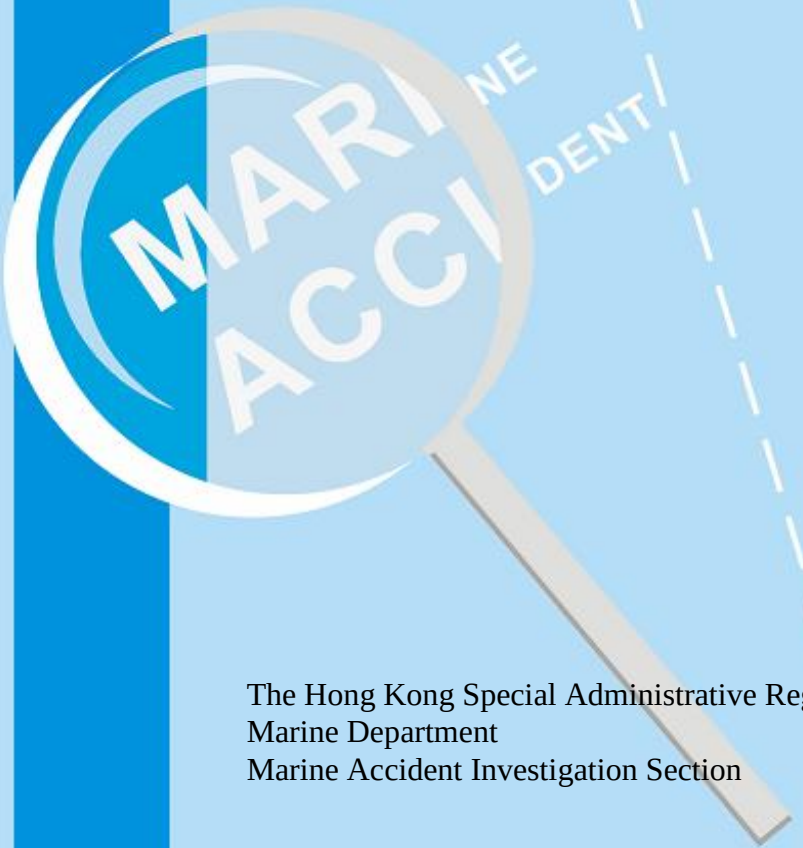
Report of Investigation into an explosion accident on board Hong Kong Registered Bulk Carrier "Great Aspiration" in waters off Falmouth, UK on 17 April 2019



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

17 December 2020

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.

Table of contents

Page

Summary

On 4 April 2019, the Hong Kong registered bulk carrier “Great Aspiration” (*the vessel*) fully loaded with coal departed from Baltimore, USA for the discharge port in Ijmuiden, Netherlands. On 17 April 2019, *the vessel* was at approximate position of 49°38.46’N, 05°55.94’W off Falmouth, UK. The crew applied hot work to dismantle the connection of a leaky hydraulic ram which was attached to No.3 cargo hold (C/H) forward hatch coaming. During the repair, an explosion in No.3 C/H took place, causing injuries to three crew who were taken to hospital by helicopter. Amongst the three injured crew, the fitter was declared dead in the hospital two days later.

The explosion was caused by flammable methane gas emitted from the coal inside No.3 C/H. The methane gas was ignited by the hot spot generated on the forward hatch coaming during the repair work. The accident may well be avoided if the master had passed the safety cargo information and warning from the shipper and the company to the chief engineer in advance and stopped the hot work. The crew also failed to take note of the hazards behind the hatch coaming. Inappropriate risk assessment was another contributory factor.

The investigation also revealed that the daily gas sampling measurement as well as ventilation for cargo holds had not been implemented cautiously. The portable gas detectors on board were also found defective without being reported to the company in accordance with the company’s procedures for repair/replacement arrangement.

1. Descriptions of the vessel

Ship name	:	*Great Aspiration* (Figure 1)
Flag	:	Hong Kong, China
Port of registry	:	Hong Kong
IMO number	:	9458767
Type	:	Bulk Carrier
Year built, shipyard	:	2010, Jiangsu Jinling Ships Shipyard Ltd, China.
Gross tonnage	:	51,130
Net tonnage	:	31,267
Summer deadweight	:	93,412 tonnes
Length overall	:	229.2 metres
Breadth	:	38 metres
Engine power, type	:	12,240 kW, DOOSAN B&W/6S60MC
Classification society	:	China Classification Society (CCS)
Registered owner	:	Merchant Bright Ltd.
Management company	:	Sinotrans Ship Management Ltd.

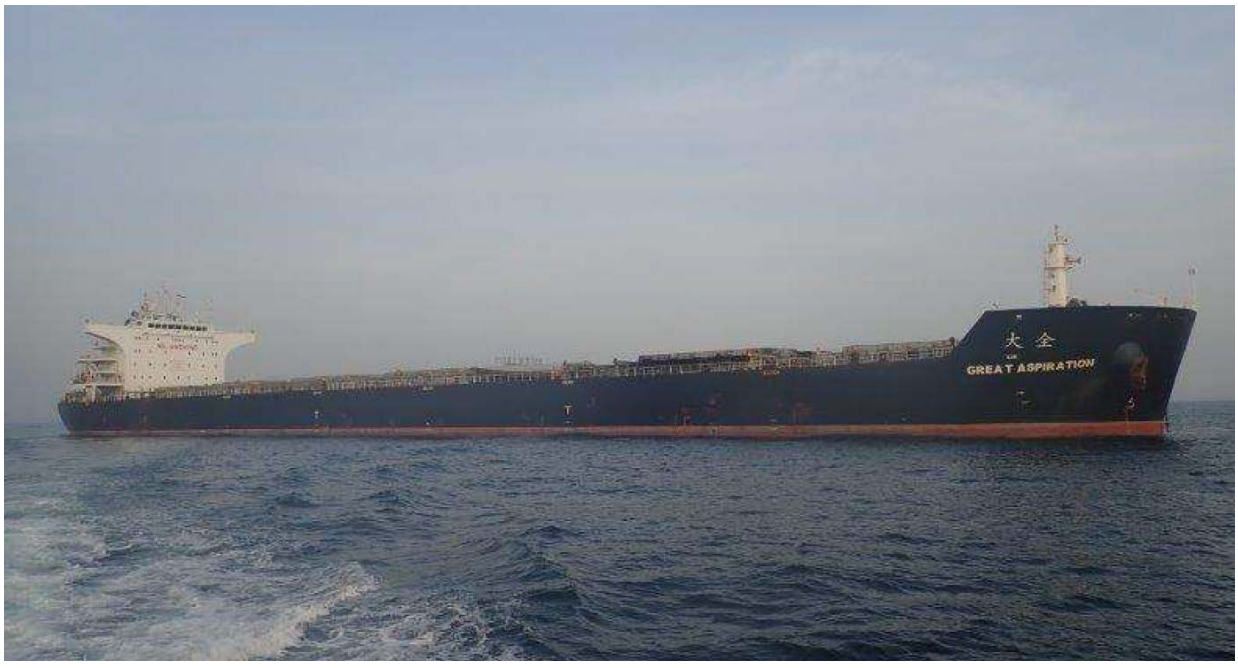


Figure 1 *The vessel*

2. Sources of evidence

2.1 The statement of the master of *the vessel.*

2.2 Information provided by the management company of *the vessel.*

3. Outline of events

(All times were local time UTC + 2 hours unless otherwise specified.)

3.1 On 4 April 2019, the Hong Kong registered bulk carrier "Great Aspiration" (*the vessel*) completed loading of 82,500 tonnes coal at Baltimore, USA. At about 1658 hours (UTC-4 hours), *the vessel* departed and commenced the laden voyage for the discharging port in Ijmuiden, Netherlands.

3.2 Shortly after *the vessel* left Baltimore, the crew noticed that there was oil leakage from a hydraulic ram attached to No.3 cargo hold (C/H) forward hatch coaming (*the ram*). Considering the potential hazards of oil leak on deck, oil wastage and sluggish hatch cover operation, the chief engineer (the C/E) decided to repair *the ram* during the voyage before arriving Ijmuiden. The proposed repair was agreed by the master and the chief officer (the C/O).

3.3 On 15 April 2019, a work team comprising the fourth engineer (the 4/E), a fitter and two oilers (Oiler A and Oiler B) was formed to handle the repair work, which involved hot work to disconnect the linkage of *the ram*. Before starting the repair work, the 4/E acted as the competent person and completed the hot work permit which was then endorsed by the C/E. The completion of the hot work permit implied that all safety measures were in place and were fully understood by the 4/E.

3.4 The repair work on 15 April 2019 involved the use of a gas torch to apply heat to free the retaining/pivot pins connecting *the ram* and the cam on top of it. When attempting to force out one of the pins sideway, the cam began moving freely. In order to prevent the cam from moving, two small brackets were welded to the hatch coaming to affix the cam in position. At the end of the day, only one pin was taken out.

3.5 The repair work was suspended on 16 April 2019 and in the morning of 17 April 2019 due to bad weather with southeasterly wind of force 6 on Beaufort scale.

3.6 On 17 April 2019 afternoon, the C/E decided to resume the repair work although the weather did not improve substantially. The master was briefed with the awareness that hot work would be involved.

3.7 Again, the 4/E obtained the hot work permit from the C/E and led the same work team to continue the unfinished repair work.

3.8 Shortly after the commencement of the repair work by using gas torch and jack, the work team encountered difficulties to remove the remaining pins. In order to facilitate the work progress, the 4/E tasked the Oiler A to bring another jack from the deck store located between No.3 C/H and No.4 C/H. He also asked the Oiler B to bring an electrical grinder from the engine room.

3.9 At about 1520 hours whilst Oiler B was leaving the work site to the engine room at the aft of *the vessel*, an explosion occurred.

3.10 The duty officer on the bridge saw a sudden flash at No.3 C/H main deck area followed by black smoke raising but without visible fire. The master immediately went to the bridge from his cabin when he heard the explosion sound. The C/E also immediately left his cabin when he saw the black smoke through his cabin's window. The C/E made his way to main deck where he found three crew of the work team coming back from ship forward end with severe burns, singed hair and that most part of their working clothes were burnt off. The C/E noticed also that the hatch covers of No.3 C/H and No.2 C/H had been dislocated from their closed position.

3.11 After first aid treatment applied to the three injured crew, the master made emergency call to Beijing International SOS at 1600 hours and subsequently, made a call to the UK Coastguard at 1625 hours.

3.12 At 1845 hours, a rescue helicopter dispatched by the UK Coastguard arrived and winched down a doctor. The helicopter then left *the vessel* for refuel. The doctor undertook first aid treatment to the three injured crew. The rescue helicopter returned at 1958 hours and picked up the three injured crew as well as the doctor from *the vessel* for hospital. *The vessel* then sailed to Falmouth, UK for seeking medical assistance and technical support. Two days later, the fitter was declared dead in the hospital.

4. Analysis

Manning of the vessel

4.1 *The vessel* was manned by a total of 21 crew from China.

4.2 The master had served as a shipmaster since 2010. He held a valid Class 1 Licence (Deck Officer) issued by the Hong Kong Marine Department (HKMD). He joined the company on 12 January 2019 when he signed on *the vessel* in Gibraltar as the master.

4.3 The C/O obtained his master's certificate of competency in 2016. He joined the company on 24 December 2018 when he joined *the vessel* in Kopra, Slovenia as the chief officer.

4.4 The C/E had served as a chief engineer since 2011. He held a valid Class 1 Licence (Engineer Officer) issued by the Hong Kong Marine Department (HKMD). He joined the company on 24 December 2018 when he joined *the vessel* in Kopra, Slovenia.

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

Working hours and alcohol abuse

4.6 There was no evidence to show that relevant crew suffered from either fatigue at work, or abuse of alcohol or drug.

Weather and sea conditions

4.7 On the day of the accident, the weather was cloudy with southeasterly strong breeze of force 6 on the Beaufort scale and rough sea condition of 3 to 4 metres high waves. The weather and the sea conditions did not contribute to the accident.

Properties of coal in bulk

4.8 With reference to IMSBC Code[1], coal is classified as cargo having "Materials Hazardous only in Bulk" (MHB), which means that it may possess chemical hazards when carrying in bulk. In accordance with the Appendix to the schedule of coal as described in the "Individual

[1] The International Maritime Solid Bulk Cargoes (IMSBC) Code adopted by International Maritime Organization, to facilitate the safe stowage and shipment of sold bulk cargoes.

Schedules of Solid Bulk Cargoes" of the IMSBC Code, coal possesses the following properties and characteristics:

(a) Coals may emit methane, a flammable gas. A methane/air mixture containing between 5% and 16% methane constitutes an explosive atmosphere which 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 cargo space or other enclosed spaces. If the cargo space boundaries are not tight, methane can seep through into spaces adjacent to the cargo space.

(b) Coals may be subject to oxidation, leading to depletion of oxygen and an increase in carbon dioxide or carbon monoxide concentration in the cargo space. Carbon monoxide is an odourless gas, slightly lighter than air, and has flammable limits in air of 12% to 75% by volume. It is toxic by inhalation, with an affinity for blood haemoglobin over 200 times that of oxygen.

(c) Some coals may heat spontaneously and the spontaneous heating may lead to spontaneous combustion in the cargo space. Flammable and toxic gases, including carbon monoxide, may be produced.

(d) Some coals may be liable to react with water and produce acids which may cause corrosion. Flammable and toxic gases, including hydrogen, may be produced. Hydrogen is an odour-less gas, much lighter than air, and has flammable limits in air of 4% to 75% by volume.

4.9 The said Appendix also states that when the shipper has informed that the cargo is liable to emit methane or analysis of the atmosphere in the cargo space indicates the presence of methane in excess of 20% of the lower explosion limit (LEL), the following additional precautions (relevant to this investigation) should be taken:

(a) Adequate surface ventilation should be maintained, except for an appropriate period for the purpose of gas monitoring.

(b) Care shall be taken to remove any accumulated gases prior to operation of the hatch covers or other openings for any reason, including discharging. Care shall be taken to operate hatch covers of the cargo spaces and other openings to avoid creating sparks. Smoking and the use of naked flame shall be prohibited.

4.10 Before the loading of coal in Baltimore, the shipper provided the cargo safety information to the master and warned him that the cargo might emit methane and/or self-heat and that procedures as recommended in the IMSBC Code should be observed.

4.11 Upon completion of cargo loading at 1335 hours (UTC-4 hours) on 4 April 2019, all C/Hs hatch covers were closed with all ventilation flaps kept shut. *The vessel* sailed from Baltimore at 1658 hours (UTC-4 hours) on the same day. The company sent email to the master reminding him to monitor the coal temperature using the "infrared temperature meter" and not to allow the crew to enter the cargo hold to take gas samples.

4.12 Nonetheless, the master failed to pass the cargo safety information to the C/E. Even when the C/E briefed the master of the repair work that would involve hot work, the master did not stop the hot work.

The hatch cover and the hydraulic rams

4.13 *The ram* under repair was one of the hydraulic rams used to jack up or lower down No.3 C/H hatch cover panels. The cover panels, once lifted, would be pushed sideways by the hydraulic motors along the rails for opening or closing No.3 C/H hatch.

4.14 As a result of the explosion, two No.3 C/H hatch cover panels were buckled and dislocated sideways from their closed position. The hatch cover securing cleats of No.3 C/H were torn apart and broken. The cover of No.3 C/H forward access was blown off.

4.15 The two No.2 C/H hatch cover panels were dislocated in lesser extent than those of No.3 C/H by the blast of the explosion. The aft ends of the two No.2 C/H hatch cover panels showed signs of the blast from No.3 C/H (Figure 2).

Figure 2 The dislocated No.2 and No.3 C/Hs hatch cover panels (looking forward)

Figure 3 The dislocated No.2 and No.3 C/Hs hatch cover panels (looking aft)

Figure 4　Aft end of No.3 C/H hatch cover port panel

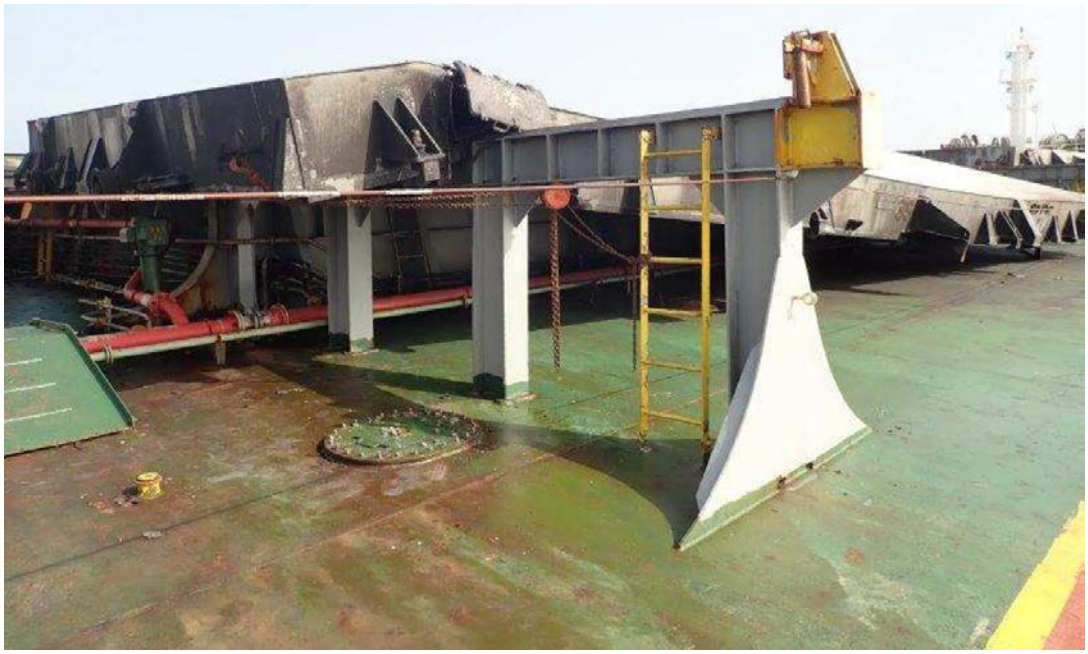


Figure 5　Aft end of No.3 C/H hatch cover starboard panel

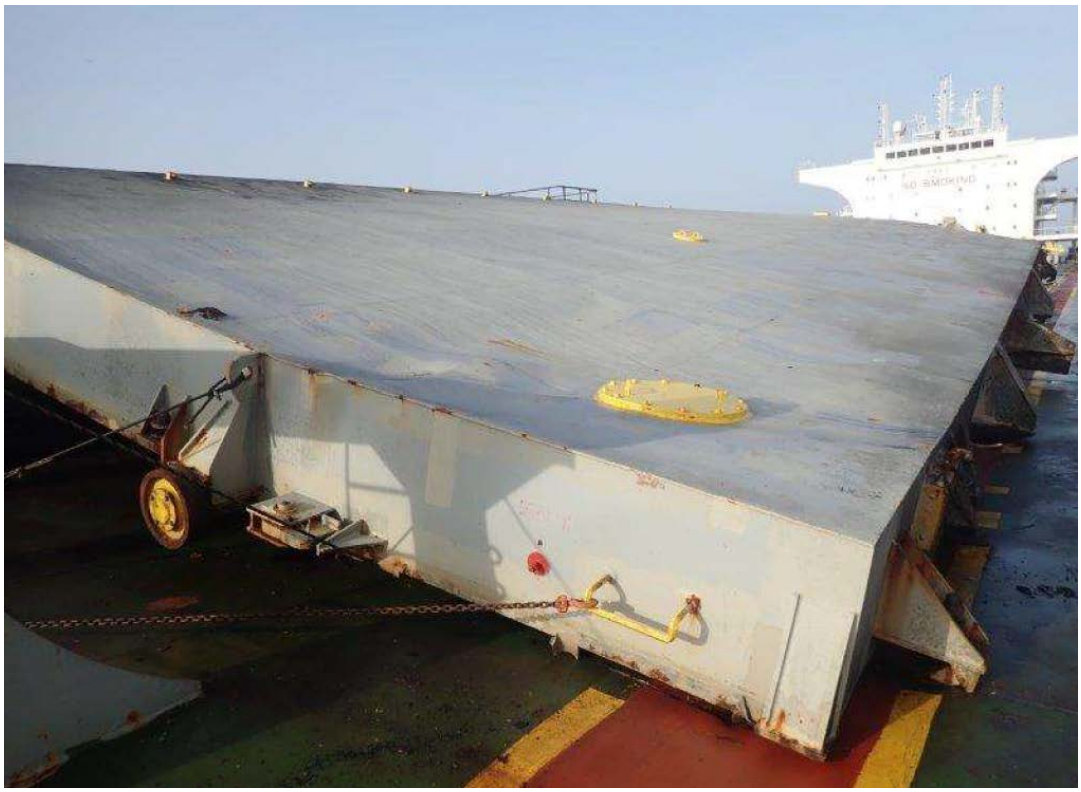


Figure 6　Forward end of No.3 C/H hatch cover port panel

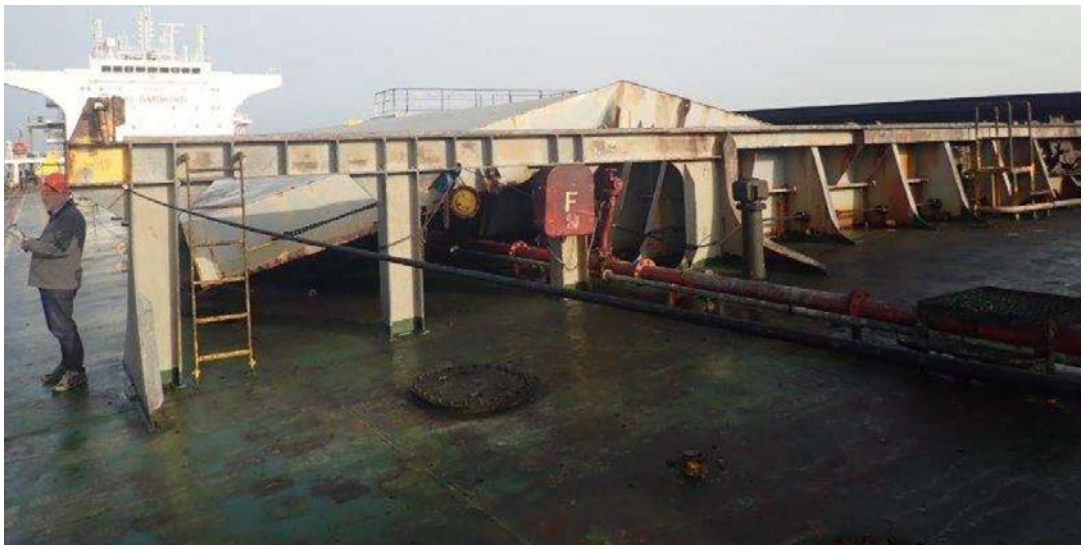


Figure 7　Forward end of No.3 C/H hatch cover starboard panel

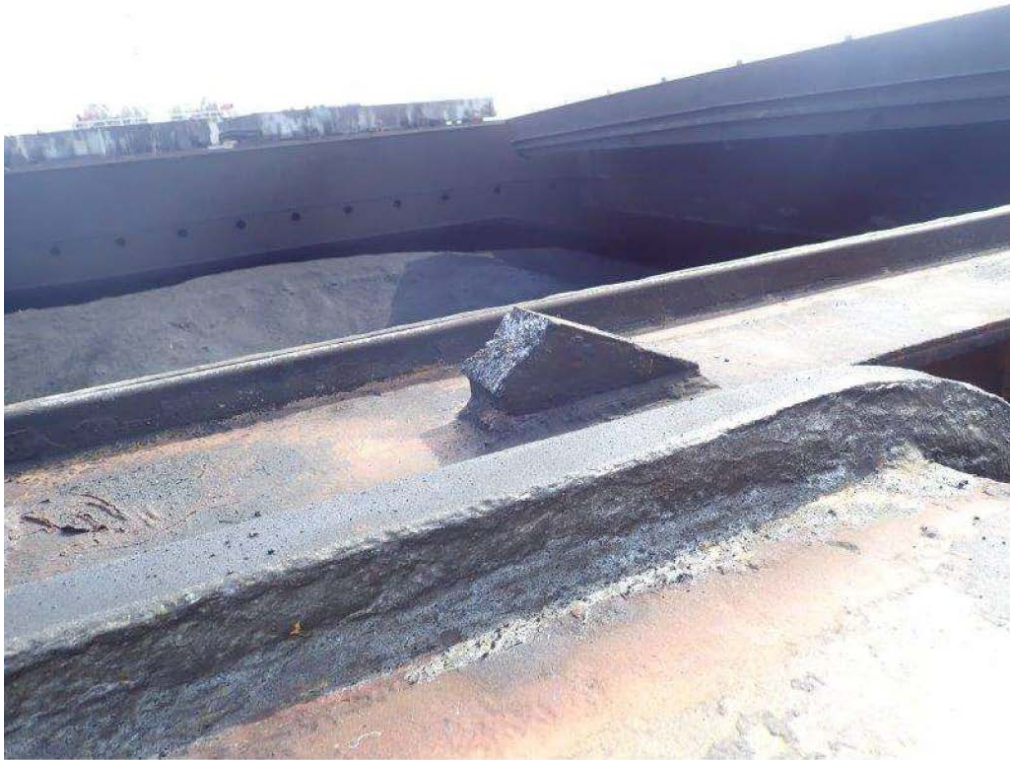


Figure 8 Broken No.3 C/H hatch cover securing cleat

Figure 9 No.3 C/H forward access hatch and the dislodged cover

The cause of explosion

4.16 In order to repair the leaky ram, the defective parts inside *the ram* must be replaced. As such, the retaining/pivot pins connecting *the ram* and the cam on top must be dismantled. On 15 April 2019, one of the pins was successfully removed after applying intense heat from gas torch and jacking force. In order to keep the cam in position during the repair work, two small brackets were welded to the hatch coaming.

4.17 Flammable methane gas emitted from coal would accumulate within the space between the top of the coal and the bottom of the hatch cover (*the space*) inside a cargo hold. When hot work involving welding was carried out outside No.3 C/H forward hatch coaming, intense heat would be transmitted to the other side of the coaming facing *the space*, i.e. a hot spot was provided to *the space*. With regard to the hot work carried out on 15 April 2019 without causing explosion, it could well be that either the methane/air mixture in *the space* on that day was not rich enough to be ignited by hot spot or the temperature of the hot spot was not high enough to trigger the explosion.

4.18 There was no evidence to ascertain the level of flammable methane/air mixture inside *the space*. It can only be deduced that the methane/air mixture accumulated in *the space* had reached a level on 17 April 2019 which could be ignited by a hot spot.

Safety management system and toolbox meetings

4.19 The shipboard safety management system (SMS) required a permit to be issued before commencing any hot work, in which confirmation of gas free was a necessity. Section SSM-016 ("*Hot Work Precautions*") of the SMS stated that "*No hot work is allowed in any compartment or tanks in which, or adjacent to which, dangerous substances are stowed, or which has not been vented of flammable gases or residue which might give rise to danger*".

4.20 Although the C/E endorsed two hot work permits on 15 and 17 April 2019 respectively, the 4/E apparently did not carry out any gas free venting operation for *the space*.

4.21 It was also found that although potential hazards of carrying coal in bulk were mentioned in the cargo safety information and that warning was

given to the master by the shipper and the company before and immediately after the loading of coal, risk assessments and toolbox meetings carried out on 15 and 17 April 2019 for the repair work did not fully assess any fire/explosion hazard in association with the likely accumulation of flammable gas in *the space*. The crew failed to take note of the hazards by carrying out hot work on the hatch coaming adjacent to *the space* which would be filled with potential flammable gas.

Safety issues

4.22 The investigation also revealed that the daily cargo holds gas sampling measurement records taken before the accident were not reliable:

(a) in the morning of 18 April 2019 after the accident, the C/O carried out gas measurement to record the percentage of LEL of all other intact cargo holds. The results ranged from 24% to 33% LEL, which were double of the daily measurement records taken before the accident. Subsequently, all the intact cargo holds were ventilated by opening the hatch covers on the same day. Despite of the ventilation, however, the measurement taken by using a portable gas detector on 19 April 2019 revealed that the LEL of No.7 C/H was still at an unsafe level ranging from 72% to 82%; and

(b) *the vessel* had two sets of portable gas detectors of the same model. However, both sets had been malfunctioned since September 2018. The equipment failure was not reported to the company for repair/replacement arrangement in accordance with SQEM Section 3.5 of the SMS.

5. Conclusions

5.1 On 17 April 2019, *the vessel,* fully loaded with coal, was en route from Baltimore, USA to Ijmuiden, Netherlands. At an approximate position of 49°38.46'N, 05°55.94'W off Falmouth, UK, an explosion occurred at *the vessel*'s No.3 C/H due to hot work applied to the forward hatch coaming of the cargo hold. The explosion resulted in three injuries and relevant crew were taken to the hospital by helicopter. Amongst the three injured crew, the fitter was declared dead in the hospital two days later.

5.2 The explosion was caused by flammable methane gas emitted from the coal inside No.3 C/H which was ignited by the hot spot generated on the forward hatch coaming during the repair work.

5.3 The investigation identified the following contributory factors:

(a) the master failed to pass the cargo safety information and warning from the shipper and the company to the C/E in advance and stopped the hot work;

(b) the crew failed to be aware of the hazards inside the cargo hold; and

(c) risk assessment for the repair work had not been carried out appropriately.

5.4 The investigation also revealed the following safety concerns:

(a) gas sampling measurement and ventilation for cargo holds had not been implemented cautiously; and

(b) on board defective gas detectors were not reported to the company as per the company's requirement for arranging repair/replacement.

6. Recommendations

6.1 The management company should issue circulars to inform all masters, officers and crew of its fleet of the findings of the investigation and lessons learnt from this accident. It should also instruct them to be familiarized with cargo safety information and follow all the required safety precautions.

6.2 The management company should conduct internal audit on board to ensure that the crew on board strictly follow the company procedures of permit to work system especially those involving hot work, gas sampling measurements and gas detector maintenance.

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

7. Submissions

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

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

(b) MAIB of Department for Transport, UK.

7.2 By the end of the consultation, no comment was received from the parties mentioned in paragraph 7.1.