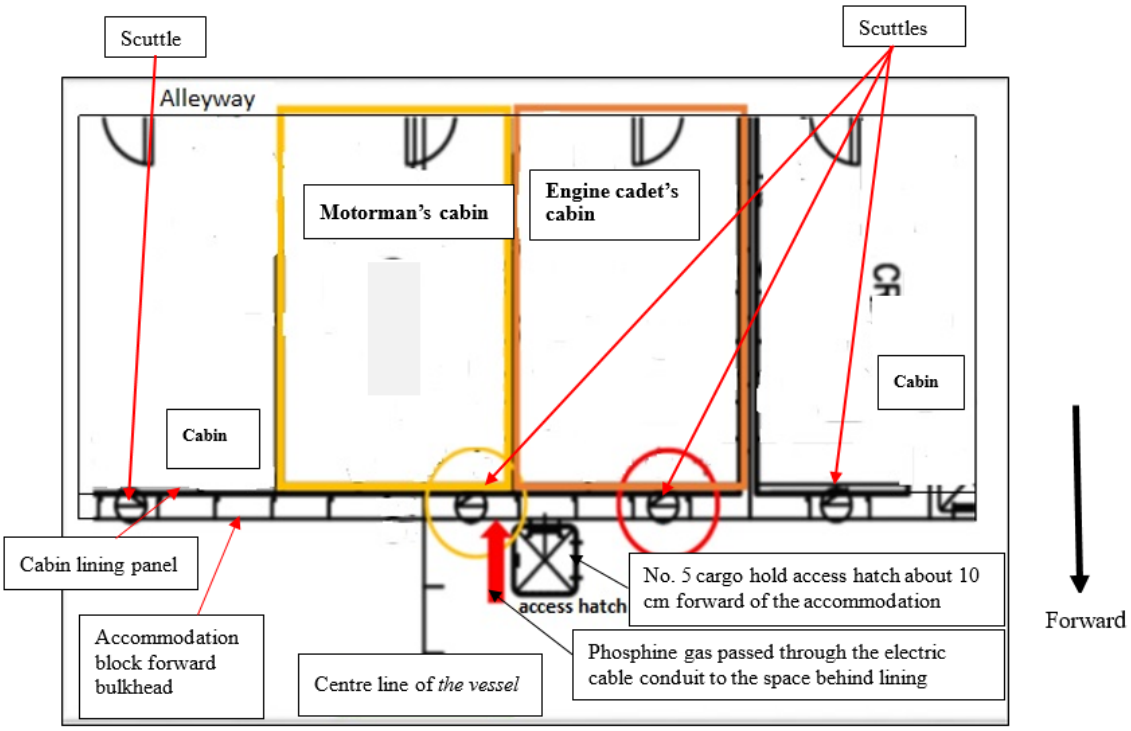

Figure 3 Layout of the crew cabins

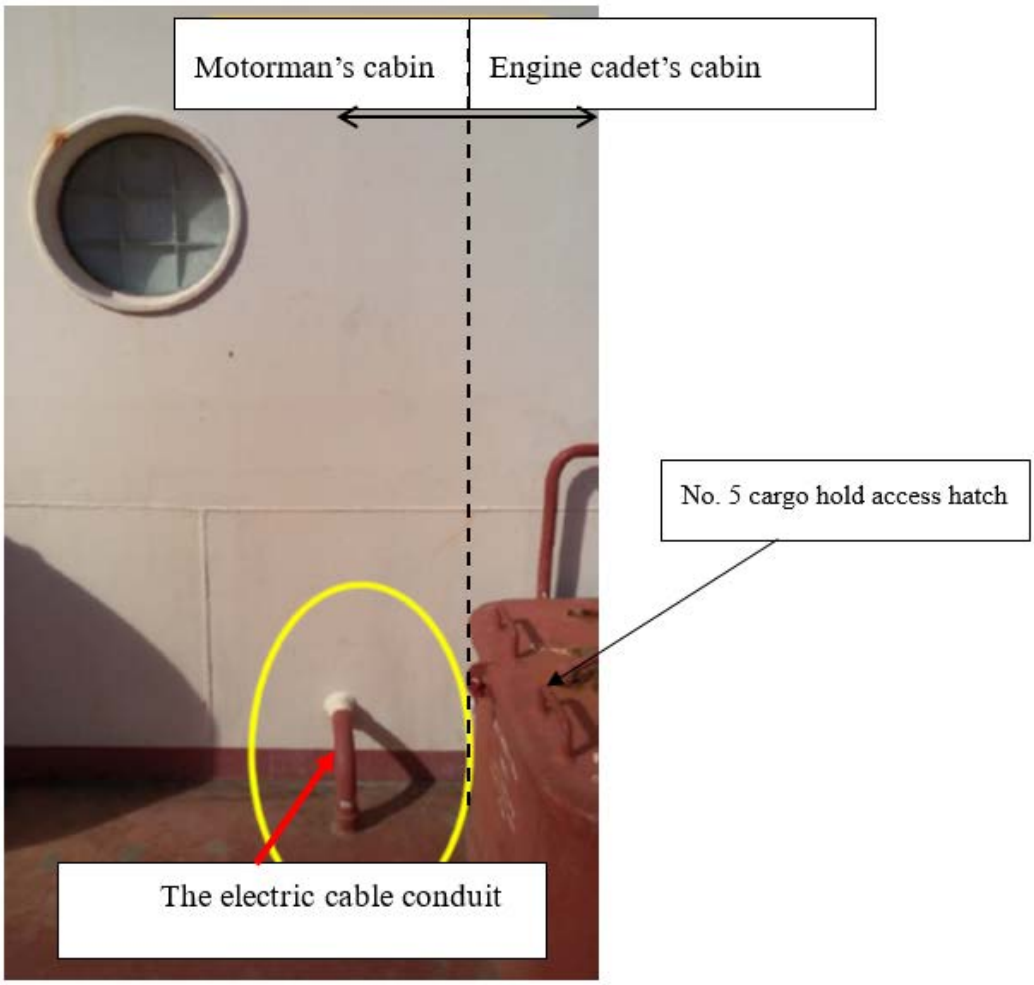

Figure 4 The conduit connecting the accommodation and No.5 cargo hold

4.17 The investigation revealed that both ends of the electric cable conduit were not sealed (Figure 5). Under the action of the blower, the phosphine gas was circulated throughout No. 5 cargo hold under relatively more positive pressure. It was apparent that the effect of pressure gradient between the cargo hold and the accommodation had sufficiently forced the poisonous gas to leak into the crew cabins via the unsealed conduit (Figure 6).

4.18 The CS of *the vessel* confirmed that the installation of the conduit was not completed in accordance with the applicable classification rules. The CS followed up this fatal accident case and reported that the electrical cable and the conduit had been removed and the openings were sealed.

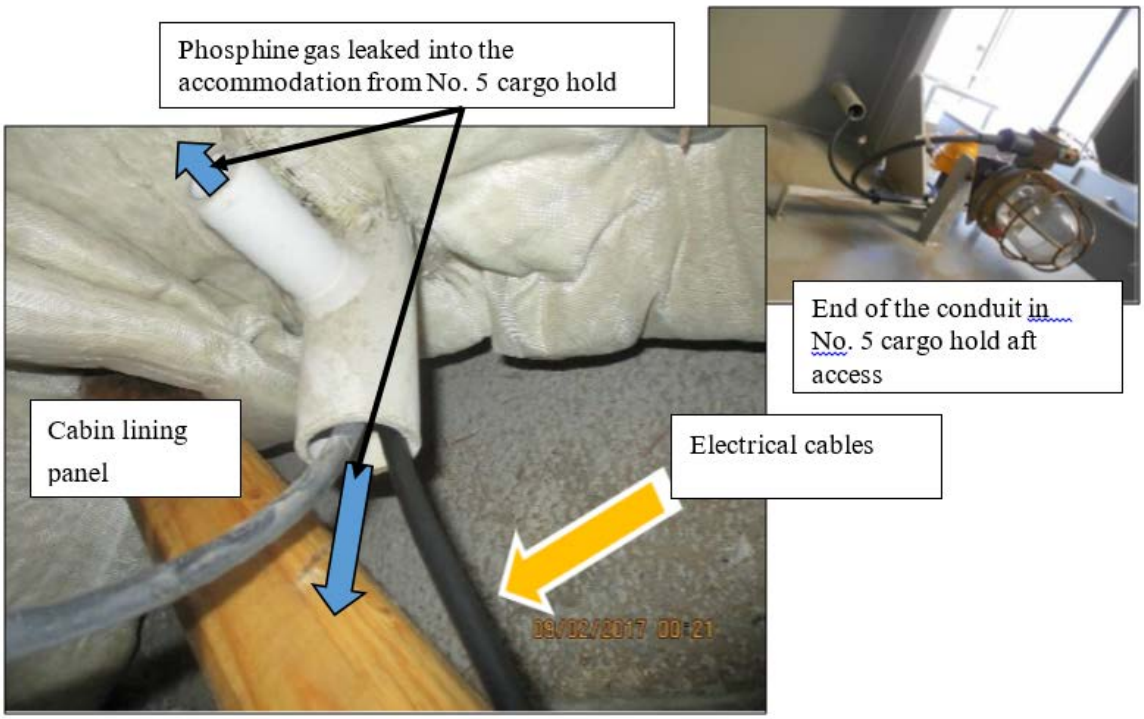

Figure 5 Gas leaking into the accommodation space through the unsealed conduit

Figure 6 Accommodation space between the forward bulkhead and the cabin lining panel

5. Conclusions

5.1 On 5 February 2017, an engine cadet on board *the vessel* was found unconscious in his cabin and was later declared dead during a voyage to Oran, Algeria. *The vessel* was loaded of wheat four days ago in New Orleans, USA, and the cargo was fumigated.

5.2 The investigation reveals the following contributory factors leading to the accident:

a) When *the vessel* was built, an electric cable conduit connecting No. 5 cargo hold and the accommodation was added at the request of the shipowner. This additional work had not been checked against the relevant rules and regulations of the classification society of *the vessel*. Both ends of the cable conduit were not sealed thus allowing the passage of phosphine gas from No. 5 cargo hold into the accommodation; and

b) the senior officers of *the vessel* were in lack of safety awareness. They did not inform the management company of the fumigation according to the company's procedures. No immediate actions were taken to detect the cause of increasing phosphine gas concentration within the accommodation.

6. Recommendations

6.1 The owner/management company of *the vessel* is recommended to:

a) issue notice/circular to draw the attention of their masters, officers and crew of the findings of the investigation, and to conduct internal audit to ensure that the company's procedures and instructions for fumigation are strictly followed by their ships' crew;

b) ensure strict compliance with the company's procedures and guidelines on fumigation of its fleet; and

c) enhance the education and training for senior officers in relation to risk assessment and awareness of toxic gas.

6.2 A Hong Kong Merchant Shipping Information Note will 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 master and the management company of *the vessel*;

b) the CS of *the vessel*;

c) the ship building yard of *the vessel* via the management company; and

d) the Ship Safety Branch of HKMD.

7.2 During the consultation period, comment from the management company was received and the report has been amended as appropriate. The CS of *the vessel*, the master of *the vessel* and the Cargo Ship Safety Section of HKMD replied that they had no comments. There was no feedback from the ship building yard of *the vessel*.