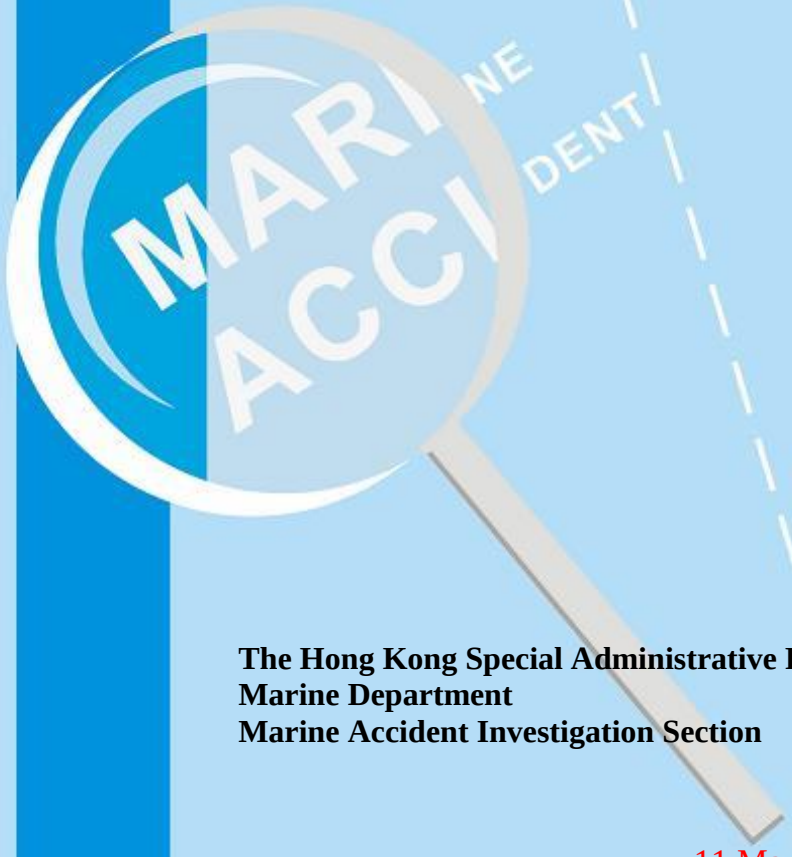
Report of investigation into the sinking of Hong Kong registered bulk carrier "*Emerald Star*" at position 19°03'N, 124°52'E, east of the Luzon Island, the Philippines on 13 October 2017



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

11 May 2021

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 9 October 2017, the Hong Kong registered bulk carrier, "*Emerald Star*" (*the vessel*) loaded with 55,000 metric tonnes (mt) of nickel ore departed from Buli, East Halmahera, Indonesia for the discharge port of Lianyungang, China.

On 12 October 2017, *the vessel* sailed closely into the path of tropical storm (TS) "KHANUN" which was at Beaufort Wind Scale force 8 with the maximum wind speed of 40 knots. She finally capsized and sank approximately in position 19°03'N, 124°52'E at about 0140 hours on 13 October 2017. Sixteen out of 26 crew members were rescued by two nearby vessels. When the search and rescue operation stood down on 18 October 2017, ten crew members including the master were still missing.

The investigation into the accident revealed that *the vessel* was loaded with nickel ore with moisture content in excess of the Transportable Moisture Limit (TML), since the crew did not strictly adhere to the requirements stipulated in the IMSBC Code[1] and the company's instructions. As a result, cargo liquefaction and shifting occurred causing *the vessel* heavily listed and capsized eventually when she was near the TS.

The investigation also revealed that the crew did not strictly follow the navigation and bridge procedures for adverse weather in voyage planning, and underestimated the effect of adverse weather to the cargo. Furthermore, the master underestimated the consequence of the liquefaction effect of the cargo failed to announce abandon ship at early stage.

[1] IMSBC Code: the International Maritime Solid Bulk Cargoes Code, entered into force on 1 January 2011 under the SOLAS Convention. The IMSBC Code is to facilitate the safe stowage and shipment of solid bulk cargoes by providing information on the dangers associated and instructions on the procedures to be adopted when the shipment of solid bulk cargoes is contemplated.

1. Description of the vessel

Ship name	:	*EMERALD STAR* (Figure 1)
Flag	:	Hong Kong, China
Port of registry	:	Hong Kong
IMO number.	:	9449261
Type	:	Bulk carrier
Year of built, shipyard	:	2010, STX Dalian Shipbuilding Co., Ltd, China
Classification society	:	DNV GL
Gross tonnage	:	33,205
Net tonnage	:	18,891
Summer deadweight	:	57,366.7 metric tonnes
Length overall	:	190.00 metres
Breadth	:	32.26 metres
Engine power, type	:	9480 kW, STX MAN B&W 6S50MC-C7
Registered owner	:	Dubai Bulkers Limited
Management company	:	Vridhi Maritime Pvt. Ltd.
Number of crew	:	26

Figure 1 *The vessel*

2. Sources of evidence

2.1 The statements of the crew and the staff of the management company of *the vessel*.

2.2 The information from the management company of *the vessel*.

2.3 The search and rescue information provided by the Hong Kong Maritime Rescue Co-ordination Centre (HKMRCC).

2.4 The information on the nickel ore mining area provided by the National Transportation Safety Committee (NTSC) of the Republic of Indonesia.

2.5 Emergency Response service of DNV GL[2].

[2] On 1 March 2021 DNV GL became DNV

3. Outline of events

(All times were local time UTC + 8 hours unless otherwise specified.)

Loading of nickel ore

3.1 Before *the vessel* arrived at the loading port Buli, Indonesia on 12 September 2017, the management company sent the precaution notice for loading nickel ore to the master reminding him that the cargo might be liquefied if shipped at excess TML[3]. The "Loss Prevention Briefing" for the "Carriage of Nickel Ore" issued by Protection and Indemnity Association (P&I) was also attached to the notice for reference.

3.2 The management company's voyage instructions advised the master that if in doubt of the cargo moisture content, Can Test on the cargo should be carried out in accordance with section 8 of the IMSBC Code before loading on board. Furthermore, the master also had the right to stop loading at any time if he considered that the moisture content of the cargo to be loaded was not safe for carriage. Charterers/shippers had to replace the entire cargo in the barge in case the cargo was rejected by the master.

3.3 On 19 September 2017, *the vessel* arrived at the anchorage of Buli, Indonesia.

3.4 By using barges, loading of nickel ore was commenced at the anchorage at 0340 hours (UTC+9, local time of Buli) on 20 September 2017.

3.5 The loading was completed on 8 October 2017. During the course of cargo loading, the shipper tendered three cargo declarations attached with "Certificates of Moisture Content and Transportable Moisture Limit" (CMCTML) to the master. The characteristics of the samples of cargo as indicated on the CMCTML were summarized in Table 1 below:

[3] Transportable moisture limit (TML) is the moisture content limit of a cargo which is considered safe for the carriage in ship for shipment. Details of its definition is given under Section 2 of the Merchant Shipping (Safety) (IMSBC Code) Regulation, Chapter 369AZ.

CMCTML testing date	Proposed Date of Loading	IMSBC Code Group	Moisture Content	TML[4]
18.09.2017	19.09.2017	A	29.99	35.25
24.09.2017	25.09.2017	A	30.64	35.53
01.10.2017	02.10.2017	A	30.48	35.39

Table 1 Characteristics of the samples of nickel ore cargo

3.6 The crew carried out Can Test on the cargo from each barge. Test samples were taken from about one metre below the cargo surface at the forward, middle and aft part of the cargo on the barges. The Can Test results were sent to the management company by email before departure.

3.7 During the loading operation, cargo on one of the barges was rejected as it failed the Can Test. The cargo was accepted later after drying under the sun and passing the Can Test. Nevertheless, the master had rejected some portions of the cargo on a few barges.

3.8 There were quite a few pouring rains during the cargo loading period. The crew had to close the hatch covers when raining commenced. When the cargo loading was completed on 8 October 2017, a total of 55,000 mt nickel ore, including 19.77 mt cargo samples in 50 bags, were loaded on board *the vessel* in five cargo holds through 23 barges. The cargo distribution in the cargo holds is shown in Table 2 below:

Cargo hold no.	No. 1	No.2	No.3	No.4	No.5
Quantity (mt)	10250	11600	9900 + 19.77 (50 bags of cargo sample)	11580.23	11650

Table 2 Cargo distribution in the cargo holds

[4] The figure of transportable moisture limit (TML) is based on a numerical value determined in laboratory. The numerical value can vary widely even for cargoes with the same description. It is not possible to predict the numerical value of a given cargo from its description, due to matters of particle size distribution or chemical composition.

3.9 Each cargo hold was about half-full after the completion of loading. The cargo top was about six to seven metres below the hatch coaming. The cargo inside the cargo holds was trimmed and pressed by cargo grabs to prevent sliding movement (Figure 2).

Figure 2 The cargo surface of one of the cargo holds after trimming

En route from Buli, Indonesia to Lianyungang, China

3.10 At about 0300 hours (UTC+9, local time of Buli) on 9 October 2017, *the vessel* departed from Buli, Indonesia for the discharge port at Lianyungang, China. The departure fore and aft drafts of *the vessel* were 12.80 metres and 13.30 metres respectively. The weather was fine at the time of departure.

3.11 On 10 October 2017, the observed weather of the sea area was northwest wind force 4 on Beaufort Wind Scale and moderate sea with northeasterly swell height of one metre. The weather forecast received by *the vessel* indicated that the sea area of the ship's planned route on 12 October would be moderate sea with swell height of 2.3 metres and wind speed of 15-20 knots.

3.12 The bilge water in each cargo hold bilge well was maintained at a level of about 60 cm height, i.e. no excessive bilge water left in cargo holds. The chief officer stated that all cargo hold inspection covers were opened for cargo inspection on 11 October 2017. The cargo condition was stable, i.e. no shifting or liquefaction.

3.13 On 11 October 2017, *the vessel* rolled and pitched moderately due to southwest wind force 5 on Beaufort Wind Scale and moderate to rough sea with northeasterly swell height of about 1.5 metres. The master considered

that the weather condition was acceptable and continued the voyage as planned.

3.14 At 1400 hours on 12 October 2017, a tropical depression (TD) formed at position 17.5°N, 125°E with Beaufort Wind Scale force 7 near center. The 2nd officer plotted the predicted track of the TD on the navigational chart and concluded that the TD would be clear of *the vessel* by 13 October 2017. The master decided to keep the original course. The TD was upgraded to a tropical storm (TS) and was named as "KHANUN" at around 1700 hours on the same day with the maximum wind speed of Beaufort Wind Scale force 8 and moving westward at about 13.5 knots.

3.15 From 1600 to 2000 hours, the master, the chief officer and the 2nd officer discussed the weather situation after the TD was upgraded to TS. They decided to maintain the original course.

3.16 At 2230 hours on 12 October 2017, *the vessel* rolled heavily.

3.17 At 0055 hours on 13 October 2017, *the vessel* listed to port side by about 5 degrees.

3.18 At 0100 hours, the master instructed all crew via public address system to put on lifejacket.

3.19 At 0105 hours, *the vessel* listed by 15 degrees to port side and rolled heavily. The sea was very rough. The wave height was about four metres with gust wind at Beaufort Wind Scale force 8. The master called a nearby Marshall Islands registered vessel *"SM Samarinda"* ("*SS*") which was about 5 nautical miles (nms) away from *the vessel* for assistance.

3.20 At 0115 hours, *the vessel* listed by 18 degrees to port side. When the 2nd officer and the duty rating were going to check the ship's condition on the port bridge wing, they were washed overboard.

3.21 At 0120 hours, except the master and duty rating on the bridge, the remaining crew with lifejackets were mustered on the poop deck. *The vessel* listed to port side by about 25 degrees and rolled heavily. The crew tried to lower the free-fall lifeboat but in vain due to excessive listing of *the vessel*.

3.22 At 0135 hours, *the vessel* was blackout and listed by 45 degrees to port side with port bridge wing immersed in the sea. *SS* lost the radar echo and the AIS signal of *the vessel* and immediately proceeded to the scene for search and rescue (SAR) operation.

3.23 At 0140 hours, *the vessel* capsized and sank at approximate position 19°03'N, 124°52'E, about 150 nms northeast off the east coast of the Luzon Island, the Philippines (Figure 4). The crew either jumped into the sea or were washed overboard.

3.24 Two liferafts were installed on each side of *the vessel*. The chief officer stated that one of the liferafts on the starboard side was launched successfully before *the vessel* capsized, but no crew member could embark on that liferaft. He also saw the liferaft on the port side released and inflated automatically when it was submerged into water. Eventually, eight crew members managed to climb into one of the inflated liferafts from the sea.

SAR operation

3.25 At 0103 hours, HKMRCC received *the vessel*'s distress signal.

3.26 A Maltese vessel, "*Densa Cobra*" ("*DC*") which was about 13 nms away from *the vessel*, also received distress message and the announcement from *the vessel* via VHF channel 16 requesting urgent help. At 0110 hours, *DC* proceeded with full speed to the scene for SAR operation and arrived at the incident area at about 0233 hours.

3.27 At 0334 hours, HKMRCC tasked a Hong Kong registered vessel "*Papuan Chief*" ("*PC*") to provide on scene assistance. *PC* proceeded with full speed to the scene.

3.28 *SS* was the first vessel arrived at the scene and found a capsized lifeboat without any person inside. Later, *DC* also arrived and closely communicated with *SS* for SAR operation.

3.29 At 0510 hours, Japan Coast Guard ("JCG") took the lead as the coordinator for the SAR operation and dispatched an aircraft as well as two patrol vessels to the scene. *PC* arrived at the scene at about 0810 hours, and more merchant vessels followed to render SAR operation.

3.30 From about 0400 hours to 1400 hours, *DC* located and picked up 11 survivors. At 1610 hours, *DC* was released to proceed to her destination port Xiamen, China with the survivors on board. *SS* located and picked up five survivors from the water, and later sent them to the Luzon Island, the Philippines. The SAR operation was continued for the remaining ten missing crew members under the coordination of JCG with other merchant vessels.

3.31 The SAR operation stood down at 1800 hours on 18 October 2017. Ten crew members including the master were still missing.

4. Analysis

Ship's certificates

4.1 *The vessel* was built and delivered for service on 21 December 2010. All statutory certificates were valid at the time of the accident.

4.2 According to DNV GL's Class Status Report issued on 13 October 2017, *the vessel* complied with all the statutory and international requirements and certifications without any conditions of class or outstanding defects.

4.3 The Statement of Compliance for the Carriage of Solid Bulk Cargoes was issued by DNV GL on 11 April 2014 and *the vessel* was suitable for the carriage of groups A and C cargoes categorised in the IMSBC Code.

4.4 *The vessel* had served for two voyages under the current time charter party without any abnormality. Before the accident, no abnormal finding on *the vessel*'s structure was reported by the crew.

Manning scale and qualification

4.5 *The vessel* was manned by 26 crew members. The master and all deck and engineer officers held valid Certificates of Competency and Licences issued by the Government of India and the Hong Kong Marine Department respectively as appropriate to their ranks. Furthermore, all deck and engine ratings also held valid certificates of proficiency issued by the Government of India. The manning scale onboard met the requirement of *the vessel*'s Minimum Safe Manning Certificate.

Arrangements at loading port

4.6 In accordance with the IMSBC Code, nickel ore in bulk was categorized as group A cargo. The nickel ore in bulk as cargo may liquefy if shipped at a moisture content in excess of its TML which could cause cargo shifting adversely affecting a ship's stability.

4.7 Before arriving the loading port Buli, the management company reminded the master of the danger of liquefaction of nickel ore if its moisture content exceeded the TML. The "Loss Prevention Briefing" from P&I was also sent to *the vessel* which stipulated that "*If the cargo is stored in uncovered stockpiles and has standing water, moisture content may be high*." and *"if can tests carried out on a cargo presented for loading indicate a propensity for liquefaction, this is a major warning sign that the cargo as a whole is unsafe for carriage."*. (see also paragraph 3.1)

4.8 The investigation found that the exposed stockpiles of the cargo in the mining area for *the vessel* were partially covered by under-sized canvas. Some cargo piles were stacking with water accumulated on the floor and some parts were exposed to the rain directly (Figure 3). Under such stock condition, it was reasonable to expect that cargo contained high moisture content.

Figure 3 Photographs showing cargo stockpiles (taken after the accident)

Cargo inspections before shipment

4.9 Section 4.4.3 of IMSBC Code stipulates that "*For a concentrate or other cargo which may liquefy, the shipper shall facilitate access to stockpiles for the purpose of inspection, sampling and subsequent testing by the ship's nominated representative.*" However, there was no evidence to show that any representative had been appointed on behalf of *the vessel*'s interest to inspect the cargo stockpiles.

4.10 Section 4.5.2 of the IMSBC Code also stipulates that "*The shipper shall be responsible for ensuring that sampling and testing for moisture content is conducted as near as practicable to the date of commencement of loading.*

The interval between sampling/testing and the date of commencement of loading shall never be more than seven days. If the cargo has been exposed to significant rain or snow between the time of testing and the date of completion of loading, the shipper shall be responsible for ensuring that the moisture content of the cargo is still less than its TML, and evidence of this is provided to the master as soon as practicable".

4.11 During the loading period of about three weeks, pouring rain occurred on 19, 20, 21, 22, 24, 25, 26, 27 and 30 September and 1, 5, 6 and 7 October 2017. However, the shipper only provided three CMCTML issued on the same day after test on 18 September 2017, 24 September 2017 and 1 October 2017. No crew member or ship's representative was arranged to access the stockpiles for inspection, sampling and subsequent testing of the moisture content of the cargo. After the significant rain, no updated CMCTML were issued according to section 4.5.2 of the IMSBC Code to reconfirm that the moisture content of the cargo met the requirements. It was obvious that during the cargo loading period in Buli, the requirements stipulated under Sections 4.4.3 and 4.5.2 of IMSBC Code were not followed closely by the shipper and the crew.

4.12 The crew did conduct Can Test to determine the possibility of liquefaction of the cargo on every barge for loading on board. However, no further laboratory verification was carried out to confirm safe carriage. For cargo failing the Can Test, the crew only carried out another test after the cargo was dried under the sun. According to the P&I's brief, Can Test should not be a substitute for proper laboratory testing using an appropriate methodology. The cargo should be rejected and retested by an independent laboratory.

The vessel's condition

4.13 The bilge wells in cargo holds were sounded every day after departure. Excess bilge water in each cargo hold would be pumped out. According to the record reported to the management company, until 11 October 2017, the total amount of bilge water pumped out was about 26.37 cubic metres. The monitoring of the bilge well water was found in order.

4.14 According to the survivors' statements, there was no abnormality found on the ship's hull. The discharge of about 26.37 cubic metres bilge water was due to the precipitation of water content in the cargo in the first three days

of the voyage. The amount was considered normal by the crew and the management company. It may be deduced that *the vessel* did not encounter water ingress problem before the accident.

4.15 *The vessel*'s departure loading condition was evaluated after the accident. The intact stability condition of *the vessel* in the departure was found meeting the criteria (including weather criterion requirements) of the 2008 IS Code[5]. *The vessel*'s initial metacentric height (GM_0) was approximately 4.792 metres which was more than the required minimum of 0.15 metre in the 2008 IS Code. In this loading condition, *the vessel*'s rolling period was about 10 seconds that would not cause much cargo liquefaction as the cargo hold bilge well sounding records were normal. However, when *the vessel* had been subjected to excessive motions under the severe weather on 11 October 2017 and onwards, cargo liquefaction phenomenon might have been developed and speeded up by heavy rolling under the severe weather, facilitating the cargo shifting inside the cargo holds.

Evaluation of cargo liquefaction scenarios

4.16 In the course of accident investigation, DNV GL Emergency Response Service (DNV GL) had performed an evaluation on *the vessel*'s possible cargo liquefaction scenarios[6] based on the departure loading condition, the sequence of events happened to *the vessel* as mentioned in paragraphs 3.17 to 3.22, with consideration that *the vessel* did not suffer from hull damage and water ingress. Two cargo failure scenarios were developed as follows:

(i) The first scenario was full liquefaction with free surface effect. The evaluation revealed that *the vessel* could survive under full free surface effect arising from cargo liquefaction in three cargo holds, and conditionally in four cargo holds, but not in all five cargo holds. As *the vessel* listed and stayed at 45 degrees port side for about 5 minutes under adverse weather, this scenario did not conform to the sequence of events of *the vessel* and was an unlikely contributor in this accident; and

(ii) another scenario was the study of full liquefaction with cargo shifting but without free surface effect. In order words, the cargo stowage collapsed with water remaining between the particles of the cargo, turning the cargo into a dense slurry shifting inside the cargo holds

[5] The IMO Code on Intact Stability for All Types of Ships Covered by IMO Instruments (IS Code) (IMO Resolution MSC.267(85) adopted on 4 December 2008)

[6] The scenario evaluations had not taken into account the environmental factors such as wind and wave effects.

and remaining in the shifted position causing permanent list. In case, when *the vessel* listed to 45 degrees port side with cargo shifting in No.3 cargo hold at 50 degrees port side and in all remaining cargo holds at 45 degrees port side, theoretically a permanent list of 45.2 degrees port side in equilibrium could be achieved allowing *the vessel* to survive in principle on still water. As this evaluation result is close to the sequence of events, further dedicated studies were made based on this scenario.

4.17 The DNV GL's further studies included the progressive development of a permanent list of *the vessel* with the possible cargo shifting sequences in the cargo holds before capsizing, as follows:

(i) When *the vessel* listed to 5 degrees port side, this might be caused by shifting of cargo in No.1 and No.2 cargo holds at 10 degrees port side. In this condition *the vessel* would retain sufficient stability and was manageable.

(ii) When *the vessel* listed to 15 degrees port side, this might be caused by shifting of cargo in No.1 cargo hold at 20 degrees port side and in all remaining cargo holds at 10 degrees port side resulting in 15.2 degrees listing to port side of *the vessel*. In this condition *the vessel* would retain sufficient stability and was still manageable.

(iii) When *the vessel* listed to 18 degrees port side, this might be caused by shifting of cargo in No.1 and No.3 cargo holds at 20 degrees port side and in all remaining cargo holds at 10 degrees port side resulting in 17.2 degrees listing to port side of *the vessel*. In this condition *the vessel* would retain sufficient initial stability and had reduced her stiffness against rolling on larger degrees to port side.

(iv) When *the vessel* listed to 25 degrees port side, this might be caused by shifting of cargo in No.1, No.3 and No.4 cargo holds at 25 degrees port side and No.2 and No.5 cargo holds at 20 degrees port side resulting in 25.1 degrees listing to port side of *the vessel*. In this condition *the vessel* would have sufficient initial static stability and critical dynamic stability but was not possible to roll back towards starboard side or reach upright position again. The stiffness against rolling to port side was further reduced promoting the cargo to shift further. When rolling on high seas and with permanent list of 25 degrees, *the vessel* might not keep appropriate position against the waves which would amplify adverse effect on the stability.

(v) When *the vessel* listed to 45 degrees port side, this might be caused

by shifting of cargo in No.3 cargo hold at 50 degrees port side and in all remaining cargo holds at 45 degrees port side resulting in 45.2 degrees listing to port side of *the vessel*. In this condition *the vessel* would theoretically survive on still water but all air pipes, vents, doors and hatches on main deck port side would be permanently submerged with high probability of flooding. The cargo would be resting against the hatch coamings, and the hatch covers would be applying pressure from inside possibly allowing water to enter the cargo holds. *The vessel* would have very poor capability to withstand the combined effects of beam wind and wave effects towards port side. Under such condition, very little external forces could cause *the vessel* to capsize.

4.18 The above further studies concluded that cargo liquefaction and subsequent shifting were the potential causes of *the vessel* to capsize.

Weather and Voyage Planning

4.19 *The vessel* departed Buli, Indonesia on 9 October 2017 and the weather was fine. However, a TD was developed and in position 17.5°N, 125°E at 1400 hours on 12 October 2017, east of the Philippines moving west at speed of 10 knots. It was upgraded to TS "KHANUN" at around 1700 hours on 12 October 2017 with the maximum wind speed of Beaufort Wind Scale force 8 and moving westward at about 13.5 knots.

4.20 Having plotted the predicted track of the TD and discussed with the chief officer and 2nd officer, the master decided to keep the planned course.

4.21 Pursuant to paragraph 5.33 of the Mariner's Handbook[7] as referred to in the navigation and bridge procedures of *the vessel's* Safety Management System, a ship should keep away roughly from within 80 nms of the storm center under all circumstances. At about 1530 hours on 12 October 2017, *the vessel* was only about 21 nms from the TS storm centre (Figure 4).

4.22 There was no evidence that the master had altered course to avoid approaching the TD/TS of "KHANUN". The master also had not prudently assessed the risk and consequence to *the vessel* and the cargo on board to suitably plan her voyage when approaching the center of the TS.

[7] Mariner's Handbook (8th Edition 2004) is a compendium of essential maritime information on charts; operations and regulations; tides, currents and characteristics of the sea; basic meteorology; navigation in ice, hazards and restrictions to navigation; and the IALA Buoyage system.

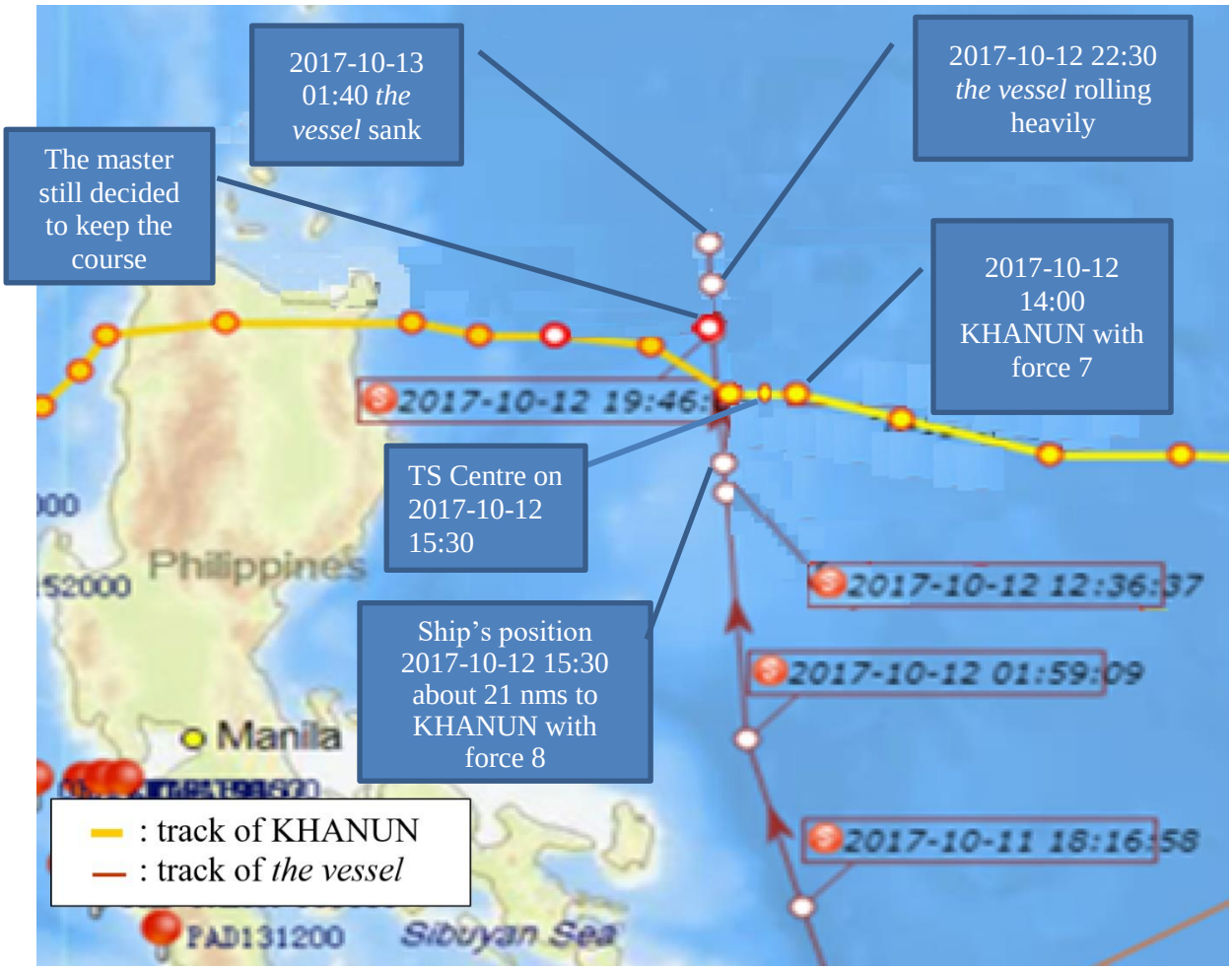


Figure 4 The tracks of *the vessel* and the TD /TS "KHANUN"

Abandon ship

4.23 As the emergency situation occurred in the early morning of 13 October 2017, the master ordered the crew to don the lifejackets at 0100 hours via the public address system. However, the master gave the abandon ship order only at 0120 hours when *the vessel* had already listed to port side 25 degrees in excess of the free-fall lifeboat launching design limit of 20 degrees maximum. Consequently, the free-fall lifeboat could not be launched at this stage and the starboard liferaft though could be launched successfully, no crew member could board the liferaft from *the vessel*.

4.24 In hindsight, if the master realized that liquefaction and shifting of cargo had occurred, and took the decision to abandon ship promptly before reaching the lifeboat design launching limit, the number of the missing crew members might be reduced.

5. Conclusions

5.1 *The vessel* with 55,000 mt nickel ore and 26 crew members on board sank at approximate position 19°03'N, 124°52'E, about 150 nms east of the Luzon Island, the Philippines on 13 October 2017 when she was en route from Indonesia to China and encountered a TS. An intensive SAR operation was initiated after *the vessel* had sent out emergency distress signals. Only 16 of the 26 crew members were rescued. The remaining 10 crew members were still missing when the SAR operation stood down at 1800 hours on 18 October 2017.

5.2 The investigation into the accident revealed that *the vessel* was loaded with nickel ore with moisture content in excess of the TML. As a result, cargo liquefaction and shifting occurred causing *the vessel* heavily listed and capsized eventually when she was near the TS.

5.3 The investigation found the following contributory factors leading to the failure to identify the excessive cargo moisture content: -

(i) the requirements of IMSBC Code for the group A cargo of nickel ore were not strictly followed, e.g. re-certifying for moisture content had not been conducted after significant rain to ensure non-compliant cargo would not be loaded on board; and

(ii) the company's instructions to check, stop and reject cargo were not well followed.

5.4 The investigation also found the following safety issues: -

(i) the intended voyage was not suitably planned according to the navigation and bridge procedures for adverse weather, and underestimated the effect of adverse weather to the cargo; and

(ii) the master underestimated the consequence of the liquefaction effect of the cargo failed to announce abandon ship at early stage.

6. Recommendations

6.1 The management company of *the vessel* should issue a safety circular to inform all masters and officers in the company's fleet regarding the findings of this accident investigation.

6.2 The management company should review and enhance the safety management system for loading bulk cargo which may liquefy, in particular the following aspects, so as to ensure that the masters of their ships will follow strictly:

(i) the requirements of IMSBC Code;

(ii) the requirement of re-certifying the moisture content of the cargo by shipper if there has been significant rain or snow during loading of bulk cargo;

(iii) all relevant shipboard procedures for voyage planning avoiding adverse weather; and

(iv) the emergency plan for immediate action, such as abandon ship etc., when ships encounter serious list.

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

7. Submission

7.1 The draft report was sent to the following parties for comments:

(i) the management company and the chief officer of *the vessel*;

(ii) the Directorate General of Shipping, India (the administrative authority of the seafarers of *the vessel*);

(iii) the Ship Safety Branch of Hong Kong Marine Department;

(iv) NTSC of the Republic of Indonesia; and

(v) DNV GL

7.2 Comments and evaluation of cargo liquefaction scenarios were received from DNV GL. The report was amended as appropriate.