

FINAL REPORT

FATAL INJURY ON BOARD THE BULK AND CONTAINER CARRIER PAC ALKAID AT THE PORT OF HOUSTON ON 20 AUGUST 2017

MIB/MAI/CAS.022

**Transport Safety Investigation Bureau
Ministry of Transport
Singapore**

8 March 2019

The Transport Safety Investigation Bureau

The Transport Safety Investigation Bureau (TSIB) is the air and marine accidents and incidents investigation authority in Singapore. Its mission is to promote aviation and marine safety through the conduct of independent investigations into air and marine accidents and incidents.

TSIB conducts marine safety investigations in accordance with the Casualty Investigation Code under SOLAS Regulation XI-1/6 adopted by the International Maritime Organization (IMO) Resolution MSC 255(84).

The sole objective of TSIB's marine safety investigations is the prevention of marine accidents and incidents. The safety investigations do not seek to apportion blame or liability. Accordingly, TSIB reports should not be used to assign blame or determine liability.

CONTENTS

PAGE

- SYNOPSIS 1
- DETAILS OF THE SHIP 2
- 1 FACTUAL INFORMATION..... 3
- 1.1 Sequence of events 3
- 1.2 The ship 8
- 1.3 The crew 11
- 1.4 The cargo loading and trimming operation..... 12
- 1.5 Working language used between crew 13
- 1.6 Safety Management System 14
- 1.7 SMS procedures on lifting gears 14
- 1.8 SMS procedures on cargo loading operations 16
- 1.9 Pontoon lifting and its accessories 16
- 1.10 The COSWP and lifting appliance requirements 18
- 1.11 Post-accident testing of the lifting hook..... 19
- 1.12 Autopsy report..... 19
- 1.13 Environmental condition..... 20
- 2 ANALYSIS 21
- 2.1 Cargo loading operations 21
- 2.2 Using pontoon to trim cargo pile 22
- 2.3 Failure of lifting hook..... 22
- 2.4 The company’s Safety Management System..... 22
- 3 CONCLUSIONS..... 24
- 4 SAFETY ACTIONS..... 25
- 5 SAFETY RECOMMENDATIONS 26

SYNOPSIS

On 20 August 2017, at about 0018H, the Singapore registered bulk and container carrier, Pac Alkaid, had completed grain cargo loading at the Cargill Grain Elevator Pier, Houston, United States.

At about 0100H, a team comprising the Bosun, an Ordinary Seaman and an Able Seafarer Deck, was tasked to close the tween deck pontoon for the last cargo hold no.5. While shifting pontoon into the no.5 cargo hold from the storage location, the team noticed piled cargo in the hold. In order to level or trim the cargo down to facilitate closing of the pontoon, the Bosun and the Ordinary Seaman, decided to use the pontoon to drag over the grain cargo.

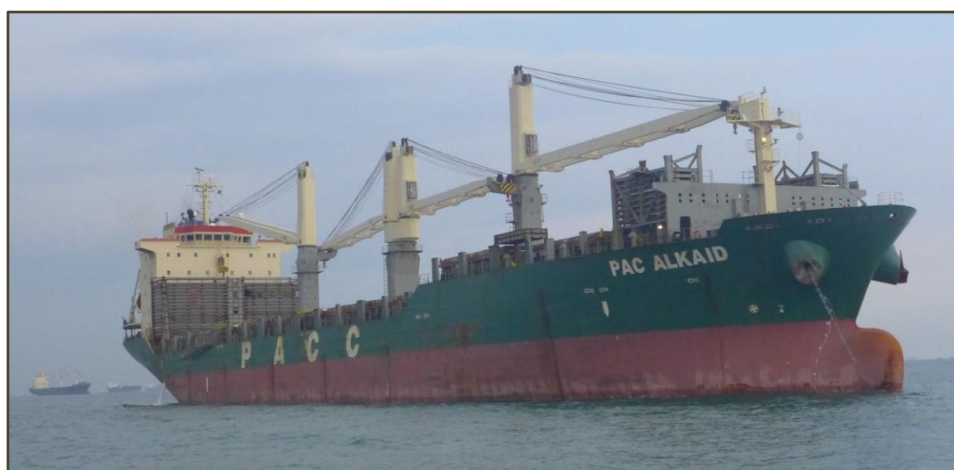
To do so, two of the four lifting wire slings were removed. While dragging the pontoon over the piled cargo with two remaining lifting wire slings secured to the pontoons with hooks, one of the hooks broke off and the other slipped out of the pontoon. The lifting wire slings swung uncontrollably and hit another Able Seafarer Deck, who was shoveling the fallen cargo at the middle of the hatch coaming centre beam, resulting in him receiving fatal injuries, as he was thrown into the cargo hold.

The TSIB classified the occurrence as a Very Serious Marine Casualty and launched a marine safety investigation.

The investigation revealed that the reference for loading limits were not clearly marked in no.5 cargo hold and the final cargo loading of the same cargo hold was not being monitored by ship's crew to prevent piling of cargo. The company had no specific procedures for cargo trimming operations. There was inadequate supervision of the crew who on their own accord used the pontoon to trim the cargo. There were no safety measures in place to prevent injury due to fall from height from the hatch coaming centre beam, safe working load of the lifting hooks was not recorded on board and the established working language was not effectively implemented.

DETAILS OF THE SHIP

Name	Pac Alkaid
IMO number	9265914
Flag	Singapore
Classification society	American Bureau of Shipping (ABS)
Ship type	Bulk and container carrier ¹
Hull	Steel
Year of built	23 October 2003
Owners	Alkaid Maritime Pte. Limited
Operators / ISM ² Managers	PACC Ship Mangers Pte Ltd
Charterers	PACC Container Line Pte Ltd
Gross tonnage	20,471
Length overall	178.80m
Moulded breadth	27.20m
Moulded depth	14.20m
Summer draft	10.427m
Cargo onboard	Grain ³



Pac Alkaid

¹ Ship description shown on the Certificate of Classification, which was issued by the Classification Society, America Bureau of Shipping, on 18 December 2016. A multi-purpose carrier, certified to carry container and dry bulk cargoes.

² International Management Code for the Safe Operation of Ships and for Pollution Prevention.

³ Voyage order indicated as bulk hard red winter wheat.

1 FACTUAL INFORMATION

All times used in this report are one of United States local time, five hours behind of the UTC (UTC – 5H), unless otherwise stated.

1.1 Sequence of events

1.1.1 On 11 August 2017, at about 2100H, the Singapore registered bulk and container carrier, Pac Alkaid (Alkaid) arrived and anchored at Houston Fairway anchorage, United States (USA).

1.1.2 While at anchorage and subsequently at the lay berth⁴ on 12-18 August 2017, the Alkaid crew went through the cleaning process in preparing the cargo holds for pre-loading inspections conducted by USDA⁵ and NCB⁶. The no.2, 3, 4 and 5 holds were planned for grain cargo loading at the Houston port.

1.1.3 On 18 August 2017, at about 2048H, Alkaid shifted from the lay berth to a cargo loading berth at Cargill Grain Elevator Pier, Houston, USA. She was tied at its starboard side to the wharf and at about 2155H, cargo loading commenced at no.2 and no.4 holds by using two grain loader chutes⁷(see **Figure 1**).

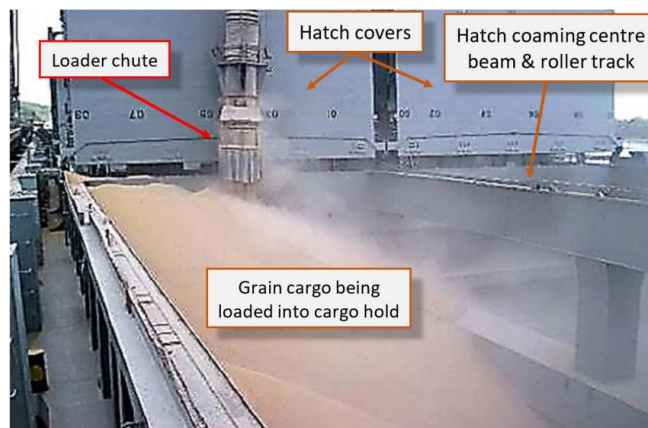


Figure 1 – Example of cargo loading by loader chute on another ship
(Photo source: The ISM Manager)

⁴ A lay berth, named City Dock #45, used for ships to carry out inspection by USDA and NCB at that time for the readiness to receive grain cargo.

⁵ USDA - The United States Department of Agriculture. It's a requirement for ship carrying grain cargo for export to be inspected by the authority prior to loading. The inspection is for holds cleanliness and cargo holds and hatch covers are clean and dry with no residue of previous cargo and no rust scale or paint flaking.

⁶ NCB - National Cargo Bureau, the second set of eyes mandated to inspect vessel for cleanliness, but focus is directed to construction of vessel to determine suitability to carry grain cargo in order to minimise the effect of grain shift.

⁷ An equipment used for grain cargo loading. As the loader chute moves around between the port and starboard side of the cargo hold to achieve loading evenly, grain cargo often falls on the hatch coaming centre beam. This may cause problem of closing hatch covers by roller track.

- 1.1.4 On 19 August 2017, at about 2140H, the loading of no.4 cargo hold was completed. About 15 minutes later, the no.2 cargo hold was also completed loading. Both no.4 and no.2 holds were not loaded completely full as pre-planned. The loading of no.3 and no.5 cargo holds continued.
- 1.1.5 At about 2230H, the Bosun⁸ was called on deck to close the tween deck pontoons for the no.2 cargo hold.
- 1.1.6 At about 2300H, the loading of no.3 cargo hold was near to completion, the final loading was supervised by the Chief Officer. The 12-4⁹ Able Seafarer Deck (12-4 ASD) and 12-4 Deck Cadet (12-4 DC) were also called on deck to assist the duty crew to clean grain cargo which had fallen on hatch coamings¹⁰. At about 2315H, the loading of no.3 hold was completed.
- 1.1.7 By about this time, the 12-4 ASD and the 12-4 DC came on deck with their own portable radios (walkie-talkies) and were instructed by the Third Officer to first clean the no.3 hatch coaming centre beam. The Ordinary Seaman (OS)¹¹ and the 8-12¹² Able Seafarer Deck (8-12 ASD), on duty carrying their own portable radios, were called to assist the Bosun to close the no.2 cargo hold tween deck pontoons. The Master and the Second Officer of Alkaid were also on deck for the draft survey¹³.
- 1.1.8 Before midnight, cargo loading at no.5 hold was near to completion and final loading for balance cargo commenced. No one was supervising this final loading. The Master and the Second Officer went to the wharf for draft survey. As per the Master's instructions, the Master himself was to check the ship's midship draft on the wharf side. The Second Officer was to check the aft draft. The Third Officer was assigned to forecastle deck to check forward draft by looking down from the ship's bow. The Chief Officer was to check midship draft at the port side (sea side).
- 1.1.9 On 20 August 2017, at about 0018H, the loading of last cargo hold (no.5) was completed. A while later, the Operator's local agent boarded Alkaid for departure port formalities.

⁸ The Bosun was a dayworker with working hours from 0800H to 1700H.

⁹ Both port and sea watch for the period of 0001H to 0400H and 1200H to 1600H.

¹⁰ The hatch coaming cleaning included three sides, i.e. the port and starboard sides and the centre beam area.

¹¹ Kept port watch for the period of 0800H to 1200H and 2000H to 2359H. A dayworker when ship was at sea.

¹² Both port and sea watch for the period of 0800H to 1200H and 2000H to 2359H.

¹³ A draft survey is performed by reading the ship's draft on the draft markings at six standard points on the hull, i.e. forward, midship and aft on both port and starboard sides. This is to determine the ship's loading condition.

- 1.1.10 At about 0020H, the 4-8 Able Seafarer Deck (4-8 ASD)¹⁴ and the Deck Cadet (4-8 DC) were also called as additional deck hands to assist with the cleaning of cargo.
- 1.1.11 At about 0040H, the final draft survey was completed, the Master and the Second Officer returned from the wharf. The Third Officer, who handed over his cargo watch to the Second Officer, was assisting the Master to prepare the departure documents. The Chief Officer went back to the ship's cargo office located beside the ship's office in accommodation to calculate the cargo quantity loaded onboard.
- 1.1.12 The shore fumigation officers soon boarded Alkaid to explain to the Chief Officer on the fumigation requirements and procedures. The Master was with the Operator's local agent discussing departure matters at the ship office. The Second Officer who was on deck, was instructed by the Chief Officer to take photos of cargo loaded in the cargo holds before closing of the hatch covers.
- 1.1.13 After closing the no.2 cargo hold tween deck pontoons, the Bosun, OS and 8-12 ASD proceeded to close no.5 tween deck pontoons. The 8-12 ASD was assigned to secure the lifting hooks onto the pontoon as well as to put the wire slings onto the no.3 crane Rams horn hook¹⁵ (see **Figure 2**). The Bosun was operating the crane and was being assisted by the OS who was inside no.5 cargo hold acting as the signalman and communicating with the Bosun using portable radio. The 8-12 ASD remained at the pontoon storage rack to prepare the next pontoon to be shifted and was not directly involved in the closing of the pontoon.

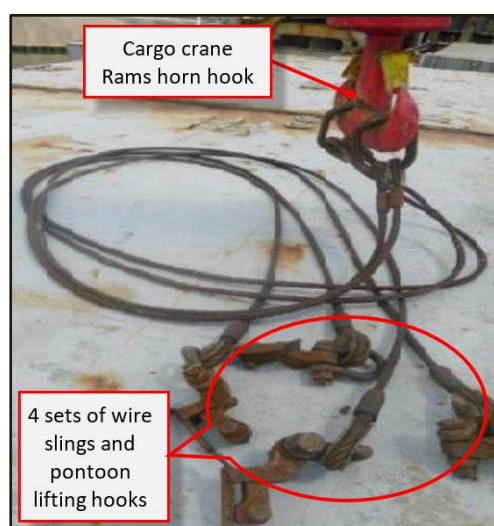


Figure 2 – View of the lifting hook (*Photo source: The ISM Manager*)

¹⁴ Both 4-8 ASD and 4-8 DC, kept watches in port and at sea for the period of 0400H to 0800H and 1600H to 2000H.

¹⁵ The crane had a Ramshorn hook – a kind of double hook shaped like the horns of a Ram.

- 1.1.14 The 4-8 ASD, the 4-8 DC, the 12-4 ASD and the 12-4 DC came to no.5 cargo hold to assist with the cleaning of cargo (grains). The 4-8 watch ASD and DC used an air hose to blow cargo while standing at the forward of the no. 5 cargo hold hatch coaming centre beam. The 12-4 watch ASD and DC were next to each other at the middle of the same beam (see **Figure 3**) and were using shovels for cleaning. According to both DCs and 4-8 ASD, they were aware of the pontoon shifting from the storage rack to no.5 cargo hold.

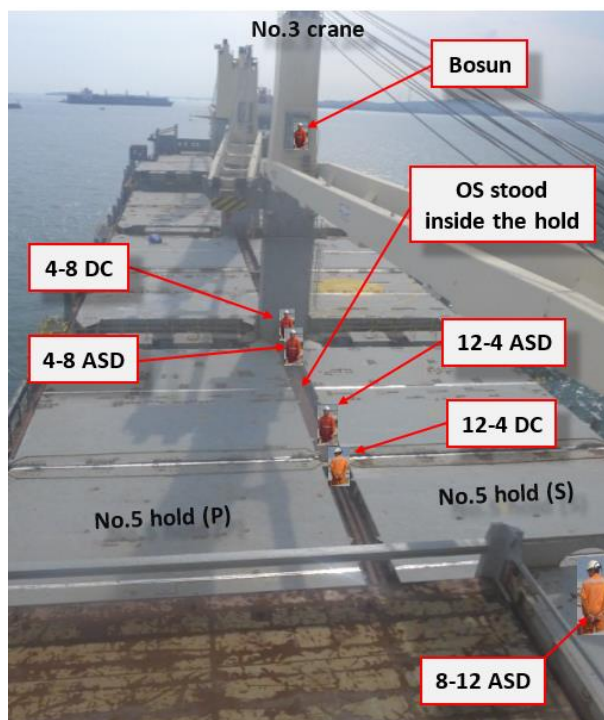


Figure 3 – Positions of persons at the time of accident, no.5 cargo hold hatch covers were in open status at the time (Not to scale - for illustration only)

- 1.1.15 According to the OS, after the first pontoon¹⁶ was lifted from the storage rack into the port side compartment of no.5 cargo hold, he noticed that the pontoon had tilted due to pile of heaped grain inside the hold and the pontoon would not close. The OS informed the Bosun in Mandarin over the portable radio and advised him to drag the pontoon over the grain (with the aim of levelling the grain). The Bosun did so but there was no change in the grain levelling and the pontoon remained tilted despite dragging it for about 5m. The OS then asked Bosun whether they should use the “same method”¹⁷ which both of them had been privy to. After a brief radio silence, at the signal of the OS, the Bosun lowered the crane wire to facilitate

¹⁶ The type-A pontoon was lifted to place at the upper tween deck level in the no.5 hold.

¹⁷ This method was used during the previous voyage by dragging the pontoon (hooked with only two lifting wire slings) over the heaped cargo of Ferro Silicon to trim it on 16 June 2017. According to the Bosun and the OS, the same Chief Officer supervised that trimming operation. There was no evidence that the trimming with pontoon was recorded in the logbook or reported to the company.

removal of two lifting hooks by the OS. At this time the 8-12 ASD remained near the pontoon storage rack.

- 1.1.16 Once the lifting wire slings were slackened, the OS removed the two fore end lifting hooks, leaving only two aft lifting hooks secured onto the pontoon (see **Figure 4**). He then positioned himself on the upper tween deck centre beam. This activity was not known to the two Filipino crew members (12-4 ASD and 12-4 DC) who were at the hatch coaming centre beam (above the position of the OS) carrying out their task of cleaning the cargo with shovels.

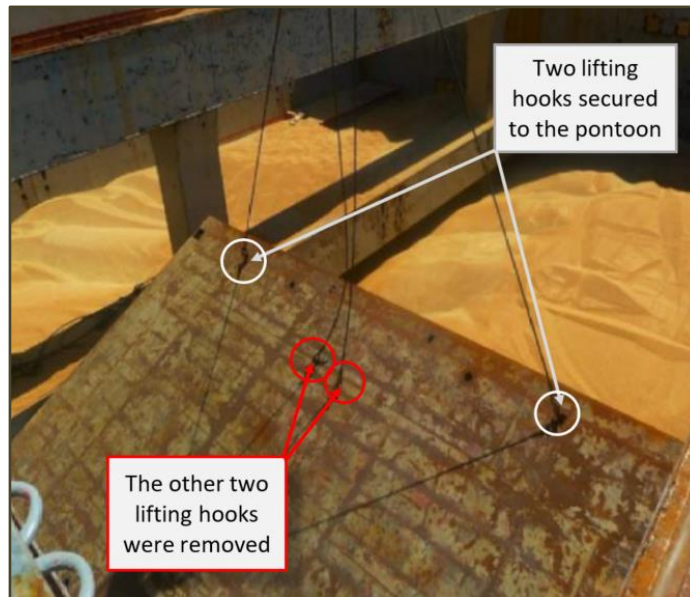


Figure 4 – View of the lifting hooks arrangement at the time of accident
(Photo source: The ISM Manager)

- 1.1.17 The Bosun lowered down the jib of the crane slowly and simultaneously slewed it towards the starboard side in order to drag the pontoon with two lifting wire slings.
- 1.1.18 At about 0100H, while the pontoon was being dragged between the ship's side bulkhead and centre beam structure for about 2m, one of the hooks broke while the other slipped out of its securing slot. The pontoon dropped on the grain cargo with a loud noise and the detached slings swung uncontrollably towards the 12-4 ASD who was shovelling at the time on the centre beam. The ASD instinctively grabbed hold of the swinging wires to avoid hitting him and followed the swinging motion. He was swung and thrown towards the starboard side bulkhead at the aft corner.
- 1.1.19 Noting the pontoon drop, the OS instinctively moved behind the centre beam. The 4-8 ASD shouted and raised the attention of the other crew in the vicinity. This shout caught the attention of the Second Officer, who was on deck taking photos of no.3 cargo hold. He then ran towards the no.5

cargo hold. The Second Officer saw the 12-4 ASD lying on the cargo next to the fuel tank structure and reported to the Master using his portable radio in Tagalog. The Master immediately requested the local agent to call for an ambulance. Meanwhile, the crew started to prepare for 12-4 ASD's evacuation from the hold.

- 1.1.20 The shore paramedics arrived in about half an hour and after examining the injured, declared him dead. Subsequently, the body of the 12-4 ASD was removed from the ship for further forensic examination.

1.2 The ship

- 1.2.1 Alkaid was a multi-purpose carrier, built with five cargo holds for the carriage of a wide range of cargoes, such as containers, ferro silicon, plywood, steel coils, grain, corn and soya beans etc. She was deployed on a tramping service.

- 1.2.2 Three cranes were installed on Alkaid along its centre line. At the time of the accident, the third crane was being used. It was fitted at the cross deck between no.4 and no.5 cargo hold, facilitating cargo operations for the two adjacent cargo holds and had a safe working load (SWL) of 40 tonnes. All three cargo cranes were capable of loading and discharging containers on deck and in cargo holds as well as in packaged type of cargo loaded in the holds (see **Figure 5**).

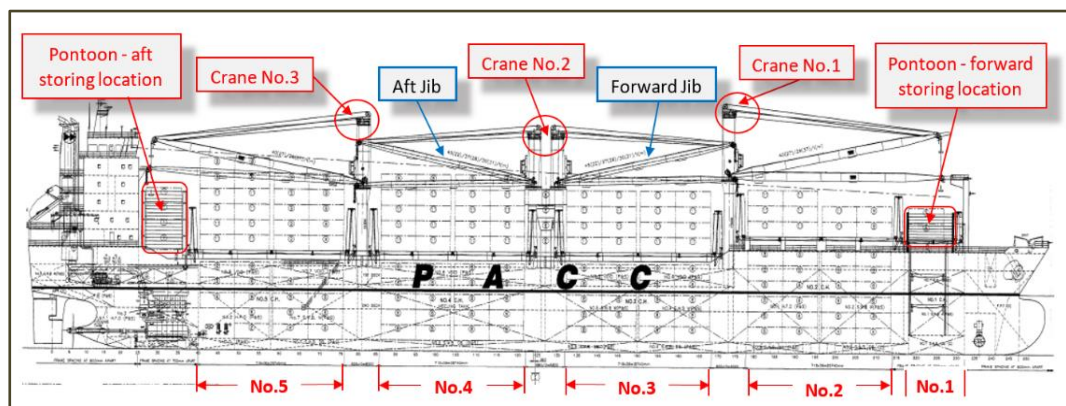


Figure 5 – General arrangement plan of ALKAID annotated by TSIB
(Source: the ISM Manager)

- 1.2.3 All cargo holds were fitted with hatch covers which rested on hatch coamings. There were four types of tween deck pontoons used inside the cargo holds, i.e. A, B, C and D-type (see **Figure 6**).

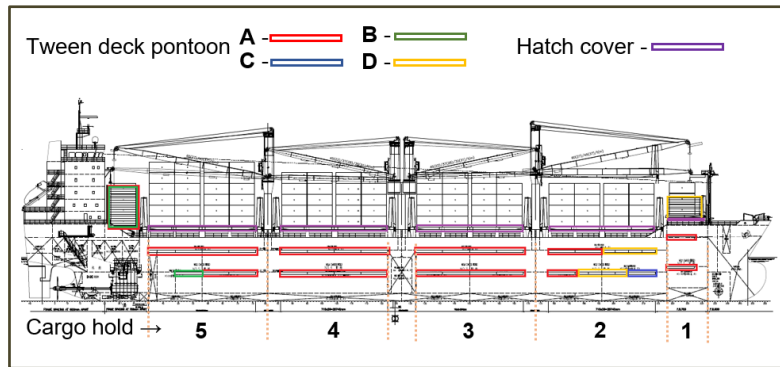


Figure 6 – Arrangement of hatch cover and pontoons annotated by TSIB
(Source: the ISM Manager)

1.2.4 All five cargo holds could be separated into three levels, by placing pontoons at upper and lower tween deck to carry different types of cargo (see **Figure 7**).

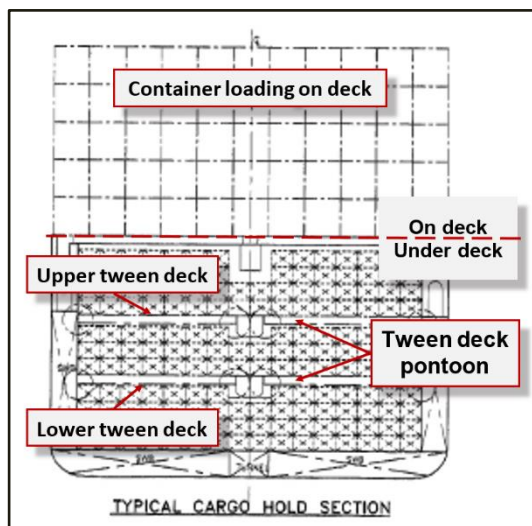


Figure 7 – Typical cargo hold section front view annotated by TSIB
(Source: the ISM Manager)

1.2.5 There were 14¹⁸ numbers of A-type and B-type tween deck pontoons used in no.5 cargo hold. At the time of the accident, the pontoon in use was the A-type, with dimensions 10.81m in width and 6.36m length. The cargo hold was separated into port and starboard compartments, each having the same width of 10.89m (see **Figure 8**). The pontoon had a clearance of about 8cm in each compartment. At the time of the accident, the pontoon to be closed was at the upper tween deck level in the port side compartment of no.5 cargo hold.

¹⁸ Inclusive of 8 pcs A-type pontoon at upper tween deck level, 4 pcs A-type and 2 pcs B-type pontoon at lower tween deck level. All pontoons had the same thickness of 0.55m. The A-type pontoon had a weight of about 14.2 metric tonnes.

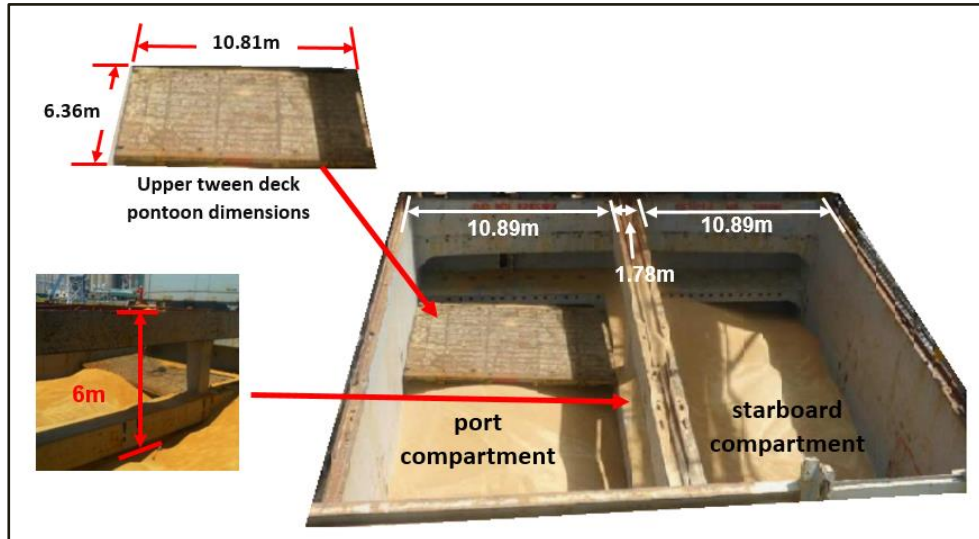


Figure 8 – Upper tween deck pontoon and no.5 cargo hold dimensions
(Photo source: the ISM Manager)

- 1.2.6 The width of the hatch coaming centre beam where the crew stood for cleaning the cargo was about 1.78m. The beam was not designed to have a fixed safety fencing. There was no temporary fencing as safety railing to prevent a fall into the cargo hold when the accident happened. The height between the cargo level and the hatch coaming centre beam was about 6m.
- 1.2.7 Alkaid was loaded with a total of 25,273 metric tonnes of grain cargo separated into four cargo holds (no.2, 3, 4 and 5) and 2,764 metric tonnes were distributed into the no.5 cargo hold which was planned as the last loading hold. On completion of loading in no.5 cargo hold, most of the cargo was levelled except for two piles at the forward end of both port and starboard compartments (see **Figure 9**).

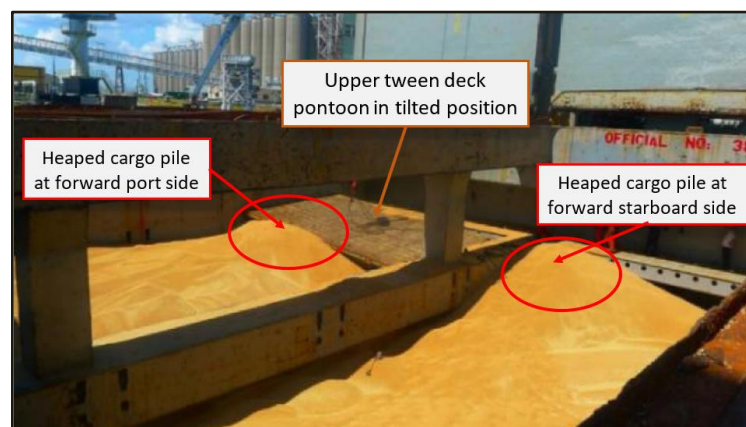


Figure 9 – View of heaped cargo piles loaded in no.5 cargo hold
(Photo source: The ISM Manager)

1.3 The crew

1.3.1 At the time of accident, 21 multi-national crew were on board and employed by the ship Operator. All crew held valid STCW¹⁹ competency certificates required for their respective positions held onboard.

1.3.2 The qualification and experience of the Master, relevant officers and crew members are listed in Table 1.

Designation onboard	Nationality	Age	Qualification	Duration onboard (month)	Experience on this type of ship (month)	Grain loading experience (time)	In rank (month)	Years in company
Master	Filipino	57	COC – Master (Philippines)	5	12	4	28	14
Chief Officer	Myanmar	35	COC – Class 1 (Myanmar)	2.5	9.5	9	9.9	1.2
Second Officer	Filipino	56	COC – Master (Philippines)	7.5	32.5	9	151	17.4
Third Officer	Filipino	22	COC – Third Officer (Philippines)	7.5	20.5 ²⁰	4	2.8 ²¹	2.5
12-4 DC	Filipino	21	Able Seafarer Deck Rating as per STCW	7.5	7.5	2	7.7	0.6
4-8 DC	Chinese	23		8	8	2	8.6	0.7
Bosun	Chinese	47		8	105	22	186	21
12-4 ASD	Filipino	38		2.5	11.5	Unknown	30	3.9
4-8 ASD	Chinese	37		8	69	16	100	11.2
8-12 ASD	Chinese	40		8	76	27	158	18.9
OS	Chinese	24		8	8	2	8.6	0.7

Table 1 – Qualification and experience matrix

1.3.3 The Bosun, joined the company as an ASD and was promoted to Bosun in 2002. He was able to communicate in English with all officers and crew on board.

1.3.4 The deceased 12-4 ASD, joined the company as an ASD in 2013. His past employment and experience before this company was not provided to the investigation team. The pre-joining ship medical check-up in May 2017

¹⁹ The International Convention on Standards of Training, Certification and Watch keeping for Seafarers (or STCW), 1978 sets qualification standards for masters, officers and watch personnel on seagoing merchant ships.

²⁰ Including 13 months served as deck cadet.

²¹ Not including 4.8 months as a Fourth Officer on board.

indicated that he was fit for the duty on board. At the time of accident, he kept on 12-4 watch in port and navigational watch at sea.

- 1.3.5 The OS, joined Alkaid as his first ship in the company in December 2016. Prior to that, he worked as a deck cadet on a bulk carrier in a Chinese shipping company. He could only speak and understand simple English. He spoke mainly Mandarin to Chinese crew to learn more about the cargo operation and to understand non-Chinese officers and crew who spoke in English. He kept on 8-12 watch in port with 8-12 ASD.
- 1.3.6 All officers and crew met the STCW and MLC Convention's requirements²² concerning hours of work and rest according to Alkaid's log records.

1.4 The cargo loading and trimming operation

- 1.4.1 After Alkaid arrived at berth, the Chief Officer discussed the loading plan with the terminal representative and the final plan was approved by the Master. The sequence of loading was agreed to be no.2 and no.4 cargo holds first, followed by no.3 and no.5 cargo holds. The agreed loading rate was 2400 metric tonnes per hour, using two crane loader chutes each capable of loading at a maximum of 1350 metric tonnes per hour.
- 1.4.2 The Chief Officer prepared his cargo loading written instructions for the port on 18 August 2017. The instructions stated that no.3 and no.4 cargo holds were not to be loaded beyond the red marked line. No.2 and no.5 cargo holds, though not marked with a red line, were not to be loaded beyond the forward/aft edge and centre beam, and above the rectangular box mark on the ship side²³(see **Figure 10**), i.e. reference for loading limit. This was to ensure proper closing of the tween deck pontoons on completion. Cargo holds no.2 and no.5 were also the last holds to be loaded with 500 metric tonnes as trimming pours²⁴. The instructions were acknowledged and signed by the Second Officer and the Third Officer.

²² STCW - the International Convention on Standards of Training, Certification and Watch keeping for Seafarers, 1978 and its amendments set qualification standards for masters, officers and watch personnel on seagoing merchant ships. MLC - the Maritime Labour Convention, 2006.

²³ These reference points were commonly understood by the ship's crew.

²⁴ Final quantity of cargo kept in reserve to load partly into a forward and partly into an aft position as necessary to bring the ship's mean draught and trim to the desired values.

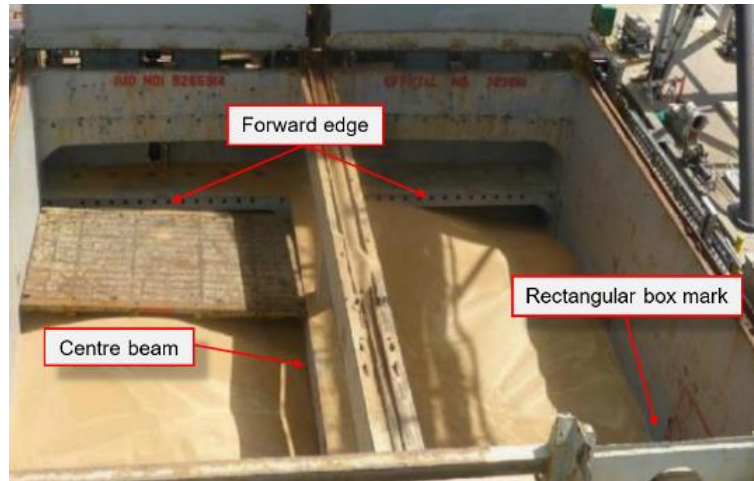


Figure 10 - Loading reference point for no.5 cargo hold in the Chief Officer's cargo loading written instructions
(Photo source: the ISM Manager)

1.4.3 The cargo loading instructions further required the officer of the watch to personally show the shore personnel the reference for loading limit. However, this was not carried out. There was no evidence to indicate that the ship's officers were not able to communicate with the shore personnel during the loading process. In the event trimming of cargo was needed, the Chief Officer would advise the shore personnel accordingly. The instructions also required the duty officers to inform the Chief Officer if they were in doubt or if the loading plan was altered.

1.4.4 According to the officers and crew of Alkaid, the trimming of piled up cargo was typically done by shovelling. However, trimming of piled cargo would require more labour intensive efforts²⁵ and could take up to a few hours depending on the amount of cargo to be trimmed.

1.5 Working language used between crew

1.5.1 Crew of four different nationalities were employed on board Alkaid, majority were Filipino and Chinese whose native languages²⁶ were not English.

1.5.2 The company's Safety Management System (SMS), section 6.6 - Working Language stipulated that English was the working language on its fleet including Alkaid, and required the company's crewing department to ensure all seafarers employed on its fleet to have a working knowledge of English. Seafarers having duties that required interaction with external parties such as surveyors, visiting third party inspectors and specialised sub-contractors were also required to be fluent in English. The records of pre-joining checks

²⁵ According to the Chief Officer, he has had prior experience of using a bulldozer to level down a cargo of coal.

²⁶ Tagalog for Filipino and Mandarin for Chinese.

for the Chinese crew prior to their engagement on Alkaid could not be provided²⁷ to the investigation team.

1.5.3 According to the Chief Officer (a Myanmar national) he could not understand either Mandarin or Tagalog. He only realised that an accident had occurred after overhearing some conversation in a native language on his portable radio.

1.5.4 According to the OS, he had difficulty in communicating with other nationality crew. Sometimes, certain detailed work required a translation by the Bosun for him to understand correctly and most of the time, he was assigned to work with the Bosun or other Chinese crew.

1.6 Safety Management System

1.6.1 The company managed a fleet of ships that comprised of dry bulk carriers, product tankers, chemical tankers, container feeder vessels and multi-purpose carriers.

1.6.2 The Document of Compliance certificate was issued to the company by the Classification Society ABS on 11 October 2016. The first annual verification was conducted on 27 September 2017 and valid until 10 December 2021.

1.6.3 The Safety Management Certificate was issued to Alkaid by ABS on 16 November 2016 and valid until 5 March 2019. The certificate was based on the completion date of the audit on 10 February 2014. The last ISM intermediate audit was conducted on 25 January 2017.

1.6.4 The company carried out an ISM internal audit on Alkaid between 5 June 2017 and 9 June 2017. The audit revealed eight non-conformities, one of which relating to incorrect enclosed space entry procedures as required by the SMS.

1.6.5 There was no deficiency reported at the last Port State Control inspection on 23 May 2017. The Flag State inspection was done on 6 June 2017 with one minor deficiency raised and corrected at the time.

1.7 SMS procedures on lifting gears

1.7.1 The company's SMS stated that when preparing for a cargo crane, a Checklist S-10 (crane operation) was to be used and risk assessments

²⁷ The crewing department did not keep records of the pre-joining checks of the Bosun and the OS who were provided by the manning agency in China. The manning agency had closed down in July 2017 prior to the accident.

(using a Q-14 form) were to be done for lifting operations or shifting of pontoon²⁸.

- 1.7.2 Two risk assessments (RA) done using the Q-14 form, prior to the accident were relating to lifting operations and shifting of pontoon. The former was documented as meant for personnel involved in the work and signed by Chief Officer. The latter was documented as meant for Duty Officers, deck crew and cadets and signed by the Chief Officer. The RA for lifting operations identified some hazards such as personnel injury²⁹ and inadequate knowledge of operation³⁰. Similarly, the RA for shifting of pontoon identified some hazards such as falling of pontoon³¹ and injury³² by lifting sling/hook.
- 1.7.3 The SMS further stated that if the cargo crane was used for any unusual lifts, a RA was to be conducted. There was no RA for that day when two lifting wire slings were used.
- 1.7.4 The SMS also stated that the SWL of the lifting equipment was not to be exceeded. Lifting gears were not to be used to lift anything except for what they were designed for or specially adapted and equipped for that purpose. Loads should, if possible, not be lifted over a person or any access way, and personnel should avoid passing under a load which is being lifted. The ship's cargo gear/hoisting equipment maintenance record indicated that all sheaves and wires of no.3 cargo crane were inspected on 18 August 2017.
- 1.7.5 The SMS further stated that, an inspection of the lifting gears should be carried out to ascertain the satisfactory condition of the lifting appliances and all loose gears intended to be used for lifting operations prior to such a use. There was no record to state whether these lifting gears had been inspected before the commencement of cargo operations at this port.
- 1.7.6 Additionally, all accessories of lifting gears such as wire slings, shackles and other gears for lifting were required to be inspected at monthly intervals and the inspection results of such checks was to be recorded. The ship's cargo gear/hoisting equipment maintenance record had an entry of satisfactory visual inspection for the forward and aft pontoon slings including shackles,

²⁸ Ensure four wire slings are hooked up and unhooked together.

²⁹ As a result of parting of lifting appliance, slipping, falling of object. Control measures included thorough inspection of lifting appliances before use and supervision of task by Chief Officer or Duty Officer.

³⁰ Control measures included a pre-job meeting to recognise the risks involved by all involved including the use of the company's Stop Work Authority procedure when any unsafe operations were observed.

³¹ Control measures included to check the sling and hook prior use and experienced persons to be involved. Duty Officer was to supervise the operation.

³² Control measures included checking slings and hooks prior to operation and not to stand under the lift.

locking pin and attachment in June and August 2017. There was no record of such inspection for July 2017.

1.8 SMS procedures on cargo loading operations

1.8.1 The SMS procedures stated that the officer of the watch's primary cargo loading duties, among others, included ensuring the sequence and rate of cargo loading to be followed as per plan. Other general responsibilities included maintaining constant communication with the terminal for cargo loading, ensuring that the cargo was evenly loaded into the hold spaces, to achieve the best stow and to ensure excess spillage was not accumulating on deck or being a threat to safety of persons on deck.

1.8.2 The SMS also required at least four persons for the shifting of pontoon. The officer of the watch was to supervise and be the signalman to give visual signals and/or instructions by radio. The crane operator was to be a trained³³ person. An ASD was required to be assigned to hook up and lock or unlock the pontoon. The fourth person was to assist as required. The officer of the watch was assigned to take photos of cargo holds while the shifting of pontoons was performed in no.5 cargo hold.

1.8.3 According to the company's SMS procedures, on completion of cargo loading, draft survey was required to be done for calculating the quantity of cargo loaded. During this time, many activities such as closing of tween deck pontoon, cleaning of fallen cargo from all hatch coamings to facilitate proper closure of hatch covers, and securing of cargo cranes were to be done. Specific safety precautions for cleaning fallen cargo while standing on the hatch coaming centre beam, were not mentioned in the SMS.

1.8.4 The SMS did not explicitly provide guidance on how the cargo trimming was to be carried out in the event cargo was loaded unevenly or piled up. The crew used their past experience and knowledge to trim the cargo, such as using a shovel.

1.9 Pontoon lifting and its accessories

1.9.1 The pontoon was typically lifted with four sets of wire slings with lifting hooks which were connected to the Rams horn hook of the cargo crane (see **Figure 11a**), in this case the no. 3 cargo crane. The lifting hooks were slotted into the tween deck pontoon (see **Figure 11b**).

³³ Though the number of hours of training was not specified in the company's SMS, hands-on training and experience at sea was deemed to be sufficient to fulfil this criterion. There are no specific training requirements for Crane operators on Singapore registered ships. However, a seafarer issued with a certificated under STCW A II/5 is deemed to possess the necessary knowledge and competence required to contribute for the safe operation of deck equipment and machinery.

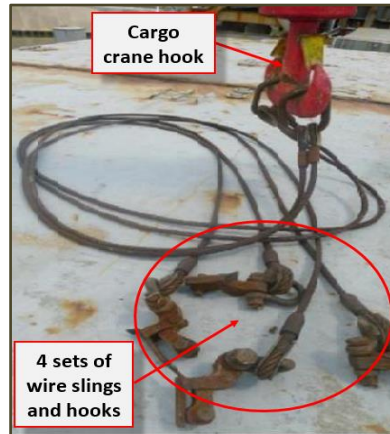


Figure 11a - Four wire slings and hooks secured on the cargo crane hook



Figure 11b – Sequence of locking the lifting hook to the pontoon
(Photo source: the ISM Manager)

- 1.9.2 An annual thorough examination on all three cargo cranes was required and this was conducted by a competent person, and a certificate³⁴ was issued accordingly on 12 June 2017. There was no record of annual inspection to indicate that the pontoon lifting slings and hooks had been inspected by a competent person.
- 1.9.3 The four sets of wire slings were certified by its manufacturer for a SWL of 12 tonnes and a Proof Load of 24 tonnes³⁵. Although the breaking load of the wire sling was not available, anecdotal evidence and approximate calculations³⁶ indicated that this would be about 60 tonnes.

³⁴ As the examination and inspection of lifting appliances are not regulated by the International Maritime Organisation (IMO) or the Flag Administration, the examination certificates indicated the compliance with the rules, guidelines, standards or other criteria stipulated by ABS. The competent person conducted the examination and inspection was the attending surveyor of ABS, who met the International Labour Organization (ILO) requirements.

³⁵ Out of the four wire slings, two sets were tested on 24 September 2010 and another two sets were tested on 6 November 2012. All four wire slings were put to operation after the two testing dates.

³⁶ The SWL of a wire sling is to be determined by dividing the load at which the sample broke, by a coefficient of utilisation. If the SWL of the sling is between 10 tonnes and 160 tonnes, the coefficient is calculated using the formula $\frac{10^4}{(8.85 \times SWL) + 1910}$. This translates to a Coefficient of 4.96. Source: International Labour Organisation's (ILO) Form No.4 – Certificate of test and thorough examination of wire rope.

1.9.4 The ISM Manager could not provide any test certificates or records to indicate the SWL or Proof Load of the pontoon lifting hooks, which had been in use for a few years prior to the occurrence.

1.10 The COSWP³⁷ and lifting appliance requirements

1.10.1 Chapter 19 (Lifting plant and operations) of the COSWP, provides guidelines on general requirements for lifting equipment on merchant ships. It requires that a valid certificate of testing and thorough examination by a competent person should be in force for every item of lifting equipment, accessory for lifting and loose gear. All items should be tested, and then thoroughly examined and certificated for use.

1.10.2 Ships are required to maintain a register of lifting appliances and loose gear used for cargo handling.

1.10.3 COSWP further highlights that accessories for lifting and loose gear, should be thoroughly examined by a competent person within 12 months immediately before using it. The four pontoon lifting hooks used on board Alkaid had no records of such examination being carried out in the last 12 months.

1.10.4 Guidelines on lifting operations mention:

- Every lifting operation must be subject to risk assessment, properly planned, appropriately supervised and carried out to protect the safety of workers.
- The use of lifting appliances to drag heavy loads with the fall at an angle to the vertical is inadvisable because of the friction and other factors involved, and should only take place in exceptional circumstances where the angle is small, there is ample margin between the loads handled and the SWL of the appliances, and particular care is taken.

1.10.5 Though not mandatory by the IMO and the Flag Administration, the Alkaid maintained a register (refer to Paragraph 1.10.2) on board that contained records of the tests, examinations, inspections and certificates indicating the SWL of loose gears. This register did not include records of annual

³⁷ Code of Safe Working Practices for Merchant Seafarers (COSWP) is not a mandatory publication for carriage on Singapore registered ships. The Maritime and Port Authority of Singapore (flag Administration) had issued a circular No.25 of 2017 – Carriage Onboard of Safe Working Practices Publications, indicating that, “...For SOLAS convention ships (>500 GT), if the SMS makes reference to relevant safe working practices code/guidelines, a copy of these code/guidelines should be made available on board.” The SMS of Alkaid made reference to the COSWP and a copy of it was on board. The COSWP is published by the UK Maritime and Coastguard Agency (MCA) provides best practice and guidance for improving health and safety on board ships.

inspection of the pontoon lifting hooks and details of certificates issued by manufacturers.

1.11 Post-accident testing of the lifting hook

1.11.1 One of the pontoon lifting hooks, which was in use at the time of the accident, was sent for a testing by an independent test facility to assess its overall condition.

1.11.2 The test result revealed that the lifting hook broke at a load of 353.0kN which was equivalent to about 36 tonnes³⁸ (see **Figure 12**). Visually there appeared no other signs of material fatigue.

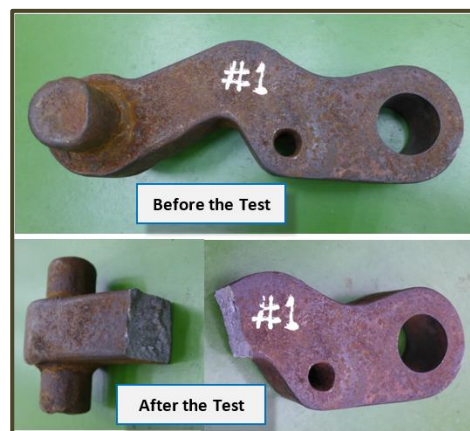


Figure 12 – The pontoon lifting hook (before and after the lab test)

1.12 Autopsy report

1.12.1 On 21 August 2017, the Harris County Institute of Forensic Sciences, conducted an autopsy with the postmortem examination of the deceased which, upon further examination, revealed the following pathological findings:

- 1) Multiple blunt force injuries
 - a. Blunt force trauma of head and neck
 - b. Blunt force trauma of torso
 - c. Blunt force trauma of extremities

- 2) Additional findings
 - a. Obesity (Body mass index: 31.2 kg/m²)
 - b. Coronary artery atherosclerosis, slight

³⁸ Information on the SWL of the lifting hook is not available to the investigation team.

1.12.2 The report revealed that the death of the 12-4 ASD was caused by multiple blunt force injuries.

1.13 Environmental condition

1.13.1 At the time of the accident, at the loading berth, the weather was fair with partly cloudy sky, visibility was good. The westerly wind was at about 8kts. The sea was calm.

1.13.2 The ambient lighting was artificial using the deck flood lights and cluster lights on the crane which illuminated the cargo hold and area of operations. The crew affirmed that the lighting was sufficient for the work to be performed.

2 ANALYSIS

The investigation focused on the following areas:

- a. Cargo loading operations
- b. Using pontoon to trim cargo pile
- c. Failure of lifting hook
- d. The company's safety management system

2.1 Cargo loading operations

- 2.1.1 Prior to completion of loading the last cargo hold (no.5), the Master required the officers including the Chief Officer to carry out the draft survey to ensure that the cargo was loaded as per expected draft for safe departure and to avoid overloading the ship.
- 2.1.2 While it could not be established when the cargo piled up in no.5 cargo hold took place, it was certain that no one was supervising the final loading of no. 5 cargo hold as required by the SMS (See Paragraph 1.8.1).
- 2.1.3 The reference for loading limit inside no.5 cargo hold, was not marked with a red line as in the case of no.3 and no.4 cargo holds, (see Paragraph 1.4.2). In addition, there was no evidence that the officers of the watch had shown the shore personnel these references as required by the Chief Officer's loading instructions. Had the reference for loading limits been clearly marked in no.5 cargo hold or shown to the shore personnel, the cargo was likely not to have been loaded beyond the limit and thus not posed a problem to the proper closure of the pontoon.
- 2.1.4 After the draft survey, when the Second Officer (who took over the duty of the watch from the Third Officer) was instructed to take photos of cargo loaded in the holds, he did not instruct the crew to wait for him to supervise the pontoon shifting operations. As a result, the crew were left to their own judgement and experience to shift the pontoon and close it.
- 2.1.5 Noting that near to the completion of cargo loading operations, multiple activities take place, involving most, if not all officers and crew. This occurrence highlights the importance of proper planning and prioritisation of tasks. If this is not done, especially for tasks that pose a higher risk, in an attempt to complete them, trivialisation can take place.

2.2 Using pontoon to trim cargo pile

- 2.2.1 The company's SMS was silent on cargo trimming procedures. The cargo loading written instructions to the duty officers stated that the Chief Officer would inform the shore personnel for trimming of the cargo, if needed. However, without monitoring of cargo loading by the ship's crew, the cargo piling up was not made aware to the Chief Officer.
- 2.2.2 Using the cargo crane to drag the tween deck pontoon for trimming a piled cargo was not explicitly prohibited by the company's procedures. When the Bosun and OS faced difficulty in closing the pontoon, as a result of piled cargo, in the absence of an officer in-charge at the location to determine a suitable method to trim the cargo, the team resorted to use the pontoon to trim as it was done two months ago. It is likely that the crew did not recognise the risks involved in dragging the pontoon, i.e. an unusual lift with two lifting wire slings instead of four (see **Figure 4**).
- 2.2.3 As noted in the COSWP, the use of lifting appliances to drag heavy loads, in this case the pontoon, was inappropriate because of the friction involved and the unknown SWL of the hooks. Even if a risk assessment is done for such a task, the investigation team is of the view that pontoon, the wire slings and hooks are not designed for being dragged over cargo as was done in this case. Suitable trimming methods must be established clearly in the SMS.

2.3 Failure of lifting hook

- 2.3.1 The SWL of the no.3 crane was certified for 40 tonnes. The A-type pontoon had a weight of about 14 tonnes. The lab test result showed the lifting hook broke at about 36 tonnes after increasing the pulling force gradually. The two sets of the wire slings each had a SWL of 12 tonnes, with an approximate breaking load of 60 tonnes based on calculations.
- 2.3.2 After dragging the pontoon for about 2m, the tension of the two wire slings attached to the lifting hooks could have increased significantly either as a result of friction alone or a combination of pontoon getting stuck in the narrow space and the grain cargo. Additional forces acted on the wires and hooks and it is likely that the SWL of the hook has been exceeded causing it to break.

2.4 The company's Safety Management System

- 2.4.1 The SMS did not require all the cargo holds to be clearly marked so as to ensure proper closing of pontoon on completion of cargo. Having such

markings would have minimised the piling of cargo by adjusting the position of the chutes.

- 2.4.2 It is understandable that piling of cargo cannot be totally eliminated. Hence, details of appropriate trimming methods and procedures should have been provided in the SMS, rather than leaving it to the crew to make their own assessments.
- 2.4.3 The working language in the company's fleet of ships including Alkaid was English. However, the Bosun and OS communicated in their own native language. The content of their conversation was not understood by other nationalities (the Chief Officer, the Second Officer who was the Officer of the watch, 12-4 ASD and 12-4 DC). This accident highlights the importance of communicating in a common working language to ensure safe operations.
- 2.4.4 The investigation team believes that despite the company's requirement to have English as the working language, it is likely that the OS had limited knowledge of English as compared to the other crew working on board. It would be desirable for the company's pre-employment checks and criteria to be re-assessed accordingly.
- 2.4.5 The investigation team also noted that the four crew involved in cleaning of the fallen cargo at the hatch coaming centre beam, which was about 6m high from the cargo level in the no.5 cargo hold, were not wearing any fall prevention equipment. Although the width of the hatch coaming centre beam was about 1.78m wide, it would be desirable for the company to review the risk of falling from height when performing work at the hatch coaming centre beam.
- 2.4.6 The SMS required lifting gears to be inspected and their results recorded. In this case, it was evident that the SWL of the hooks (loose lifting gears) in use for pontoon lifting were not known and recorded on board. The failure of such loose gears could pose a risk to the ship and its crew as the other lifting gears, they should be treated with equal importance. Proper certification and regular inspection is thus necessary.

3 CONCLUSIONS

From the information gathered, the following findings, which should not be read as apportioning blame or determining liability to any particular organisation or individual, are made.

- 3.1 On completion of loading, the pontoon could not be closed due to piled up cargo in no.5 cargo hold. This was because the reference for loading limit in this hold was not marked and there was inadequate monitoring of the final cargo loading operation which resulted in piling of the cargo. Tasks were not properly planned and prioritised.
- 3.2 The crew, without supervision, and in the absence of trimming methods, used the pontoon to trim the cargo by dragging it over the cargo surface. This caused one of the hooks to break and the other one slipped out of the pontoon securing point. The pontoon and its associated loose gears are not designed for such operations.
- 3.3 The detached lifting wire slings caused fatal injuries to a crew working on the hatch coaming centre beam. There were no fall prevention measures in place for personnel working at that location.
- 3.4 The SMS did not, amongst other things did not ensure that the common working language was used and that the SWL of the lifting hook was recorded on board.

4 SAFETY ACTIONS

During the course of the investigation and through discussions with the investigation team, the following safety actions were initiated by the company.

4.1 Actions taken by the ISM Managers

4.1.1 A Safety Circular (SAF/2017/24) was issued to its fleet ships on 23 August 2017 after the company's preliminary findings, the circular addressed to the following areas:

- Require the ship's Chief Officer or other competent persons to inspect conditions of all lifting gears and its associated accessories and check against with certificates before put into use.
- Prohibit use of ship's pontoons for sweeping or levelling of cargo.
- Require the use of pontoons using all four slings at all times for ensuring equal distribution of load.
- Prohibition of deviation from the company's established SMS procedures, unless in an emergency for safety of life as decided by the Master, in which case such deviation shall be reported to the company.

4.1.2 A 'Stop Work Authority' was inserted in the company's SMS manual on 17 March 2018. This was to encourage ships' crew, irrespective of rank, as well as shore staff to stop the work, if any unsafe actions or unsafe conditions at or around working areas on board its ships are observed. Thereafter work is not to resume until corrective actions are taken.

5 SAFETY RECOMMENDATIONS

A safety recommendation is for the purpose of preventive action and shall in no case create a presumption of blame or liability.

5.1 PACC Ship Mangers Pte Ltd (the ISM Manager)

5.1.1 To ensure reference for loading limit in all cargo holds is marked clearly and maintained to minimize piling of the cargo and to facilitate proper closing of pontoons. **[TSIB-RM-2019-008]**

5.1.2 To establish clear procedures in company's Safety Management System for trimming of piled cargo. **[TSIB-RM-2019-009]**

5.1.3 To ensure the SMS requirements for common working language are implemented on board its fleet of ships. **[TSIB-RM-2019-010]**

-End of Report-