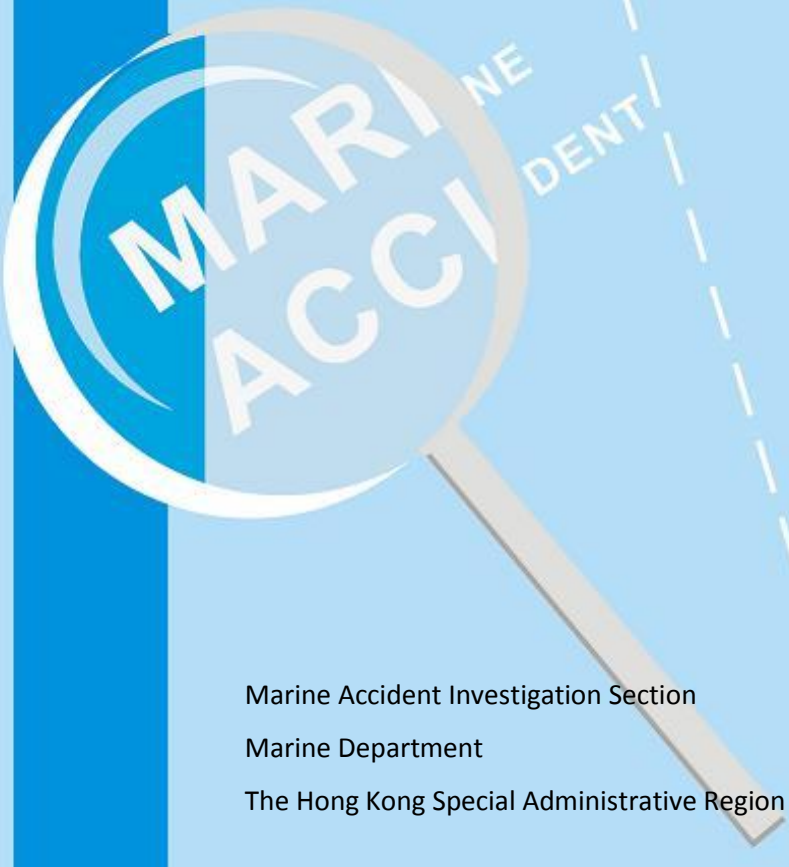
Report of Investigation into the fatal accident on board Hong Kong Registered Ship "*Pacific Endeavor*" at Zhenjiang, China on 21 June 2013.



Marine Accident Investigation Section

Marine Department

The Hong Kong Special Administrative Region

10 December 2014

Purpose of Investigation

This incident is investigated in accordance with the Code of the International Standards and Recommended Practices for a Safety Investigation into a Marine Casualty or Marine Incident (the Casualty Investigation Code) adopted by IMO Resolution MSC 255(84).

The purpose of this investigation conducted by the Marine Accident Investigation and Shipping Security Policy Branch (MAISSPB) of Marine Department, in pursuant to the Merchant Shipping Ordinance Cap. 281, the Shipping and Port Control Ordinance (Cap. 313), or the Merchant Shipping (Local Vessels) Ordinance (Cap. 548), as appropriate, is to determine the circumstances and the causes of the incident with the aim of improving the safety of life at sea and avoiding similar incident in future.

The conclusions drawn in this report aim to identify the different factors contributing to the incident. They are 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

1. Summary

1.1 On 21 June 2013, the Hong Kong registered bulk carrier “Pacific Endeavor” (hereinafter referred to as the Vessel) was suspiciously flooded with sea water at the void space at the aft transverse bulkhead lower stool of cargo hold No.3. The Bosun proceeded to enter the enclosed space alone without following the company’s Safety Management System and the approval by the Master. The Bosun entered the void space and lost his conscious there. He was sent to hospital for rescue. However, he was certified dead by the hospital on the same date.

1.2 On that day, when the Vessel completed her discharging of coal cargo at Zhenjiang, China, the Bosun on board was suffocated inside the void space at the aft transverse bulkhead lower stool of cargo hold No.3.

1.3 The investigation into the accident revealed that the enclosed lower stool space was not properly ventilated before entry. The Bosun was likely overcome by high concentration of carbon monoxide and oxygen depletion inside the space that was lethal to him.

1.4 The investigation had also revealed that the procedures stipulated in shipboard Safety Management Manual (SMM) had not been followed on the entry of enclosed spaces or confined dangerous spaces.

2. Description of the Vessel

2.1 Particulars of "*Pacific Endeavor*"

Port of Registry	:	Hong Kong
IMO Number	:	9040352
Official Number	:	HK-3780
Call Sign	:	VRLV6
Classification Society	:	Nippon Kaiji Kyokai
Type of Ship	:	Bulk Carrier
Keel Laid	:	06 May 1992
Built At	:	Oshima Shipbuilding Co., Ltd., Japan.
Ship Owner	:	Pacific Endeavor Shipping Inc., Hong Kong
DOC Company	:	Hong Kong Ming Wah Shipping Co., Ltd, HK
Length	:	176.8 metres
Breadth	:	30.5 metres
Depth	:	15.8 metres
Gross Tonnage	:	24,139
Net Tonnage	:	14,384
Deadweight	:	43,366
Main Engine	:	one set of Diesel United SULZER 6RTA52
Engine Power	:	7,024 kW
No. of Crew	:	28

Fig 1: M.V. "*Pacific Endeavor"*

2.2. **"Pacific Endeavor"**, a five-hold bulk carrier built by Oshima Shipbuilding Co., Ltd., Japan, in 1992. She was powered by a six-cylinder marine diesel engine, Diesel United SULZER 6RTA52, capable of developing engine power of 7,024 kW. The Vessel was owned by Pacific Endeavor Shipping Inc., Hong Kong and managed by Hong Kong Ming Wah Shipping Co., Ltd, Hong Kong (hereinafter referred to as the Company).

2.3 There were five cargo holds on board the Vessel, with the No.3 cargo hold for ballast purpose as well. The cargo hold transverse bulkhead lower stool was provided only at the forward and aft sides of the No.3 cargo hold.

2.4 There were four fuel oil tanks on board the Vessel. They were all located within cargo areas. No.1 fuel oil tank (C) was located underneath No. 3 cargo hold. No.2 fuel oil tanks (Port and Starboard) were located under No. 4 cargo hold. And No.3 fuel oil tank (C) was located underneath No. 5 cargo hold.

3. Sources of Evidence

a) The statements of the Master, Officers and crew of "*Pacific Endeavor";* and

b) Information provided by the Ship Management of "*Pacific Endeavor".*

4. Outline of Events

(All time shown in this report is local time, GMT+8hours)

4.1 On 19 June 2013, the ship arrived discharging port “Zhenjiang Port” China to discharge cargo “Coal” (36,861 metric tons) in bulk which had been loaded in Samarinda, Muara Jawa Anchorage, Indonesia.

4.2 At 0705, on 21 June 2013, when the ship crew were inspecting cargo holds after the completion of cargo discharging at Zhenjiang Port, the Third Officer reported to the Chief Officer that water leaked from the transverse bulkhead lower stool space between cargo hold No.3 and No.4. The water was seeping from the welding joint that attached the bulkhead ladder onto the lower stool slope plating of No.3 cargo hold aft bulkhead. Therefore, the Chief Officer and the Bosun went down to the No.3 cargo hold to inspect the area. To further investigate the source of leak, the Chief Officer decided to open the access cover of the space from No.4 cargo hold side.

4.3 The Chief Officer reported to the Master that they planned to open the access cover to verify the space through the manhole from outside for any water accumulation inside. Master agreed on this.

4.4 After clear-up of the No.4 cargo hold by stevedore, the Bosun prepared to open the access cover with the help of the Ordinary Seaman #2. At about 0920, the access cover was opened. The Chief Officer lowered down a torch light to the Bosun and presumed he would check the space from outside without entering. The Chief Officer then proceeded to No.3 cargo hold to re-inspect the seeping area. However, the Bosun entered the space alone with walky talky and left the Ordinary Seaman #2 keeping watch outside.

4.5 At 0923, when the Chief Officer found the leaking stopped at the seeping area, he called the Bosun on walky talky but no answer. The Ordinary Seaman #2 then reported to the Master about the incident.

4.6 At 0930, the Master summoned the search and rescue team (SAR). The SAR team equipped with breathing appliance sets proceeded to the scene. Shortly afterward, the Master also rang up emergency hotline for shore support.

4.7 At 0948, the Bosun was removed out of the space by the SAR team. The crew applied first aid to the Bosun while waiting for ambulance.

4.8 At 1000, the Master informed Company and sought assistance from local authorities. Shortly afterward, the ambulance arrived and transported the Bosun to hospital. Thereafter, the Bosun was certified dead by the doctor in the hospital.

5. Analysis of Evidence

Working experience & training

5.1 The Master of the vessel had about thirty years of seagoing experience, and about fourteen years of which were in the capacity of a ship master. He took over as the Master of the Vessel for about five months before the accident. He held a Certificate of Competency as Master issued by the People's Republic of China on 29 June 2010 valid until 29 June 2015.

5.2 The Chief Officer had about eight years of seagoing experience and about two years of which were in the capacity of a chief officer. He took over as the Chief Officer of the Vessel for about three months before the accident. He held a Certificate of Competency as Master issued by the People's Republic of China on 27 June 2013 valid until 27 June 2018.

5.3 The Ordinary Seaman #2, joined the Vessel on 24 May 2013. He was a qualified seaman with basic training certificate dated 17 May 2012. This was his first contract in the Company and he had about one year of experience as ordinary seaman.

5.4 The Bosun held a "Certificate of Competency" to support navigation issued by the People's Republic of China on 22 November 2010 valid until 22 November 2015. He started working as assistant Bosun in his last contract for about five months ago. He worked on board the Vessel on 20 June 2013 as Bosun for the first time and just one day before his death. It was reported that the Bosun had performed his shipboard familiarity, training and instructions required by SOLAS III/19.2 and 19.4 on the date when he joined the Vessel on 20 June 2013.

Working hours

5.5 There was no evidence to show any staffs had deviation on rest hours prior to the accident. Fatigue of crew members was not considered as a factor leading to the accident.

Alcohol Abuse

5.6 There were no indications or evidence of alcohol abuse of the crew and the officer involved.

Cargo holds and Transverse Bulkhead Lower Stool

5.7 Cargo hold No.3 was a combined ballast/ cargo hold with a deep tank transverse bulkhead at its forward and aft ends. These two bulkheads were constructed as vertically corrugated with a lower stool (Fig. 2).

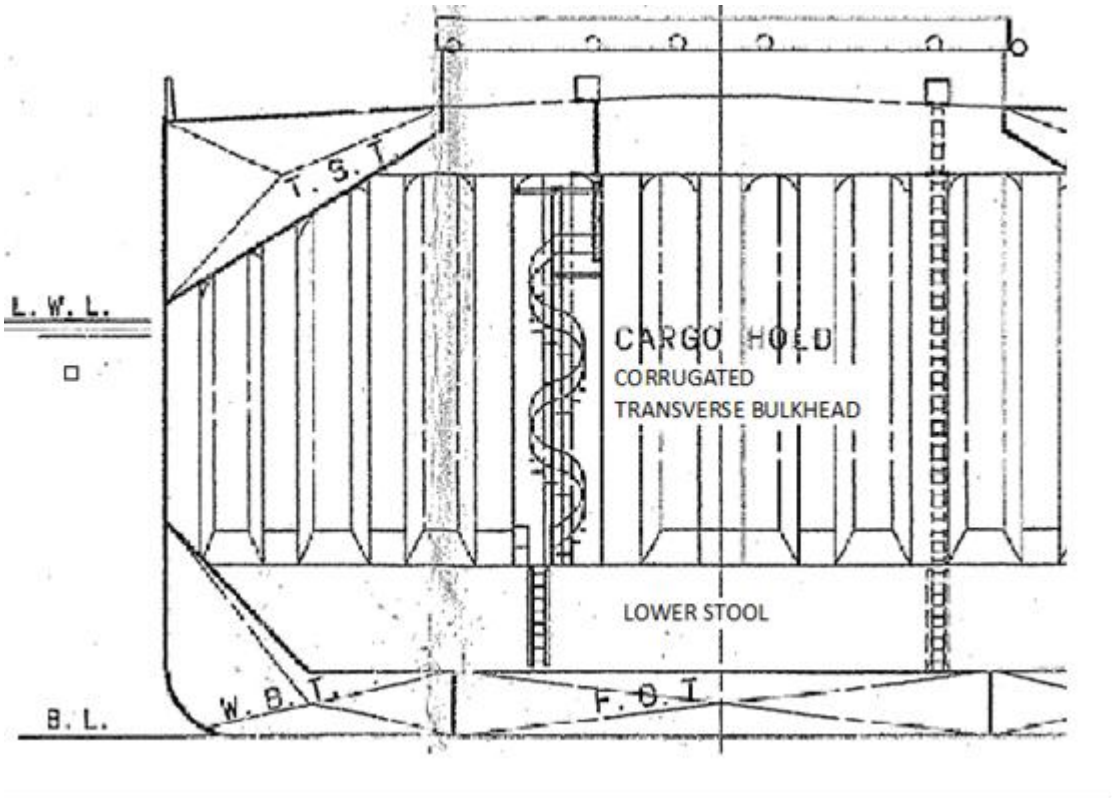


Fig. 2: No.3 Cargo Hold Aft View

5.8 Transverse Bulkhead Lower Stool Space between cargo hold No.3 and No.4 (hereinafter referred to as the Lower Stool Space) where the deceased was found, was a void space (Fig. 3).

5.9 The "Lower Stool Space" had watertight boundaries and had access only from cargo hold No.4.

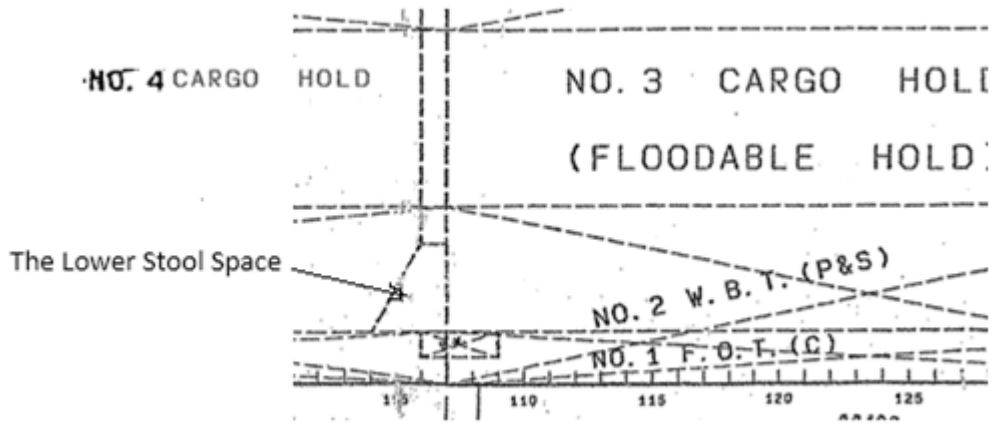


Fig. 3: The Lower Stool Space

Suspicious water leaking from lower stool space into cargo hold

5.10 On 21 June 2013, the Third Officer reported to the Chief Officer on his finding of water leaking from the "Lower Stool Space" during his inspection in No.3 cargo hold. The water seeped (shown in Fig. 4) at one metre high above inner bottom from the fillet weld joint that attached the No.3 cargo hold aft access ladder onto the bulkhead lower stool plating.

Fig. 4: Suspected area of water seeping out.

5.11 Under normal condition, no water should entered inside the "Lower Stool Space". To check for water level by opening the access cover on boundary was risky as water pressure might possibly be built up inside the "Lower Stool Space" when water was seeping out at about one metre high.

5.12 The Chief Officer had instructed the Bosun to inspect the "Lower Stool Space" without informing him all the potential hazards. The Bosun then entered the space through the manhole without authorization and considering the potential hazards. In this case, neither the Chief Officer nor the Bosun had followed the safe working practice.

Coal - hazardous cargo in bulk quantity.

5.13 According to International Maritime Solid Bulk Cargoes Code, the Coal (bituminous and anthracite) was a natural, solid, combustible material consisting of amorphous carbon and hydrocarbons.

5.14 Coal was categorized as Group "B" (classed MHB) due to its potential chemical hazardous when in bulk quantity. Coal may create flammable atmospheres, may heat spontaneously, may deplete the oxygen concentration, may corrode metal structures. The situation was worsen on board by the heated fuel oil tanks underneath the cargo holds (No.3, No.4 and No.5) as shown in Fig. 5.

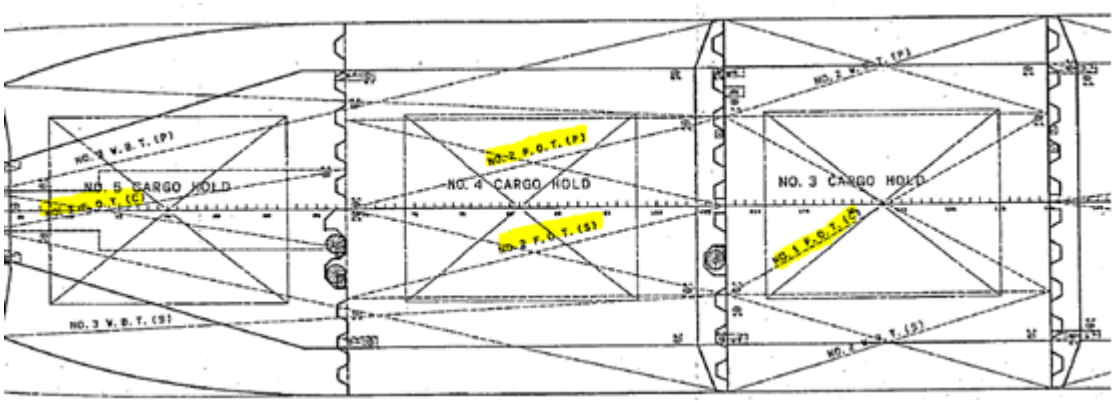


Fig. 5: Fuel Oil Tanks Arrangement.

5.15 Coals may emit methane, a flammable gas. A methane/air mixture in certain degree is explosive and can be ignited by sparks or naked flame, e.g., electrical or frictional sparks, a match or lighted cigarette. Methane is lighter than air and may, therefore, accumulate in the upper region of the enclosed spaces.

5.16 Coals may be subject to oxidation, leading to depletion of oxygen and an increase in carbon dioxide (CO_2) or carbon monoxide (CO) concentrations in the cargo hold. CO gas is toxic and odorless gases.

5.17 Some coals may be liable to react with rain water and produce acids which may produce hydrogen gas which is also odorless, flammable and toxic gases. Hydrogen is much lighter than air.

The atmosphere of the "Lower Stool Space"

5.18 The "Lower Stool Space" was not provided with any natural ventilation, as it was neither a Statutory nor a Class requirement, considering the size and the non-availability of permanent bilge line for the space. Therefore the air inside the space did not circulate under normal condition.

5.19 Toxic, flammable gases such as carbon monoxide, hydrogen and methane, were odorless in nature. They could be emitted from the cargo "Coal" and accumulated amply in the cargo holds during the 9 days voyage from Muara Jawa, Indonesia to Zhenjiang, China. The gases emission could be accelerated by the heating from the fuel oil tanks underneath the cargo holds.

5.20 The gases could leak into "Lower Stool Space" through the following openings due to potential poor seamanship at closing:

- One piece of access cover from No.4 Cargo hold.
- Two piece of manhole covers of the No.3 Cargo hold bilge wells.
- Miscellaneous penetrations, e.g. the cargo hold water ingress alarm sensor connections, sounding pipe.

5.21 Oxygen depletion inside the space may be the result of the corrosion and methane gas leaked into the space.

5.22 Effects and symptoms of oxygen depletion:

Oxygen is essential to life; the normal atmosphere has an oxygen content of 20.8 percent by volume. In general, oxygen deficiency leads to a loss of mental alertness and a distortion of judgment and performance. It cannot be determined through an individual's senses. This happens within a relatively short time without the person's knowledge and without prior warning. For oxygen content 6 - 8%, fainting within a few minutes, resuscitation possible if carried out immediately. For oxygen content 0-6%, fainting almost immediate, death or severe brain damage.

5.23 Effects and symptoms of high carbon monoxide concentration:

A carbon monoxide concentration of 0.05 percent (500 ppm) may produce unconsciousness in a little more than an hour, and may prove fatal in four hours. However, higher concentrations may cause almost immediate unconsciousness and death within a few minutes.

5.24 The deceased was not responding to the watch keeper outside at about three minutes after the entry, and he had no heart-beat when removed out of the space at about 28 minutes. Probably the atmosphere in the "Lower Stool Space" could not sustained life with high level of carbon monoxide and lack of oxygen.

5.25 After the accident, no chemist was available to report on the content of the air inside the space.

Safety Management Manual

5.26 The shipboard Safety Management Manual (SMM), document number: SOPM-5.3, stipulated the requirements on the entry of enclosed spaces or confined dangerous spaces. The following procedures stated in the manual had not been complied with by the crew during the accident:

- The Chief Officer or the Chief Engineer should furnish the risk assessment and control report. The report should be approved by Master.
- Before any entering, the space should be thoroughly ventilated by natural or mechanical means, if necessary, the air content within the space should be tested for oxygen, toxic and flammable levels. In case the testing could not be done from outside, a man with breathing set and safety gears should enter the space to test the air content. The tank entry will be allowed only if the result is satisfactory.
- Full evaluation to the space should be carried out. Only under absolute certainty, the space could be entered without breathing appliance set.
- Any entry made should keep on updating the Bridge, Engine Room, and the duty seaman, to avoid any unsafe operation to endanger the life inside the space.
- The "Enclosed Space Entry Permit" should be displayed at the entrance. Personnel should signed the permit before entering.

6. Conclusions

6.1 On 21 June 2013, the Hong Kong registered bulk carrier “Pacific Endeavor” was suspiciously flooded with sea water at the void space at the aft transverse bulkhead lower stool of cargo hold No.3. The Bosun proceeded to enter the enclosed space alone without following the company’s Safety Management System and the approval by the Master. The Bosun entered the void space and lost his conscious there. He was sent to hospital for rescue. However, he was certified dead by the hospital on the same date.

6.2 On that day, when the Vessel completed her discharging of coal cargo at Zhenjiang, China, the Bosun on board was suffocated inside the void space at the aft transverse bulkhead lower stool of cargo hold No.3.

6.3 The investigation into the accident revealed that the enclosed lower stool space was not properly ventilated before entry. The Bosun was likely overcome by high concentration of carbon monoxide and oxygen depletion inside the space that was lethal to him.

6.4 The investigation had also revealed that the procedures stipulated in shipboard Safety Management Manual (SMM) had not been followed on the entry of enclosed spaces or confined dangerous spaces.

7. Recommendations

7.1 A copy of this report should be sent to the Master and the Company of the Vessel, advising them the findings of this incident.

7.2 The cargo hold transverse bulkhead lower stool space was a confined space. It was obvious that the crew members failed to observe the requirement of Safety Management Manual (SMM) on board. The officer must ensure the crew to follow the procedures-SOPM-5.3 of SMM prior the entry.

7.3 The Company should be at the earliest to implement the SOLAS Chapter III, Part B, Regulation 19.3 with regard to “enclosed space entry and rescue drills” at least once every two months. This regulation becomes effective on 1 January 2015.

7.4. The management company/ship owner should inform the Shipping Division of Marine Department of the action taken on the implementation of the corrective actions in accordance with the findings of this accident investigation.

8. Submissions

8.1 In the event that the conduct of any person or organization is commented in an accident investigation report, it is the policy of the Marine Department to send a copy of draft report to that person or organization for their comments.

8.2 The draft report was sent to the Manager of the *Vessel* of *Hong Kong Ming Wah Shipping Co., Ltd, HK* for the comments.

8.3 During the consultation period, comments from the Manager of the *Vessel* were received and had been properly considered and the report has been amended accordingly.