

Final Report

COLLISION

**CRYSTAL SUNRISE
AND
ASTRO SATURN**

**OFF PILOT WEST BOARDING GROUND ALPHA
(PWBGA)**

**SINGAPORE TERRITORIAL WATERS
17 APRIL 2018**

MIB/MAI/CAS.044

Transport Safety Investigation Bureau
Ministry of Transport
Singapore

13 October 2020

The Transport Safety Investigation Bureau of Singapore

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

Table of Contents

SYNOPSIS	1
1 FACTUAL INFORMATION	5
1.1 Narratives	5
1.2 Electronic evidence	22
1.3 Crewing and statutory matters.	25
1.4 Bridge layout and design of CS	28
1.5 Deck lights configuration of AS	29
1.6 Location of occurrence	30
1.7 Environmental conditions	31
1.8 Singapore Vessel Traffic Information System (VTIS)	31
1.9 Snapshot of plume modelling by MPA	31
1.10 Bridge Resource Management and Safety Management Procedures	32
2 ANALYSIS	34
2.1 Conduct of navigation	34
2.2 Bridge Resource Management	35
2.3 Actions prior to collision	36
2.4 Conduct of navigation	38
2.5 Actions prior to collision	39
2.6 Incidental observations	40
3 CONCLUSIONS	41
4 SAFETY ACTIONS	43
5 SAFETY RECOMMENDATIONS	46

SYNOPSIS

On 17 April 2018, a Singapore flagged liquefied gas carrier Crystal Sunrise¹ and a Greek flagged crude oil tanker Astro Saturn² were involved in a collision about 0.75nm southeast of the Pilot West Boarding Ground 'Alpha' (PWBGA), within the westbound lane of the Singapore Strait, Traffic Separation Scheme (TSS), in Singapore territorial waters.

Before the collision, the Crystal Sunrise was on a north easterly heading at about five knots, crossing the Precautionary Area of the TSS, to embark the Singapore Pilot at the PWBGA, while the Astro Saturn was heading westerly at about four knots, towards Tanjung Pelepas Pilot Boarding Ground.

The incident occurred in fair weather, overcast sky with good visibility. The sea was slight with the north easterly wind at about five knots. The current was setting at about 121°True (T) at 0.5 knot. As a result of the collision, the no.3 port side cargo tank of the Crystal Sunrise was ruptured and nearly 2000 metric tonnes of Butane cargo were reported loss to the atmosphere, while the Astro Saturn sustained damages to its port bow. There were no injuries reported and both vessels were rendered unfit to continue their passage, in the opinion of the respective Masters.

The Transport Safety Investigation Bureau classified the occurrence as a very serious marine casualty.

The investigation revealed that the following were contributory to the occurrence:

- In the planning and execution of the passage, the bridge team of Crystal Sunrise had likely underestimated the traffic conditions in the area. When picking up the Pilot at the PWBGA, the bridge team of Crystal Sunrise lost situational awareness which resulted in the vessel entering the westbound lane of the TSS against the general direction of traffic flow. The bridge watch level was not following the Company's SMS and the issues in bridge resource management had resulted in different vessels in the vicinity being referred by the bridge team.

¹ Loaded with about 46,000 metric tonnes(mt) of Propane and Butane in air.

² Loaded with about 99,000mt of fuel oil.

- When receiving a Mooring Master, the Astro Saturn was navigating closer to the northern limit of the TSS near to the location where vessels would embark Pilots for Singapore. The Astro Saturn did not coordinate with the Mooring Master to ensure that the boarding took place at the pre-agreed location in the Precautionary Area. The bridge team had likely been distracted by the boarding of the Mooring Master and did not detect the collision situation when the Crystal Sunrise course had changed.

VIEW OF VESSELS³



Figure 1 – Crystal Sunrise



Figure 2 – Astro Saturn

³ Images of both vessels - Courtesy of Marine Traffic.

DETAILS OF VESSELS

Name	Crystal Sunrise (CS)	Astro Saturn (AS)
IMO No.	9631682	9235725
Flag	Singapore	Greek
Classification Society ⁴	Nippon Kaiji Kyokai (Class NK)	Det Norske Veritas and Germanischer Lloyd (DNV-GL)
ISM RO ⁵ for Safety Management Certification (SMC ⁶)	ClassNK	DNV-GL
Ship Type	Liquified petroleum gas carrier	Oil tanker
Builder	Kawasaki Heavy Industries Japan	Daewoo Shipbuilding and SME, South Korea
Year	2013	2003
Owner	Kumiai Navigation (Pte) Ltd	Saturn E.N.E
Company ⁷	Anglo-Eastern Shipmanagement (S) Pte. Ltd	Pantheon Tankers Management Ltd.
Gross tonnage	46,885	57,022
Length overall	229.9m	248.0m
Breadth moulded	37.2m	43.0m
Depth moulded	21.0m	21.0m
Mean draught	10.6m	14.5m
Main Engine(s)	Kawasaki-MAN B&W / Maximum output 13,210 kW @ 89rpm	HSD Engine – MAN B&W Maximum output 14,242 kW @ 91rpm
Propeller	1 x Right-hand propeller	1 x Right-hand propeller
Cargo details	Propane: 34,817.506mt Butane: 11,452.384mt (In Air ⁸)	99,100mt of fuel oil

Table 1

⁴ Classification Society also referred to as a Recognised Organisation (RO), which means an organisation that has been assessed by a flag State and has the delegation of authority to perform statutory certification and services on behalf of the flag State.

⁵ Flag State approved RO for issuance of Safety Management Certificate.

⁶ SMC means a document issued to a ship which signifies that the Company and its shipboard management operate in accordance with the approved safety management system.

⁷ Responsible for the operation of the ship to carry out all duties and responsibilities imposed by the ISM Code.

⁸ Standard term used in the carriage of LPG, taking into consideration the effect of temperature on density and volume of the cargo.

1 FACTUAL INFORMATION

All times (H) used in this report are in Singapore local time, which is eight hours ahead of Coordinated Universal Time (UTC⁹). Ships mean times on CS and AS were the same as Singapore local time.

The investigation team conducted interviews¹⁰, reviewed the recordings of the voyage data recorders (VDRs), event logs/documents and statements from both vessels' bridge team and correlated with information from Singapore Vessel Traffic Information System (VTIS).

1.1 Narratives¹¹

According to the bridge¹² team of CS

- 1.1.1 On 5 April 2018, CS departed the port of Mesaieed, Qatar, for Japan¹³. En route, CS was scheduled to take bunkers at the port of Singapore¹⁴. At open sea, the bridge was typically at bridge watch level 1 (BW-1), that is, manned by one watchkeeping officer and would be upgraded to BW-2 in the hours of darkness with an Able Seafarer Deck (ASD) performing lookout duties. Both these BW levels would have the helmsman available on call.
- 1.1.2 On 16 April 2018 at about 0812H, before entering One Fathom Bank in the Strait of Malacca¹⁵, the Master of CS carried out the main engine and steering gear test, as per the Company's procedures.

⁹ UTC – Coordinated Universal Time, is the primary time standard by which the world regulates clocks and time.

¹⁰ Interview was carried out for bridge team of CS. Interviews of AS could not be carried out as the vessel continued its passage to Malaysia.

¹¹ Combination of statements of the personnel involved and information obtained from the respective Company.

¹² The bridge of a ship or the wheelhouse from which the ship can be commanded. When a ship is under way, the bridge is manned by an officer of the watch aided accordingly, depending on the bridge watchkeeping level. During critical manoeuvres, the Master will typically be on the bridge, supported by an officer of the watch, one Able Seafarer Deck (ASD) for lookout and one ASD for hand steering.

¹³ Estimated time of arrival (ETA) on 26 April 2018. The passage plan was prepared by the Second Mate in two parts, i.e. first part covering departure from the Middle East till passing Sri Lanka, and the second part covering the remaining passage which included entrance to One Fathom Bank, transit through Singapore Strait and South China Sea towards Japan. The first part was signed by the Master prior departure from Qatar. The second part, according to the Second Mate had been prepared after departure from Qatar. According to the Master the Second Mate had to be reminded a few times to complete the passage plan for the whole passage.

¹⁴ ETA Singapore was in the early morning hours of 17 April 2018.

¹⁵ The passage plan required the bridge team composition to be at BW-3, BW-4 (at Master's discretion) upon entering One Fathom Bank. BW-3, that is, two watchkeeping officers (one of them could be the Master/Chief Mate), and one lookout (helmsman on call).

- 1.1.3 In preparation for arrival in Singapore, the Master arrived at the bridge at about 2338H on 16 April 2018. The bridge team's composition at that time was BW-3¹⁶ with the Third Mate (3M) as the officer of the watch (OOW) having the conn¹⁷, assisted by one Junior watchkeeping officer (JWKO) and one ASD as lookout. The weather was fair with good visibility. The wind was *light airs* with the current setting at about 121°True (T) at 0.5 knot¹⁸.
- 1.1.4 At about midnight¹⁹, the Master took over the conn and maintained the bridge watchkeeping level at BW-3. A few minutes later, the Second Mate (2M) keeping the 0000-0400H, took over the watch from the 3M, who left the bridge soon after together with the JWKO. The 2M being the OOW, assisted in navigation, communication and radar watch, while the ASD alternated between lookout and hand steering²⁰. As per the Company's SMS on pre-arrival checks, all navigational aids were checked and tested to be working satisfactorily. Both radars (X²¹ and S-band) had automatic radar plotting capabilities and the Electronic Chart Display and Information System (ECDIS²²) had automatic information system (AIS)²³ overlay.
- 1.1.5 At about 0015H, the Chief Mate (CM), who had been called by the 3M, arrived at the bridge. The CM then went down from the bridge at about 0028H, having been asked²⁴ to supervise the preparation of boarding arrangements for the Pilot on the port side.

¹⁶ BW-3 consisted of two watch officers, one of whom may be either the Master or Chief Mate, and one lookout, with the helmsman available on call.

¹⁷ Conn of the vessel means having command of the vessel's movement at sea.

¹⁸ Knots (kts) is a unit of speed equal to one nautical mile (1.852km) per hour

¹⁹ At this time, a change of navigational watch also took place and the 3M handed over watch to the 2M and left the bridge. The ASD from the 3M's watch handed over the lookout duties to the ASD from the 2M's watch.

²⁰ When the ASD was performing hand steering, the 2M was performing the role of the lookout.

²¹ Connected to the ship's Voyage Data Recorder (VDR)

²² An ECDIS is a geographic information system used for nautical navigation that complies with International Maritime Organization (IMO) regulations as an alternative to paper nautical charts. The system displays the information from Electronic Navigational Charts (ENC) or Digital Nautical Charts (DNC) and integrates position information from position, heading and speed through water reference systems and optionally other navigational sensors. Other sensors which could interface with an ECDIS are radar, Navtex, AIS, and depth sounders. It should be capable of continuously plotting the ship's position, thus, enabling the mariner to execute in a convenient and timely manner all route planning, route monitoring and positioning currently performed on paper charts.

²³The IMO Resolution A.917 (22) states that the purpose of the AIS is to identify vessels; assist in target tracking; simplify information exchange (e.g. reduce verbal mandatory ship reporting) and provide additional information to assist situation awareness. The onboard AIS broadcast series of standardised information to achieve the purpose.

²⁴ Based on the CM's statement.

- 1.1.6 On 17 April 2018, at about 0030H, CS passed waypoint (WP²⁵) 61²⁶ and was about 7.7nm southwest of Tanjung Piai light beacon, on a course of 127°True (T) at 10.4 knots. About the same time, the Master reported CS' position in the eastbound lane of the Singapore Strait TSS to VTIS West (W) on VHF Ch.73 upon entering Sector 7 as required by STRAITREP²⁷ (see **figure 3**).

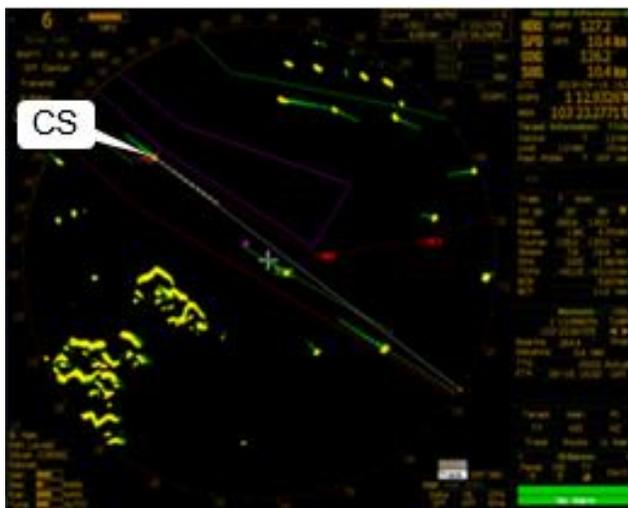


Figure 3 - X-band radar display²⁸ at 0030H

- 1.1.7 At about 0042H, the Master called Singapore Pilots²⁹ and confirmed the Pilot boarding time as 0220H at Singapore PWBGA for Sudong Anchorage. The Master tested the engine ahead and astern movements satisfactorily and instructed the ASD to engage hand steering.
- 1.1.8 At about 0106H, when CS was at WP 62 in the Precautionary Area³⁰ of the TSS, on a course of 117°T at about eight knots, the Master arranged for the

²⁵ A reference point between the point of departure and the destination, particularly a point on a course line the coordinates of which are defined in relation to any electronic aid to navigation.

²⁶ WP numbering as indicated by CS' radar display.

²⁷ Reference with Port Marine Circular, No.65 of 1998 – 'STRAITREP' is the Mandatory Ship Reporting System in the Strait of Malacca and Singapore adopted by the International Maritime Organisation (IMO) and came into force on 0000 hours UTC on 1 December 1998. The objectives of the STRAITREP are:

- a) to enhance the safety of navigation;
- b) to protect the marine environment;
- c) to facilitate the movements of vessels; and
- d) to support SAR and oil pollution response operations.

²⁸ Name markings on radar display hereinafter annotated by TSIB.

²⁹ Pilot Office Mission Command Centre (MCC) on VHF Ch 20. Boarding speed was advised about four to six knots.

³⁰ Referring to IMO routine measures, a Precautionary Area comprises an area within defined limits where ships must navigate with caution and within which the direction of traffic flow may be regulated.

night signal consisting of three all-round green lights³¹ in a vertical line to be displayed in following the recommendation for vessels crossing the TSS and Precautionary Areas in Singapore Strait during hours of darkness. By about 0124H the port side arrangements for the pilot ladder were prepared and while on the way to the bridge the CM was asked to prepare the arrangements on the starboard side³².

- 1.1.9 At about 0130H, CS was steering 060°T headed for the PWBGA (about 6.2nm right ahead at WP 64) with a course made good (CMG³³) 069°T and a speed made good (SMG³⁴) at 6.6 knots passed WP 63. At that time, the Master noticed one target proceeding on the same way towards PWBGA (target 44 on the X-band radar), circled in white (see **figure 4**), about 3nm at two points³⁵ on the starboard bow, later identified as the JBB Yu Hang 259.

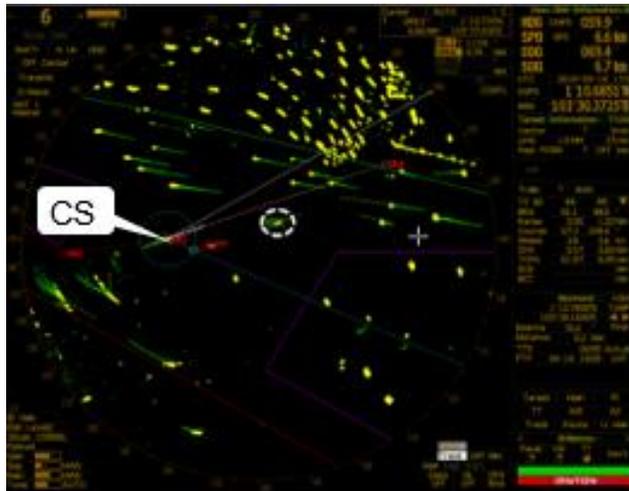


Figure 4 - X-band radar display at 0130H
(Note: Most westbound targets were not acquired)

- 1.1.10 By about 0145H, CS was steering 064°T with CMG 072°T and SMG 5.7 knots, 4.6nm away from PWBGA. In the Master's assessment, the traffic condition in Singapore Strait at that time was normal, based on the Master's previous

³¹ The technical specifications of the lights used in the "3 green lights" signal should, if possible, comply closely with positioning and technical details of lights in Annex 1 of COLREGs (International Regulations for Preventing Collisions at Sea, 1972). Display of these lights is intended to enhance navigational safety so that vessels in appropriate lanes can identify the vessels intending to cross the Precautionary Areas in the hours of darkness and take actions, if required. *Source – MPA Port Marine Circular no. 4 of 2013.*

³² The Master informed the investigation team that this was because the conditions on the starboard side were deemed more favourable.

³³ CMG is the direction in which a ship or vessel has travelled with the effects of wind and current.

³⁴ SMG is the average speed in knots which was maintained in proceeding along the intended track to the destination.

³⁵ A point is about 11.25 degrees (from centreline of the vessel measured from the bow). Fine on the bow, thus, indicated bearings that are less than a point or close to the bow.

experience having navigated the area in the past.

- 1.1.11 At about 0200H, CS was steering 062°T with CMG of 069°T and SMG 6.1 knots. The Master noted JBB Yu Hang 259 was still about two points on the starboard bow at about 2.1nm. At that time, the Master recalled noticing several westbound vessels on the starboard side but confirmed (to the investigation team) that none of them were acquired on the X-band radar. Two other targets circled in white were heading towards CS (see **figure 5**). The Master further added that the S-band radar was also being used to acquire targets.

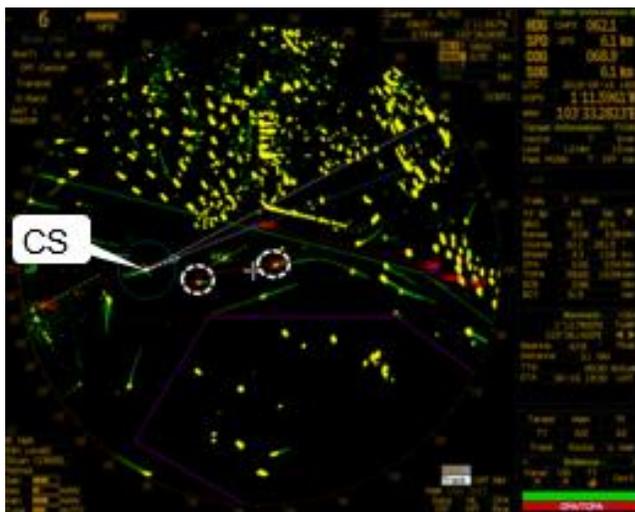


Figure 5 - X-band radar display at 0200H

- 1.1.12 At about 0205H, the range scale of the X-band radar was reduced from 6nm to 3nm. At about this time, a small vessel was seen at about four points on CS' port bow. The target was acquired, and the Master assessed that the coastal vessel at about 2nm away would pass CS' bow with the closest point of approach (CPA³⁶) of about 0.3nm. Another vessel, (target 56) was also acquired and indicated that the vessel would pass on CS' starboard side with a CPA of about 0.48nm.
- 1.1.13 The Master gradually reduced the speed by moving the engine telegraph from dead slow ahead to slow astern until a speed of about five knots was achieved to prepare for Pilot boarding (see **footnote 29**). Once the speed was achieved, the telegraph was set at slow ahead to maintain the appropriate speed.
- 1.1.14 At about 0213H, the Master heard VTIS (W) calling AS "...two ships

³⁶ Closest point of approach (CPA) is an estimated point in which the distance between two objects, of which at least one is in motion, will reach its minimum value. This value is used to evaluate the risk of a collision.

approaching the pilot station western boarding ground alpha, the second ship is the LPG tanker Crystal Sunrise, keep a lookout". AS was heard by CS' bridge team, acknowledging this message with an "OK I see them OK".

- 1.1.15 By about 0214H, CS steering 072°T, with CMG 077°T and SMG seven knots, was about 1.17nm Southwest of PWBGA, the Master overheard on the VHF that the Pilot had boarded JBB Yu Hang 259. At that time following targets were acquired on CS' X-band radar:

Vessels	Position from CS	Course x Speed	Remarks
Target 61	082.7°T x 2.39nm	286°T x 9.5 knots	Westbound and moving along the outside northern edge of the TSS
Target 62	091°T x 2.46nm	277°T x 6.6 knots	Identified later to be AS following the westbound lane of the TSS.

Table 2

- 1.1.16 At about 0215H, the CM had reported through walkie talkie that the boarding arrangements for the Pilot were ready on the starboard side. The CM was then instructed to receive the Pilot at the starboard side pilot ladder. At about that time, Master overheard³⁷ a call from the JBB Yu Hang 259 requesting for starboard to starboard passing arrangement with AS.
- 1.1.17 At about 0218H, the Master was heard inquiring "*What is the pilot boat doing – not coming? Call Pilot*". About a minute later, the 2M obtained confirmation from the Pilot Office (MCC) that the Pilot would board as scheduled and that the pilot boat was waiting³⁸ on CS' starboard bow. At that time, the Master could be heard instructing the 2M "*... keep an eye on the ship from the starboard³⁹ side...*".
- 1.1.18 At about 0220H, CS was steering 073.6°T, with CMG 080.8°T and SMG 5.9 knots when the Master was heard enquiring again, "*...why is he (referring to the Pilot) not coming*". The 2M was heard responding "*No, he is waiting⁴⁰ for us*". The targets that were acquired on the X-band radar were as follows:

³⁷ The VDR confirmed such a call being made.

³⁸ At this time the pilot boat was about 0.4nm from CS.

³⁹ At that time, there were two vessels on CS' starboard side, the AS and Xin Hai Da, also a tanker. Instruction was heard over the VDR. From this conversation, it was unclear which vessel was being referred to, by the Master.

⁴⁰ During the interview, the Master stated that due to this information that the pilot boat was waiting for CS, the Master's intention was to take CS towards the pilot boat's location. This intention was not conveyed to the 2M.

Vessels	Position from CS	Course x Speed	Remarks
Target 61	070.2°T x 1.17nm	281°T x 9.2 knots	Crossed and passed clear of CS' bow from starboard to port
Target 62	094.2°T x 1.49nm	276°T x 5.1 knots	

Table 3

1.1.19 In addition, the Master also instructed⁴¹ the 2M to “...*watch out for target 59...*”. The investigation team could not see target 59 on X-band radar. However, during the interview, the Master was shown the X-band radar image and the Master mentioned that it is possible that target 59, which was heard in the VDR audio recording, could be acquired on S-Band radar. He further mentioned that this target 59 (allegedly on S-band radar) should be corresponding to target 61 on X- band radar. (see **figure 6**).

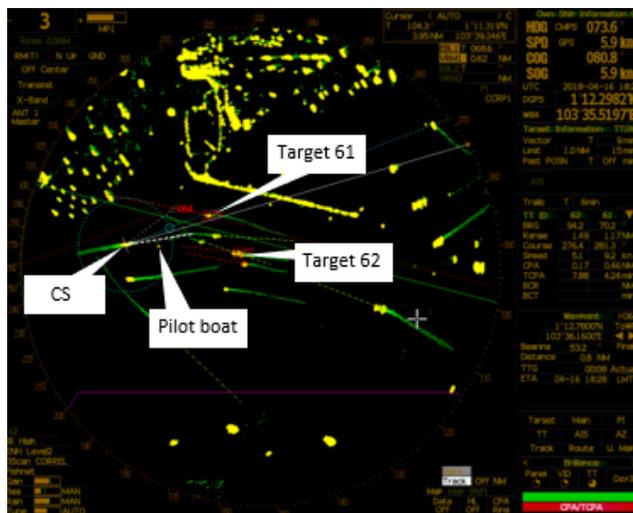


Figure 6 – X-band radar display at 0220H

1.1.20 At about 0221H, the pilot boat was waiting⁴² on CS' starboard side, having earlier embarked a Pilot on JBB Yu Hang 259. The Master gave a 15° starboard helm⁴³ followed by dead slow ahead on the engine, to head towards and at the same time to provide a lee⁴⁴ for the pilot boat.

⁴¹ Instruction was heard over the VDR. Target 59 could not be identified on the X-band radar from the VDR data.

⁴² The pilot boat was waiting inside the Precautionary Area.

⁴³ The helm angle corresponds to the rudder angle, with 15° starboard helm, it corresponds to 15° of starboard rudder angle.

⁴⁴ The side of the ship that was facing away from the wind. It is a normal practice to facilitate safe boarding.

- 1.1.21 At about 0222H, the Master enquired⁴⁵ and was responded by the 2M, that the ship on the starboard side with its deck lights⁴⁶ lit was stopped and was not at anchor⁴⁷. The Master further enquired⁴⁸ the distance of the ship (with deck lights lit) from CS' bow, but before being responded by the 2M, the Master reduced the helm angle from starboard 15° to starboard 10°, and finally to midship⁴⁹.
- 1.1.22 By about 0224H the pilot boat was alongside CS which was at the edge of the Precautionary Area (0.5nm south of PWBGA) and CS' heading was turning clockwise from 090°T to 102°T, as she proceeded towards the westbound lane (see **figure 7**).

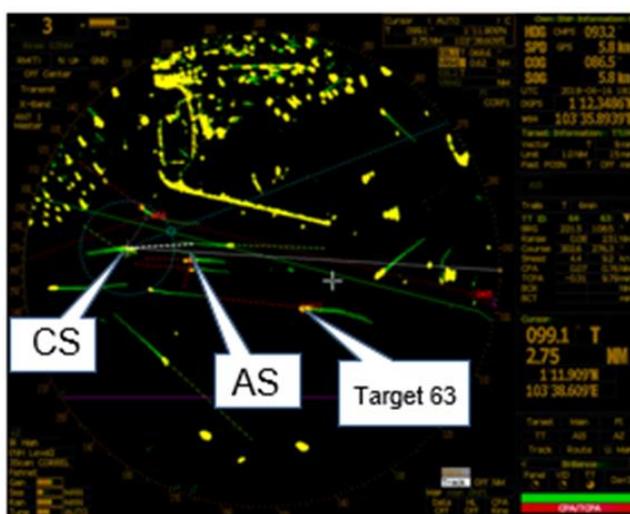


Figure 7 – X-band radar display at 0224H

- 1.1.23 At about 0225H⁵⁰, the Master enquired the CM, “...whether the Pilot was coming up (referring to the Pilot boarding CS) or not...”. The CM responded that the Pilot was on the gangway and that the pilot boat had not cleared the ship’s side (see **figure 8**).

⁴⁵ Based on audio recording on the VDR – whether the ship on the starboard side with deck lights was at anchor.

⁴⁶ Later identified to be AS (target 62). The Master said that the two of them (the Master and 2M) distinctly recalled seeing AS deck lights ON which gave the perception that AS was possibly at anchor, and hence the related queries.

⁴⁷ COLREGs Rule 30(c) – A vessel at anchor may, also use the available working lights to illuminate her deck.

⁴⁸ The 2M responded that the vessel was 1nm away. When shown the VDR data during the interview, the Master responded that target 62’s data (range, course, speed, CPA etc.) was in the background, and not visible on the radar screen, as other targets had been acquired. When a target is in the background, the data of that target is hidden until being “interrogated” by clicking on the target. This was verified by the investigation team during the VDR replay.

⁴⁹ This was the last helm order. CS’ heading was still turning at a Rate of Turn (ROT) of 8°/min

⁵⁰ By this time pilot boat was alongside CS, and the latter’s heading was about 113°T.

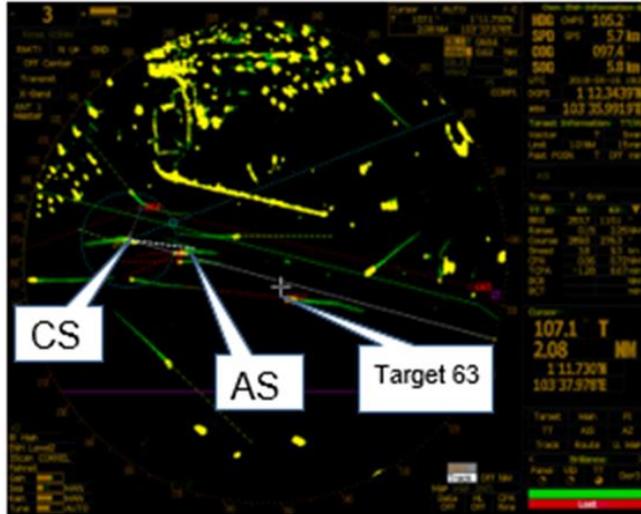


Figure 8 - X-band radar display at 0225H – Pilot boat alongside CS

- 1.1.24 Shortly after, when the pilot boat was reported clear, CS was in the westbound lane, on a heading of 115°T, with CMG 104°T and SMG 5.8 knots. At that time AS was nearly right ahead (fine on the starboard side) of CS at about 0.6nm away. The Master queried the 2M whether the vessel on the starboard bow (referring to AS⁵¹) was moving. The 2M responded that the vessel (referring to target 63, which was about 2nm away) was moving at 9.3 knots.
- 1.1.25 A further response from the 2M stated “*Sir, alter course to port*”, to which the Master exclaimed “*I can’t alter course to port*” was recorded⁵² on the VDR.
- 1.1.26 At about 0226H, when the Pilot was on deck, CS was on a heading of 116°T (and still turning to starboard), with SMG about 5.8 knots, the Master stopped the engine. From CS’ VDR conversation, the Master stated that AS was crossing the bow⁵³ and again exclaimed: “*how can I go to the port*⁵⁴” (see **figure 9**).

⁵¹ AS was at a SOG of 3.8 knots.

⁵² Only this conversation was in the Hindi language.

⁵³ AS was about 0.6nm on a heading of 274°T and a CMG of 259°T and doing about four knots.

⁵⁴ During the interview, the Master added that by this time AS was on CS’ port bow, and hence the assessment that alteration to port was not possible considering that the intention of AS was unknown and the risk of CS’ tanks containing propane being impacted adversely, if there was a collision.

1.1.29 Immediately after the collision, the Master stopped the engine and sounded the ship's general alarm followed by an announcement of the emergency. The Pilot assisted the Master to report the occurrence to Singapore VTIS (W).

1.1.30 The collision did not result in any injuries on board CS. In the opinion of the Master the collision rendered the vessel unfit to continue its passage due to following damages (see **figures 11, 12 and 13**):

- No.3 port side water ballast tank and IBS⁵⁷ tank; and
- No.3 port side cargo tank that caused cargo leakages⁵⁸ into the atmosphere.



Figure 11 - External view of the vessel's damages in the midship section



Figure 12 – Internal view of the vessel's damage (view from inside the tank)

⁵⁷ Inter Barrier Spaces (IBS) is the space between the primary and the secondary barrier.

⁵⁸ Recorded loss of 1949.426 mt Butane cargo to atmosphere.

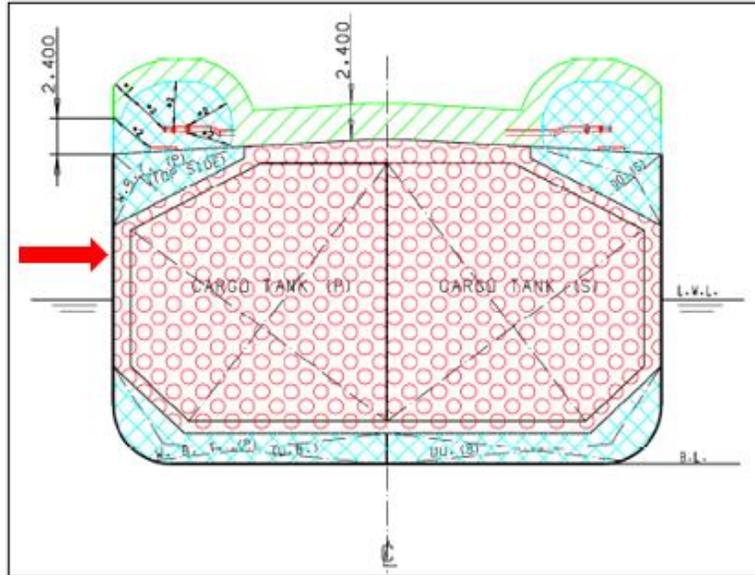


Figure 13 - Cross-section view of no.3 cargo tank indicating the approximate location of the damage (annotated by TSIB with a red arrow on CS port side)

According to the bridge team of AS

- 1.1.31 On 17 April 2018, at about 0001H, AS departed⁵⁹ Singapore Eastern Holding Bravo Anchorage (AEBH) under Singapore pilotage and after disembarking the Pilot, was bound for Tanjung Pelepas Pilot Boarding Ground (TPPPBG), Malaysia⁶⁰, a short two-hour passage.
- 1.1.32 At about 0024H, after the Pilot disembarked, AS joined the westbound lane of the TSS at about 0030H. The weather was fair, with an overcast sky and good visibility. The sea was slight with a north easterly wind at about five knots.
- 1.1.33 The bridge team⁶¹ comprised the Master, who had the conn, two 2Ms, the Duty 2M(A) was in charge of navigation, communication and radar watch and was assisted by an additional 2M(B), and two ASDs, one keeping a lookout while the other handling the helm.
- 1.1.34 Following the passage plan, with Raffles lighthouse bearing 247°T at 9.76nm, AS was being steered at 219.8°T, with CMG 220°T and SMG 5.2 knots (see **figure 14**).

⁵⁹ As per the Company's SMS checks for navigation, all navigational aids were checked and working satisfactorily. Both radars (X and S-band) had automatic radar plotting capabilities and the ECDIS had AIS overlay.

⁶⁰ AS was expected to pick up a Mooring Master in approximate position 01°12'N 103°35'E, which was about 4nm SE of TPPPBG and about 1.4nm SW of PWBGA, inside the Precautionary Area.

⁶¹ According to SMS, the composition of bridge team for Singapore Strait BW-3 i.e. comprised the Master + two licensed officers of watch/one duty ASD + one extra ASD.

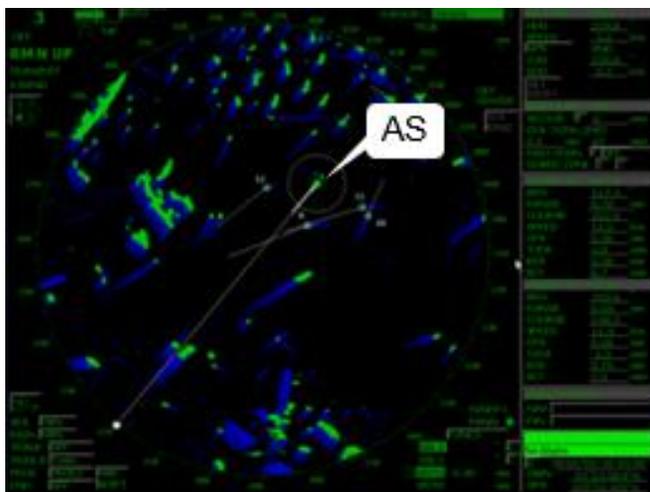


Figure 14 – X-band radar display at 0030H

- 1.1.35 At about 0130H, AS was about 1.2nm south of Raffles Lighthouse, steering 277°T, with CMG 266°T and SMG 10.8 knots, AS entered Sector 7 of the STRAITREP (see **figure 15**) and reported to VTIS (W) on VHF Ch.73.

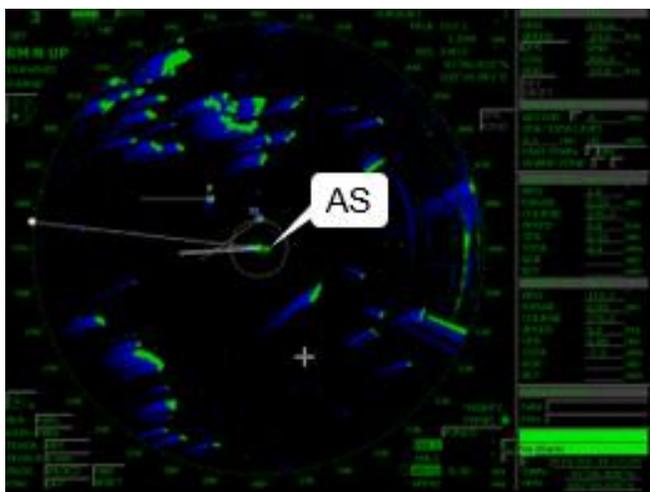


Figure 15 – X-band radar display at 0130H

- 1.1.36 At about 0145H, AS was steering 305°T, with CMG 305°T and SMG 11.2 knots passed about 2.6nm West of Raffles Lighthouse. The Master called and confirmed with Fendercare⁶² station the boarding time as 0230H, a boarding speed of about four knots and the location⁶³ that the Mooring Master was to board AS.

⁶² Fendercare provides Mooring Masters to facilitate ship to ship operations, conducted outside port limits of Malaysia.

⁶³ This position was inside the Precautionary Area at about 1.4nm SW of PWBGA.

- 1.1.37 At about 0200H, AS was steering 300°T, with CMG 303°T and SMG 11.2 knots, passed WP 6 and the Master stopped the engine⁶⁴. The Master (based on experience) decided to adjust AS' course⁶⁵ towards TPPPBG by staying closer to the northern edge of the TSS to minimise the encounter with inbound vessels embarking Pilot at PWBGA.
- 1.1.38 At about 0207H, a conversation was recorded⁶⁶ on the bridge audio (Voice 1) *“Call the Bosun to go outside...switch on the lights”*. About five minutes later when AS was being steered 280°T and doing about 6.2 knots, another conversation was recorded on the bridge audio⁶⁷ (Voice 2) – *“Lights on deck⁶⁸ – to be switched on(?)*, which was followed by (Voice 1) – *Yes, switch on”*.
- 1.1.39 At about 0213H, AS acknowledged information from VTIS (W) about *“...Two ships approaching the PWBGA. The second ship is LPG tanker Crystal Sunrise...keep a lookout”*. At this time, it was noted that CS would be crossing AS bow at a distance of about 1.1nm.
- 1.1.40 At about 0214H, the Mooring Master on the workboat called AS requesting a “flashing light” for the workboat to identify AS. Soon after a series of flashes from AS' Aldis Lamp⁶⁹ were heard on the VDR audio recording.
- 1.1.41 At about 0215H, when AS was being steered 279°T, with CMG 281°T and SMG 6.1 knots, the following targets were acquired on the radar:

Vessels	Position from AS	Distance	Remarks
Xin Hai Da	At port beam	0.2nm	Proceeding the same way and almost similar speed
JBB Yu Hang 259	About fine on the port bow	2.4nm	Crossing AS' bow from port to the starboard side
Target 19	About 1.5 points on the port bow	2.5nm	Later identified as CS ⁷⁰ , besides displaying three

⁶⁴ Adjusting speed to about four knots for embarkation of the Fendercare Mooring Master.

⁶⁵ The planned course line (passage plan) would result in AS passing south of PWBGA with a CPA of about 0.57nm. The new course line (after adjustment of course) would result in AS passing south of PWBGA with a CPA of about 0.34nm.

⁶⁶ Information obtained from AS' VDR.

⁶⁷ The Company expressed the view that this conversation referred to deck lights being switched “off” since a searchlight had been switched “on” to help rigging of the pilot ladder.

⁶⁸ It could not be established how many lights on deck were lit. According to the Company of AS, the starboard side bridge wing was lit for facilitating the embarkation of the Mooring Master.

⁶⁹ Also referred to as a Signalling Lamp.

⁷⁰ Information from the statement of the 2M(A) of AS.

			green lights in a vertical line, was also displaying two masthead lights and a green sidelight (indicative that the vessel would be crossing AS' bow from port to the starboard side)
Target 21	At about one point on the starboard bow	2.4nm	Identified and confirmed to be the workboat with the Mooring Master

Table 4

1.1.42 At about 0218H, AS was steering 280°T, making good a course of 279°T and speed of about 5.2 knots, the Master stopped AS' engine.

1.1.43 At about 0220H, with the AS' speed about 4.6 knots, the Master tested AS' engine with ahead and astern movements satisfactorily. At that time, the bridge team noted the following targets on the X-band radar (see **figure 16 and table 5**).

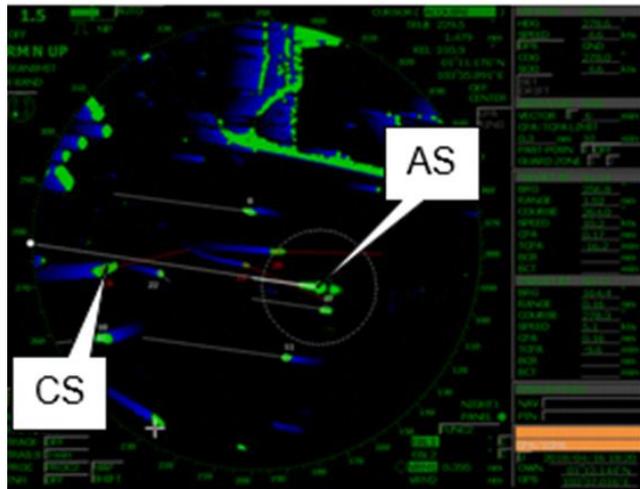


Figure 16 – X-band radar display at 0220H

Vessels	Position from AS	Distance	Remarks
Xin Hai Da	At port beam	0.15nm	Proceeding the same way and almost similar speed
CS	Fine on the port bow	1.5nm	Crossing AS' bow from port to the starboard side

Workboat	Fine on the starboard bow	0.5nm	Approaching AS' starboard side
----------	---------------------------	-------	--------------------------------

Table 5

- 1.1.44 By about 0224H, AS was steering 268°T, with CMG 265°T and SMG 3.9 knots, passing⁷¹ CS' starboard to starboard at a CPA of about 0.16nm. At about this time, the workboat was alongside AS to embark the Mooring Master. The 2M(B) was sent on deck to receive the Mooring Master (see **figure 17**).

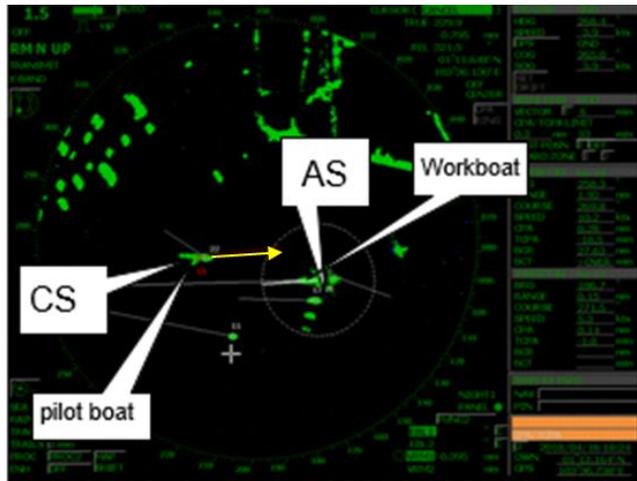


Figure 17 – X-band radar display at 0224H – Approximate vector of CS Indicated by yellow arrow (annotated by TSIB)

- 1.1.45 At about 0226H, AS was steering about 272°T, with CMG 259°T (setting towards south) and SMG 3.7 knots, the Master moved the engine telegraph to slow ahead. At that time, CS which was initially passing starboard to starboard, was now at one point on AS' starboard bow at about 0.5nm away, and with a reduced CPA of about 0.15nm.
- 1.1.46 By about 0227H, AS was at a CMG of about 261°T when CS was observed to be about 0.4nm away, and the bridge team noted that CS' aspect had changed progressively, i.e. the masthead lights and sidelights (from green sidelight changing to both red and green and finally displaying a red sidelight), indicating that CS was now in a crossing situation with AS from starboard to port (see **figure 18**).

⁷¹ AS' radar indicated that a small boat (pilot boat) was alongside CS at this time.

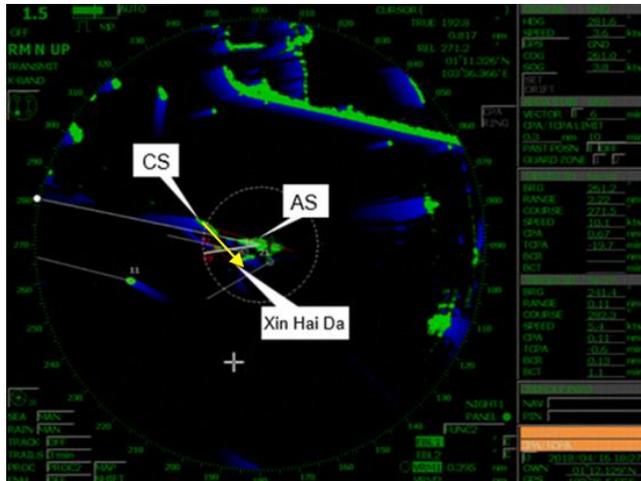


Figure 18 - X-band radar display at 0227H – Approximate vector of CS after changed, annotated by TSIB

- 1.1.47 Seeing the starboard to starboard passing situation developing into a crossing situation, with a risk of collision, the Master of AS gave a full starboard helm while simultaneously moving the engine telegraph from slow ahead to full ahead (to increase the rate of turn⁷²) with the intention to pass port to port with CS. From the VDR recording, the bridge team could be heard calling CS to warn of the risk of collision but did not receive a reply⁷³.
- 1.1.48 At a time recorded as 0229H, AS' port bow collided with CS' port midship section. After the impact, both vessels separated but remained in close vicinity of each other.
- 1.1.49 After the collision, the Master stopped the engine and sounded the ship's general alarm followed by an announcement of the emergency.
- 1.1.50 The Master reported the occurrence to Singapore VTIS (W) and made general safety broadcast on VHF Ch.16 and Inmarsat-C.
- 1.1.51 AS sustained damages at the forward port side bulwark, forecandle, adjacent structure⁷⁴ and to its port side anchor. (see **figures 19 and 20**). At about 0248H, the Master of AS informed VTIS (W) of the intention to continue AS' passage and to drift off to Tanjung Pelepas, Malaysia, for further advice from the Company.

⁷² All ships of 50,000 gross tonnage and upwards shall have rate of turn indicator, or other means, to determine and display the rate of turn.

⁷³ A review of the VDR of CS did not indicate such a call being heard.

⁷⁴ Damages and deformed from Fr. 100 to Fr. 115 (port bow).

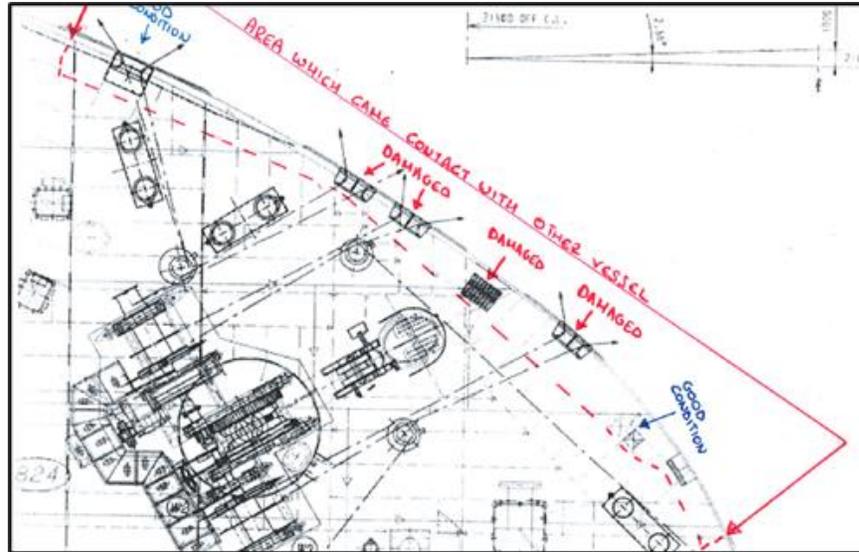


Figure 19 – Plan view of the damaged section (Source: Company of AS)



Figure 20 – Damaged section of the port side as viewed from the bow (Source: Company of AS)

1.2 Electronic evidence

- 1.2.1 The investigation team extracted the electronic evidence, primarily the data from VDRs of both vessels. To obtain a holistic picture of the developments that took place from 0200H till the time of the collision, the data was imported into the Marine Accident Data Analysis Suite (MADAS⁷⁵), displayed on BA

⁷⁵ MADAS was conceived by Avenca in conjunction with the UK MAIB and NTSB to meet the specific requirements of accident investigators. MADAS enables investigators to fuse digital data from all available sources (e.g. VDR, ECDIS, AIS, VTS, GPS, etc.)

Chart 4040 showing PWBGA at WP 64 with the bund for the Tuas Mega port and yellow flashing buoys in front. The red and blue dashed lines are the courses as per the passage plan for CS and AS respectively. The yellow dashed lines indicate the northern and eastern extent of the Precautionary Area (see **figure 21**).

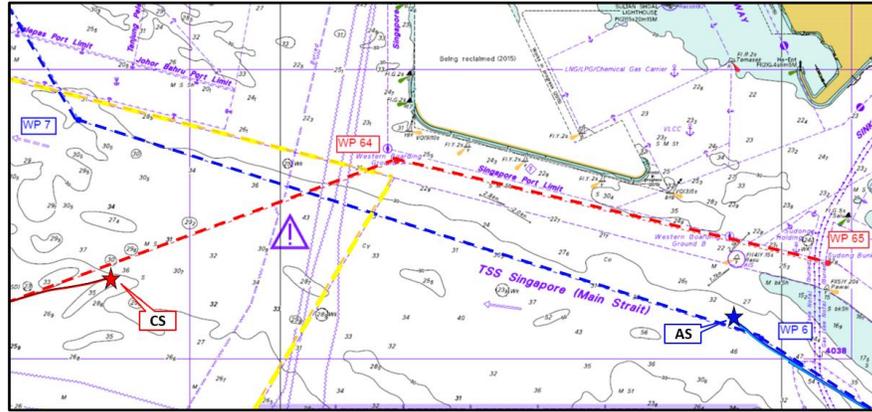


Figure 21 - At 0200H CS was within the Precautionary Area and AS was in the westbound lane (distance between CS and AS was about 6nm) – annotated by TSIB

1.2.2 By about 0224H, when CS was at the edge of the Precautionary Area with the helm at midship, CS still had a rate of turn (RoT) of about 12°/min to starboard, while AS was on a westerly heading. At that time both vessels were about 0.65nm away and appeared to be passing starboard to starboard of each other at a CPA of about 0.16nm or less than two cables⁷⁶ (see **figure 22**).

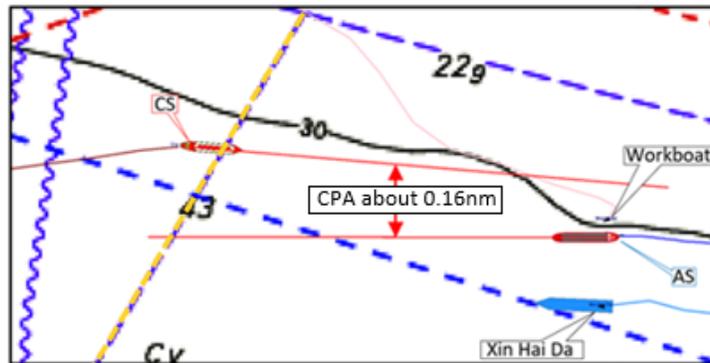


Figure 22 – At 0224H the distance between CS and AS was about 0.65nm (1204m). Approximate vectors showing vessels' heading annotated by TSIB for clarity.

1.2.3 Subsequently, by 0225H CS' heading continued turning clockwise to

⁷⁶ An international cable length is a nautical unit of measure equal to one tenth of an international nautical mile i.e. 1nm (10 cable) is equivalent to 1852m.

starboard, with a decrease in distance to AS from five to three cables at 0226H and two cables at 0227H (see **figures 23, 24 and 25**).

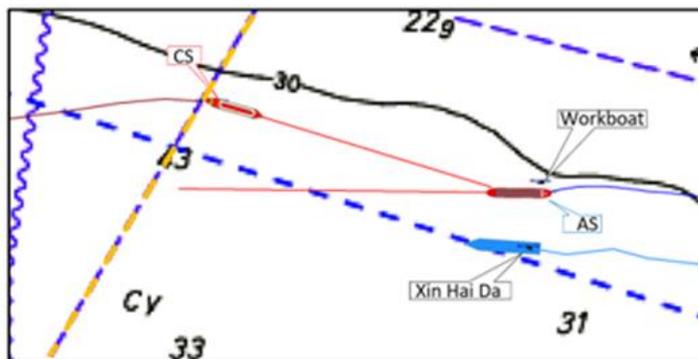


Figure 23 - At about 0225H, CS entered the westbound lane of the TSS. The distance between CS and AS was about 0.5nm

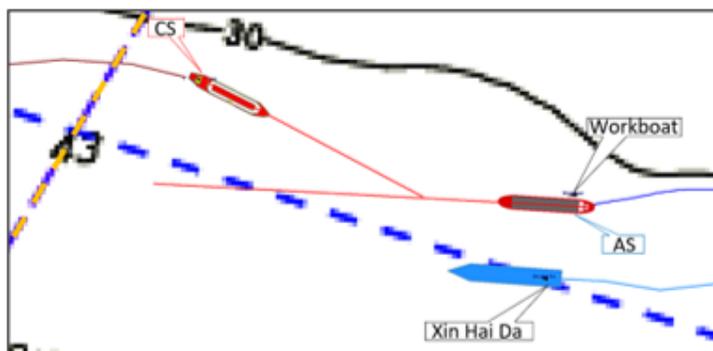


Figure 24 – At about 0226H the distance between CS and AS was about 0.34nm

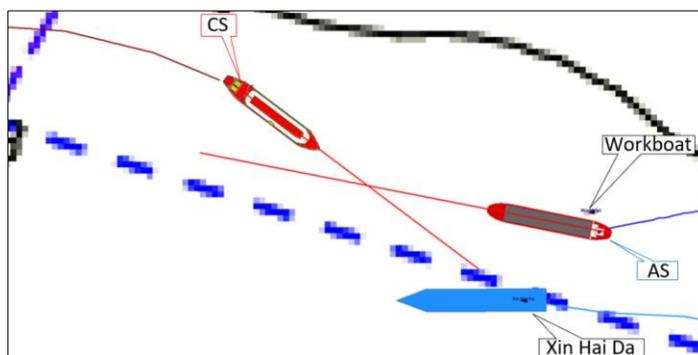


Figure 25 – At about 0227H the distance between CS and AS was about 0.19nm. AS' heading indicating a turn to starboard.

1.2.4 Before the collision, both vessels were approaching each other with the following configuration (see **figures 26 and 27**)

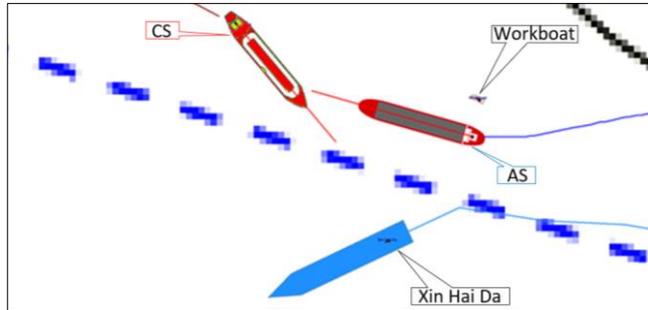


Figure 26 – Positions of CS and AS at 0228H before the collision

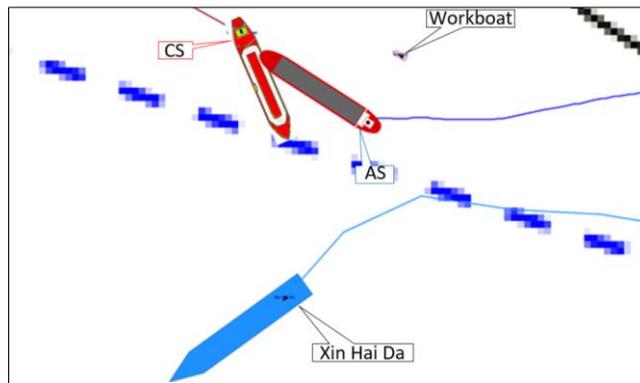


Figure 27 – Collision at 0229H

1.3 Crewing and statutory matters.

Bridge team of CS

Designation	Nationality	Age (yrs)	Qualification (Issuing Authority)	Joined/Service on board	In-Rank experience service total (yrs)	Service with Company/Remarks (yrs)
Master ⁷⁷	Indian	57	Master II/2 (FG), India	Mar 2018 ⁷⁸	27.0	4.9 ⁷⁹
2M	Indian	32	OOW	Mar	2.5	6.8

⁷⁷ First command obtained in 1991 on general cargo ships. Switched to gas carriers in 2007 in the capacity of a junior officer and Chief Mate. Joined another Company in 2009 and served as a Master on cargo ship.

⁷⁸ Prior to embarkation, the Master had been through a detailed vetting process of recruitment, which included psychometric analysis, safety and quality course, bridge team management for five days which included simulator-based exercise on Singapore strait transit and briefing at the Company's offices.

⁷⁹ During the interview, the Master informed the investigation team that this trip calling the Port of Singapore in the rank was after a long gap. The Master's last visit to Singapore on a vessel was 2010 in the capacity as a Master. The Master further added that the bridge team members, i.e. the 2M and helmsman were young and not as proactive as the Master had expected them to be for this transit. The Master also informed the investigation team that traffic was extraordinary, especially after WP 62 and when CS altered course into precautionary area of TSS. Traffic was also extraordinary as CS approached PWBGA.

			(Deck) II/1, India	2018 ⁸⁰		
ASD Helmsman	Indian	28	Rating II/4, India	Oct 2017	2.9	2.9

Table 6

- 1.3.1 CS was manned by 24 officers and crew of Indian⁸¹ nationality. The statutory certificates for all the crew were valid at the time of occurrence. The records of hours of rest and work documented by the officers were as per their Company's SMS and indicated that the rest hours were following the 'Hours of rest' requirements⁸².
- 1.3.2 The Master subsequently expressed that the volume⁸³ of emails from office, owners and charterers asking for details about CS' ETA and various distances added to the Master's stress, which could have been avoided.
- 1.3.3 The investigation team gathered that a bridge team meeting⁸⁴ was held on 16 April 2018 by the Master with all the navigating officers. The Master recalled being informed by the navigating officers that during the previous voyage, the same passage plan was used by CS during that transit, the course line to WP 64 was at an angle (instead of a right angle) to the general direction of traffic flow, and that the Pilot at that time boarded the vessel slightly south of PWBGA.

⁸⁰ Joined the vessel a few days before the Master had joined. On being asked about the working relationship, during the interview, the 2M shared that the Master had on a few occasions in the past sounded the 2M for not completing the passage plan on time. The 2M felt that opinions provided to the Master were not valued and that the 2M had been rebuked by the Master in front of other officers.

⁸¹ Working language as per the Company's SMS was English.

⁸² Maritime Labour Convention (MLC) 2006 provides guidelines on minimum number of hours of rest required for seafarers on merchant ships. Same establishment of rest periods for watchkeeping personnel contained in the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended (STCW Convention). The Master had gone to rest at about 1730H on 16 April 2018 and was well rested.

⁸³ The investigation team determined that on the 16 April 2018 there were a total of 33 emails exchanged between CS and various shore parties of which 20 mails were sent by CS. There were two emails from the Charterer asking ETA for a future voyage. Although this email did not indicate an urgency to send the information by end of business hours on that day, it was responded to by CS on the same day. The remaining mails were generated from CS for the vessel's activities in Singapore, typical daily noon position reporting and sending work planner etc. to the office.

⁸⁴ According to the Company's SMS, hazards to navigation as identified in the passage plan and their controls should be discussed during this meeting. Follow up briefing when encountering or expecting to encounter any hazards during the voyage were also to be discussed.

1.3.4 Recalling the effectiveness of bridge team meeting, the Master admitted⁸⁵ that the expectations of the navigating officers of crossing the TSS at an angle should have been better managed by being more assertive so that the passage plan could have been amended⁸⁶, for the arrival into Singapore.

1.3.5 During the Master's initial⁸⁷ interview, the Master informed the investigation team that the CM was required to receive the Pilot as per Company's SMS. The Master added that working in a new setup was one of the reasons why the status quo⁸⁸ was maintained. The Master could not provide reasons for navigating the vessel at a lower bridge composition than what was prescribed in the Company's SMS for such areas.

Bridge team of AS

Designation	Nationality	Age (yrs)	Qualification (Issuing Authority)	Joined/Service on board	In-Rank experience service total (yrs)	Service with Company/Remarks (yrs)
Master	Hellenic	41	Master II/2 (FG), Greece	Feb 2018	2.4	7.2
2M (A)	Filipino	35	OOW (Deck) II/1 Philippines	Feb 2018	4.1	1.2
Add 2M (B) (On deck to receive the Pilot)	Hellenic	55	OOW (Deck) II/1 Greece	Sep 2017	13.1	13.1
ASD1 (Helmsman)	Filipino	38	Rating II/4, Philippines	Mar 2018	5	5
ASD2 (Look-out)	Filipino	32	Rating II/4, Philippines	Mar 2018	3	3

Table 7

⁸⁵ The response was in relation to a question on how this passage was planned to be executed by the Master, including vetting of the passage plan.

⁸⁶ The Master opined that the ideal approach towards WP 64 should have been at right angle to the general direction of traffic flow of the TSS, as it would allow for the crossing to be in a shorter time and provide a clearer aspect to vessels in the westbound lane.

⁸⁷ During subsequent correspondence the Master informed the investigation team that the CM had no reason to be on deck to supervise the preparation of the pilot boarding arrangements and that it could have been done from the bridge.

⁸⁸ Working with existing passage plan and maintaining past practice.

1.3.6 AS was manned by 28 officers and crew of various nationalities comprising Hellenic, the Philippine, Romanian and Ukrainian. The statutory certificates for all the crew were valid at the time of occurrence.

1.3.7 The records of hours of rest and work documented by the officers were as per their Company's SMS and indicated that the rest hours were following the 'Hours of rest' requirements.

1.4 Bridge layout and design of CS

1.4.1 CS had a traditional bridge layout, with the steering column behind the conning position. To the left of the steering column was the engine telegraph control console and to the right of it were the two radars and ECDIS (see **figure 28**). During the passage, the Master was toggling among acquiring and plotting targets on the radar, taking collision avoidance measures, looking out, as well as operating the telegraph and the 2M was assisting with communications, radar and ECDIS & occasionally the telegraph.

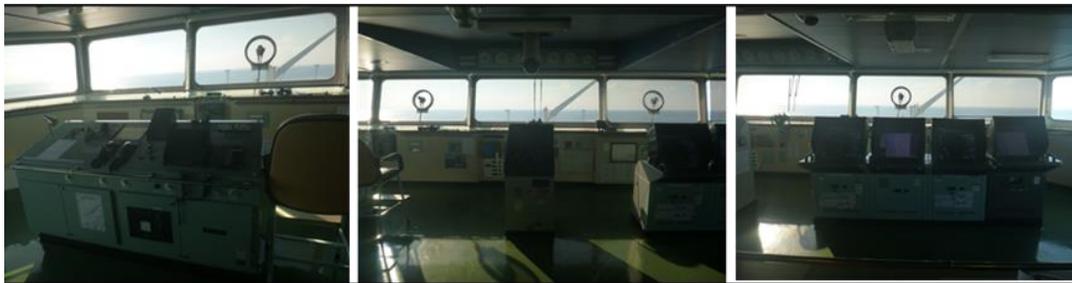


Figure 28 - From left to right – Telegraph console, steering column (with RoT indicator) and radar/ECDIS consoles

1.4.2 The Master of CS stated that the only RoT indicator on the bridge was at the helmsman's position (circled yellow in left hand side, see **figure 29** below) and opined that had it been provided⁸⁹ on the panel above the conning position (right hand side of **figure 29** below), it would have allowed the Master to have a better estimation of the vessel's RoT. When asked, the Master of CS confirmed that the vessel's RoT in the process of embarking the Pilot, had not been recognised by the Master, and that the 2M had not informed the Master of the effect of the current on CS' movement.

⁸⁹ As per SOLAS/V Reg.19.2.9.1 – All ships of 50,000 gross tonnage and upwards shall have a RoT indicator, or other means to determine and display the rate of turn. CS, because of its size, was not required to be fitted to display such an indicator. Notwithstanding, the steering column was provided with such an indicator and the helmsman was heard on the audio mic informing the Master of the RoT at regular intervals.



Figure 29 - Panel above the conning position showing, among others, wind speed and direction, engine rpm, rudder angle, etc.

1.5 Deck lights configuration of AS

1.5.1 AS, like most vessels of its size, in addition to navigation lights (see **figure 30**, indicated by the dotted orange circle), had deck lights (dotted blue circle) fitted on the bridge front, midship mast and the foremast. Additionally, a searchlight (dotted red circle), for pilot embarkation was fitted at the extremities of the bridge wings. The deck lights would normally be used for operations in the port and were required to be kept switched off for the safety of navigation.



Figure 30 – Lights configuration of AS⁹⁰ – annotated by TSIB

1.5.2 The Company of AS informed the investigation team that based on the Company's interview with the bridge team, there was no evidence of deck

⁹⁰ Photo source – Vesseltracker.com

lights being switched on before the collision, and that only the (one) searchlight on the starboard bridge wing (annotated with a red dotted circle) had been switched on between 0207H and 0212H to facilitate the preparation of the pilot ladder for the Mooring Master.

1.6 Location of occurrence

1.6.1 The incident occurred⁹¹ about 0.75nm south by southeast of PWBGA i.e. within the westbound lane of the Singapore Strait TSS in Singapore territorial waters.

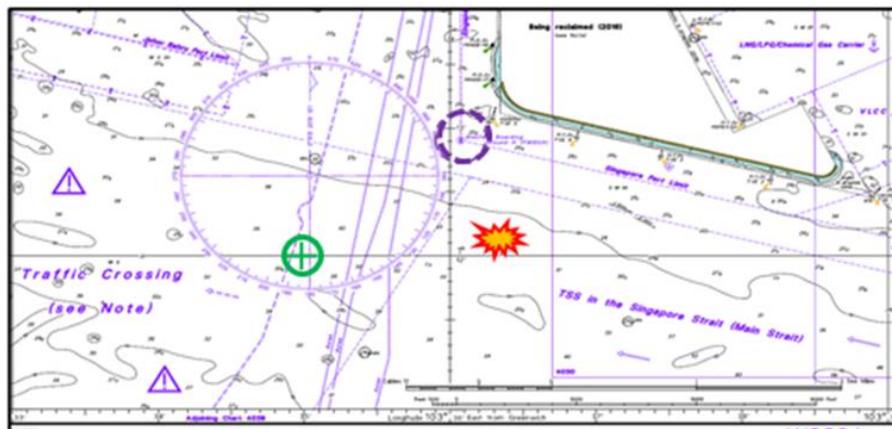


Figure 31 - Location of occurrence. Green crosshair indicates intended Fendercare Mooring Master boarding position. Purple dashed circle indicates PWBGA – annotated by TSIB

1.6.2 Near this area, eastbound vessels proceeding to embark Pilot at PWBGA could expect numerous crossing situations with vessels in the westbound lane of the TSS and extra caution⁹² needed to be exercised. There were sufficient aids to navigation available for position fixing and parallel indexing.

1.6.3 The investigation team obtained anonymous feedback from Singapore Pilots, who would typically board inbound vessels at PWBGA. The feedback mentioned, a prudent approach was required when picking up Pilot at PWBGA.

1.6.4 The feedback also mentioned that some vessels were observed to enter the Precautionary Area on a northerly heading (refer **footnote 85**) and then alter to starboard on an east-southeast heading towards PWBGA. Other vessels

⁹¹ Approximate position Latitude: 01°.12.2'N 103° 36.3'E.

⁹² PWBGA is about 0.3nm from the bund of Tuas Mega port.

would continue in the Precautionary Area further, before altering on a north-easterly heading⁹³ towards PWBGA. Furthermore, for assisting the shipmasters, the Pilot would normally board about 1nm away from the PWBGA, in the Precautionary Area, either on the western or the southern side of the PWBGA, depending on the approach of the vessels.

- 1.6.5 The feedback expressed that because of the limited sea room for manoeuvring at the boarding area, it would be desirable for vessels following the westbound lane of the TSS to proceed further south of the lane and take early actions to allow more navigable sea room for inbound vessels embarking the Pilot.
- 1.6.6 Before the occurrence, the pilot boat was in the Precautionary Area⁹⁴ and at the time the Pilots boarded the JBB Yu Hang 259 and CS⁹⁵ respectively, the pilot boat was at the edge of the Precautionary Area.
- 1.7 Environmental conditions
 - 1.7.1 The weather was fair, overcast sky with good visibility. The sea was slight with the north easterly wind at about five knots. The current was setting between 121°T and 128°T and about one knot.
- 1.8 Singapore Vessel Traffic Information System (VTIS)
 - 1.8.1 MPA operates the VTIS, which integrates data from various sources including the radars, AIS, closed-circuit television system, very high-frequency communications system and vessel databases, to provide an accurate and comprehensive understanding of the traffic in the Singapore Strait and Singapore port waters. The VTIS provides timely information and advice to help vessels transit safely through the Singapore Strait, as well as manage traffic within Singapore port waters.
 - 1.8.2 About 16min prior to the collision (see 1.1.14 and 1.1.40), VTIS (W) had advised AS to watch out for CS which was picking up the Pilot at PWBGA. This advice was acknowledged by AS.
- 1.9 Snapshot of plume modelling by MPA
 - 1.9.1 The wind direction at the time of the incident was from the north. Modelling of

⁹³ Based on the passage plan of the CS.

⁹⁴ Obtained and validated information from VTIS data.

⁹⁵ Pilot boarded CS at 0224H.

the gas plume (see **figure 32**) was conducted after the incident and it was assessed to have dissipated away from Singapore, below flammable level, within an hour.

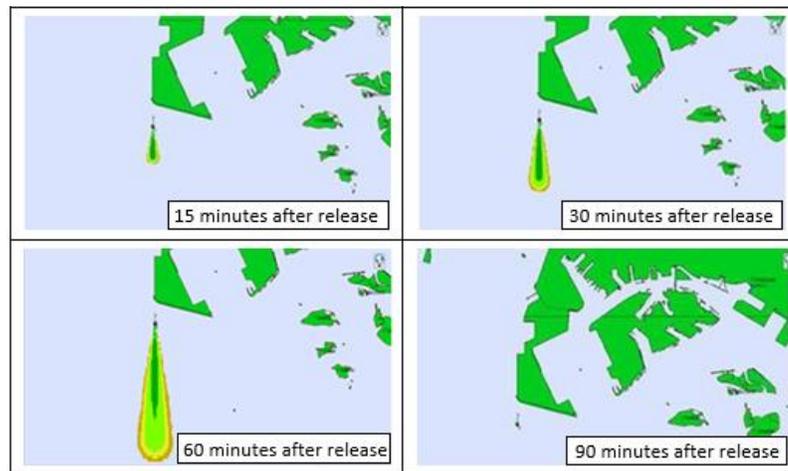


Figure 32 – Plume modelling after the occurrence (Source: MPA)

1.10 Bridge Resource Management and Safety Management Procedures

1.10.1 The definition of effective Bridge Resource Management (BRM⁹⁶) or Bridge Team Management (BTM) as provided in the International Chamber of Shipping's (ICS) Bridge Procedure Guide⁹⁷:

A bridge team...well briefed...supporting each other will have good situational awareness. Its members will then be able to anticipate dangerous situations arising and recognize the development of a chain of errors, thus enabling them to take action to break the sequence.

1.10.2 Effective BRM is part of any vessel's Safety Management System (SMS), that begins at the initial passage planning stage and includes preparation of berth-to-berth operational matters.

1.10.3 BRM is the effective management and utilisation of all resources, human and technical, available to the bridge team to ensure the safe completion of the vessel's voyage. BRM reduces the risk of marine casualties by helping the bridge team to anticipate and correctly respond to their operating condition.

1.10.4 Among others, the critical elements of communication, teamwork, decision-

⁹⁶ STCW Convention and Code on Bridge Resource Management was already in force since 1 January 2017. The definition of BRM is also provided in the the Bridge Procedures Guide – publication by the ICS which is intended to reflect best navigational practice on merchant ships and embraces internationally agreed standards and recommendations adopted by the IMO.

⁹⁷ A copy of the guide was available on CS and AS and referenced in the respective SMS.

making and fatigue, form the principles of BRM and when correctly practised would assist the bridge team in, among others:

- Maintain its situational awareness.
- Continually monitor vessels' progress.
- Anticipate dangerous situations; and
- Undertake appropriate contingency plans when required.

- 1.10.5 Bridge team members of both vessels held valid training certificates for BRM.
- 1.10.6 According to the SMS requirements of the Company of CS, if the entire passage plan cannot be completed before sailing, the ship may depart the port, provided that the first part of the passage plan is completed. The remainder plan must be completed as soon as possible after departure. The SMS also stated that vessels are required to consult Sailing Directions, Port Entry Guides and Company's circulars so that the planned passage does not contravene local requirements⁹⁸.
- 1.10.7 The Company of CS further clarified that the Company did not require the CM to receive the Pilot (as opined by the Master in the initial interview). The Company's SMS recommended⁹⁹ Master to have the CM on the bridge during approaches to port as far as practicable.
- 1.10.8 After the collision, the Company of AS had amended a section of the SMS to state specifically under the section of Singapore Straits and Tanjung Pelepas, that the use of deck lights during the night time should be avoided to prevent distractions to other ships, and that transits between ports in the area of Tanjung Pelepas and Singapore are to be performed during daylight hours only.
- 1.10.9 The Company of AS further clarified that the position provided (inside the Precautionary Area) by Fendercare was a routine boarding area for Mooring Masters to board their ships for ship to ship (STS) operation. On this day when the Mooring Master boarded AS in the TSS of the westbound lane, according to the Company of AS, there was no opportunity for the Master to question the intended position for boarding.

⁹⁸ The SMS further referenced Singapore Port Marine Circular 04 of 2013 which states, when crossing the TSS and Precautionary Area, to cross on a heading as nearly as practicable at right angles to the general direction of traffic flow. The previous voyage to Singapore CS used the same passage plan, i.e. at an angle to PWBGA.

⁹⁹ As per SMS procedure SBP 3.2.17.8

2 ANALYSIS

Bridge team of CS

2.1 Conduct of navigation

- 2.1.1 When CS was entering the Precautionary Area on a north easterly heading in accordance with its passage plan to head towards WP 64, the current started to influence CS' heading, which was initially being managed appropriately by the Master.
- 2.1.2 Subsequently, it was evident that the Master was making CS head towards the location of the pilot boat, instead of heading towards the PWBGA, as per the passage plan, which was further north. The reason for this could be because the Master was under the impression¹⁰⁰ that CS would likely be required to head towards the pilot boat's location, which was not the case.
- 2.1.3 It is a common practice for pilot boat to approach a vessel from the vessel's stern. In this case, the pilot boat would have matched the heading and speed of CS for boarding, if CS had continued its heading towards the PWBGA. There was no need for CS to proceed towards the "location" where the pilot boat was. Nevertheless, as far as practicable, boarding of Pilot should be at or near the PWBGA.
- 2.1.4 By about 0224H, when the pilot boat was alongside, CS had already reached the edge of the Precautionary Area. Prior to picking up the Pilot, the last helm order to the helmsman was "midship". Without an active "heading to steer" given to the helmsman, CS' heading would have been affected by the prevailing East by south easterly current when the pilot boat came alongside CS.
- 2.1.5 The bridge team displayed loss of situational awareness when they did not recognise this effect of the current while embarking the Pilot which resulted in CS entering the westbound lane of the TSS against the general direction of traffic flow, on an easterly heading. With the helm at midship, the engine was stopped, after receiving report that the Pilot was on deck and the boat was clear of the shipside. The easterly heading, however, continued to change as CS turned clockwise to starboard due to an existing RoT. The earlier aspect

¹⁰⁰ It was possible that the perception arose because of how the Pilot boarded the JBB Yu Hang 259 and the information given to the Master during the bridge team meeting on 15 April 2018 regarding CS' previous passage to Singapore.

of CS which was on a starboard to starboard passing with AS (see **figures 7, 17 and 22**), had evolved into a crossing situation, where CS' bow was now showing an aspect of crossing the path of AS (see **figures 18 and 24**).

2.1.6 It would be desirable for the bridge team to follow the passage plan in picking up the Pilot from the PWBGA and take into consideration the effect of the sea current on the vessel when picking up the Pilot.

2.2 Bridge Resource Management

2.2.1 The bridge team of CS consisted of the Master, 2M, and ASD (on hand steering). This composition was not as per the Company's established SMS for navigation in such areas and proved to be inadequate. Not having been to the port of Singapore for a long time, the bridge team of CS might have underestimated the traffic situation that CS would encounter near PWBGA.

2.2.2 The 2M was focusing on the radars and monitoring CS' passage on the ECDIS, in addition to operating the telegraph. There was no dedicated lookout¹⁰¹ who could have monitored the targets in the vicinity, including the status of AS (whether anchored or underway¹⁰²), and fed the information to the Master. A proper lookout¹⁰³ would have given more accurate information¹⁰⁴ that AS was indeed a power-driven vessel making way through the water, as she was displaying lights of such a vessel.

2.2.3 The plan on how PWBGA was to be approached, and how many members were to be on the bridge team was not discussed during the bridge team meeting. Similarly, the passage plan clearly stated what the bridge team composition was expected to be during the passage in Singapore Strait. Both these events were a missed opportunity for the Master to plan the passage properly as well as for the OOW to inform the Master that the bridge team composition on the day was not as per the passage plan. It is also likely that the Master had not taken details in the passage plan into account at the time of approving it.

2.2.4 Instead of having the senior-most navigator i.e. the CM (after the Master) on

¹⁰¹ Especially after the lookout who was tasked to engage the manual steering.

¹⁰² The term underway means that the vessel is not at anchor or made fast to the shore or aground.

¹⁰³ COLREGs Rule 5 – Look-out - Every vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision.

¹⁰⁴ By using other means, such as visual bearing, distance by radar, AIS and ECDIS.

the bridge for support (as per Company's recommendation), the CM was tasked¹⁰⁵ to first supervise the preparation of the pilot ladder arrangements and then to receive the Pilot. Proper planning could have allowed another officer to be called to receive the Pilot and the CM's assistance on the bridge could have been useful for improving the situational awareness of the bridge team at the time when CS was entering the Precautionary Area to make its approach to PWBGA.

- 2.2.5 The navigational information provided by the 2M to the Master was passive, that is, information given only when asked. Although AS had been acquired by the 2M to be a vessel following the westbound lane of the TSS since 0214H, this information had not been actively shared with the Master in a timely manner. It appeared that the Master and 2M were working with limited teamwork which resulted in limited information exchange between them.
- 2.2.6 Communication is the foundation of effective BRM to ensure the information obtained is processed and conveyed timely. Whether the past working relationship (**see footnote 79**) between the Master and 2M contributed to this lack of proactive communication, could not be firmly established, but could not be ruled out as a possible contributing factor. The BRM on CS was ineffective in the management and utilisation of all resources, both human and technical. When the 2M felt a strain in the relationship, the matter should have been brought up and discussed openly during bridge team meeting for ensuring safety of navigation.
- 2.2.7 Although the Master added that the volume of emails from the shore office added stress, the investigation team views that this could have been managed appropriately by allocating resources timely.
- 2.2.8 Although the Company had taken reasonable steps to equip the Master by providing an area-specific simulator exercise as a part of the Bridge Resource Management training during the recruitment process, the Master had not ensured that the Bridge team provided adequate support for navigation.
- 2.3 Actions prior to collision
- 2.3.1 The Master was aware of AS' presence on the starboard side and perceived that the vessel was at anchor. This perception was likely due to the deck lights (refer to para 1.1.39 – AS had likely switched on its deck light) seen by the bridge team.

¹⁰⁵ The Master's opinion that the Company's SMS required the CM to receive the Pilot was incorrect.

- 2.3.2 Subsequently, when the Master was advised by the 2M to “Alter course to port” (refer paragraph 1.1.25), the Master expressed doubt on the ability to do so, especially due to the uncertainty of AS’ actual movements. It was also evident that when communicating with each other prior to the collision, both the Master and 2M were referencing to different vessels, with the former referring to AS, and the latter referring to target 63.
- 2.3.3 As mentioned in 2.2.2, the bridge team of CS had not maintained proper lookout prior to the collision. This had likely contributed to the Master’s inability to make a proper assessment to determine the risk of collision as per the COLREGs Rule 7¹⁰⁶. The COLREGs (Rule 7b and 7c) recognises that the risk of collision should be appropriately addressed and without any assumptions based on scanty radar information. This improper assessment then led to an incorrect assumption and the action to be taken to avoid a collision as per the COLREGs Rule 8¹⁰⁷.

¹⁰⁶ COLREGs RULE 7 – Risk of Collision

- a. Every vessel shall use all available means appropriate to the prevailing circumstances and conditions to determine if risk of collision exists. If there is any doubt such risk shall be deemed to exist.
- b. Proper use shall be made of radar equipment if fitted and operational, including long-range scanning to obtain early warning of risk of collision and radar plotting or equivalent systematic observation of detected objects.
- c. Assumptions shall not be made on the basis of scanty information, especially scanty radar information.
- d. In determining if risk of collision exists the following considerations shall be among those taken into account:
 - i. Such risk shall be deemed to exist if the compass bearing of an approaching vessel does not appreciably change.
 - ii. such risk may sometimes exist even when an appreciable bearing change is evident, particularly when approaching a very large vessel or a tow or when approaching a vessel at close range.

¹⁰⁷ COLREGs RULE 8 - Action to avoid collision

- a) Any action taken to avoid collision shall, if the circumstances of the case admit, be positive, made in ample time and with due regard to the observance of good seamanship.
- b) Any alteration of course and/or speed to avoid collision shall, if the circumstances of the case admit, be large enough to be readily apparent to another vessel observing visually or by radar a succession of small alteration of course and/or speed should be avoided.
- c) If there is enough sea room, alteration of course alone may be the most effective action to avoid at close quarters situation if it is made in good time, is substantial and does not result in another close-quarters situation.
- d) Action taken to avoid collision with another vessel shall be such as to result in passing at a safe distance. The effectiveness of the action shall be carefully checked until the other vessel is finally past and clear.
- e) If necessary, to avoid collision or allow more time to assess the situation, a vessel shall slacken her speed or take all way off by stopping or reversing her means of propulsion.
 - i. A vessel which, by any of these Rules, is required not to impede the passage or safe passage of another vessel shall, when required by the circumstances of the case, take early action to allow sufficient sea room for safe passage of the other vessel.

- 2.3.4 As a result, actions to be taken were left till the last minute, as happened in this case and the Master subsequently giving a port helm of 20° to a full port helm, in addition to half astern followed by full astern on the engines.
- 2.3.5 At about 0228H, when the Pilot arrived at the bridge, the astern engine movement further caused CS' bow to cant (turn) to starboard. It must be noted that even if the engine would have been put to full astern at this time, the turn to starboard was inevitable and the collision was unavoidable as the two vessels were too close to each other.
- 2.3.6 The investigation team also noted that when taking actions to avoid collision with AS, appropriate sound and light signals as required by the COLREGs Rule 34(a) and (b), if given, would have possibly indicated to the bridge team of AS on actions being taken by CS.

Bridge team of AS

- 2.4 Conduct of navigation
- 2.4.1 When AS passed WP 6, the Master's intention was to stay closer to the northern limit of the TSS was (in the Master's opinion) to minimise the encounter with the inbound vessels. The investigation team opined that by doing so, the possibility of bunching and the risks associated with it, near PWBGA increased, giving less room for AS to manoeuvre closer to PWBGA.
- 2.4.2 Considering that the position provided by Fendercare for the boarding of Mooring Master was in the Precautionary Area, it would have been desirable for the Master, considering all information, to make changes to the passage plan¹⁰⁸ at the appraisal and planning stage, rather than during the execution stage. Accordingly, AS' passage could have been kept closer to the southern limit of the TSS, before approaching the Fendercare rendezvous position, once in the Precautionary Area.
- 2.4.3 In fact, by navigating closer to the northern limit of the TSS to pick up the Mooring Master in the westbound lane of the TSS had increased the risk of

-
- ii. A vessel required not to impede the passage or safe passage of another vessel is not relieved of this obligation if approaching the other vessel so as to involve risk of collision and shall, when taking action, have full regard to the action which may be required by the Rules of this Part.
 - iii. A vessel the passage of which is not to be impeded remains fully obliged to comply with the Rules of this Part when the two vessels are approaching one another to involve risk of collision.

¹⁰⁸ SOLAS V/34, as amended – Safe Navigation - Guidelines for voyage planning (Resolution A.893(21))

AS encountering inbound vessels picking up a Pilot as evident in this case.

2.4.4 The Company of AS informed the investigation team that based on the Company's interview with the bridge team, the deck lights were not switched on before the collision. Correlating the account of the bridge team of CS and information from the VDR of both vessels suggested that some deck lights on AS were indeed lit¹⁰⁹, which may have led to the confusion on the bridge of CS regarding the status of AS prior to embarking the Pilot.

2.5 Actions prior to collision

2.5.1 Despite being advised by VTIS (W) to look out for CS, the Master of AS did not coordinate with the workboat on where the embarkation of the Mooring Master was to take place. Instead, the Master relied on the workboat making its approach towards AS by providing light indications (see paragraph 1.1.41) for identification purposes.

2.5.2 It appeared that while embarking the Mooring Master, with CS having crossed AS' bow, the bridge team of AS did not anticipate CS turning into the path of AS. Although, the Master of AS reacted to the change in aspect of CS at about 0227H, the possibility of the AS' bridge team being distracted, with the presence of a workboat and the embarkation of the Mooring Master could not be ruled out. This situation highlighted the importance of an enhanced level of attentiveness especially in an area where vessels were involved in embarking Pilots.

2.5.3 When the Master of AS saw CS turning into its path and expressed doubt of CS' intention or action to the other bridge team members, although the bridge team of AS attempted to call CS before the collision, appropriate sound and light signals as per COLREGs Rule 34(d)¹¹⁰ should have been made. It would also have been prudent for the Master of AS to, as per COLREGs 8(e), take all way off by stopping or reversing the means of propulsion to avoid a collision, while making sound and light signals to indicate such manoeuvres in

¹⁰⁹ The investigation team could not establish with certainty how many deck lights on AS were lit to facilitate the embarkation of the Mooring Master.

¹¹⁰ Rule 34 (d) When vessels in sight of one another are approaching each other and from any cause either vessel fails to understand the intentions or actions of the other, or is in doubt whether sufficient action is being taken by the other to avoid collision, the vessel in doubt shall immediately indicate such doubt by giving at least five short and rapid blasts on the whistle. Such signal may be supplemented by a light signal of at least five short and rapid flashes.

accordance with COLREGs Rule 34(a¹¹¹) and (b¹¹²).

2.6 Incidental observations

2.6.1 It is noted that the arrangement to pick up Pilot and Mooring Master for both CS and AS respectively were made separately. The investigation team also noted that the prudent approach required when picking up Pilot at PWBGA considering the limited sea room for manoeuvring.

2.6.2 Although the Pilot Office provided the boarding speed (see paragraph 1.1.6) at the time CS called to confirm the pilot booking time, it would be good to remind shipmasters to come to designated pilot boarding grounds for embarking of Pilot.

¹¹¹ Rule 34 (a) - When vessels are in sight of one another, a power-driven vessel underway, when manoeuvring as authorised or required by these Rules, shall indicate that manoeuvre by the following signals on her whistle: -

- i. One short blast to mean "I am altering my course to starboard";
- ii. two short blasts to mean "I am altering my course to port";
- iii. three short blasts to mean "I am operating astern propulsion"

¹¹² Rule 34 (b) - Any vessel may supplement the whistle signals prescribed in paragraph (a) of this Rule by light signals, repeated as appropriate, whilst the manoeuvre is being carried out:

These light signals shall have the following significance:

- i. One flash to mean "I am altering my course to starboard";
- ii. two flashes to mean "I am altering my course to port";
- iii. three flashes to mean "I am operating astern propulsion";

3 CONCLUSIONS

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

- 3.1 The bridge team of CS had likely underestimated the traffic conditions at PWBGA. This could have attributed by the Master's long gap of operating in this part of the world and lack of proactive communication between the Master and 2M by not taking the details contained in the passage plan into account when executing it.
- 3.2 In approaching PWBGA to embark the Pilot, CS did not follow the passage plan to pick up the Pilot from the designated area.
- 3.3 The bridge team of CS appeared to have lost situational awareness and did not notice the clockwise turn of CS' heading which resulted in CS entering the westbound lane of the TSS. This had developed into a crossing situation with AS instead of the earlier starboard to starboard passing.
- 3.4 The bridge team composition for CS was not in accordance with the Company's SMS which resulted in the lack of proper lookout.
- 3.5 There was inadequate BRM on board CS, particularly on the sharing of vital information of other vessels in the vicinity and use of resources. This had resulted in the Master and 2M referencing to the movement of different vessels in the vicinity prior to the collision. In addition, the CM was sent to receive the Pilot instead of doing more important navigational duties. The lack of effective BRM had also resulted in the delay in assessing the impending collision.
- 3.6 The delayed assessment of the risk of collision by the bridge team of CS had rendered the subsequent avoidance actions by the crew to be ineffective.
- 3.7 Receiving the Mooring Master inside the TSS at an area near the Pilot boarding ground, instead of the rendezvous position (in the Precautionary Area), and keeping the passage closer to the northern limit of the TSS,

indicated that the Master of AS had incorrectly perceived the traffic condition and movement of vessels in the area.

- 3.8 The AS' bridge team likely had been distracted when the Mooring Master was boarding the vessel and did not detect the collision situation when CS' course changed.
- 3.9 When CS' aspect was noted to change and not knowing CS' intention, the Master of AS, instead of stopping the engines or taking all way off, increased the engines to full ahead with a helm of full to starboard.
- 3.10 To facilitate the embarkation of the Mooring Master, some of the deck lights of AS were switched on which led to the confusion on the bridge of CS regarding the status of AS.
- 3.11 Both CS and AS did not sound or make the appropriate signals as per COLREGs Rule 34(a) and (b) when taking actions to avoid collision with each other.
- 3.12 Regardless of the approach required for boarding of Pilot at PWBGA, a reminder could be given by the Pilot Office to proceed towards the Pilot boarding grounds for embarking of Pilot.

4 SAFETY ACTIONS

Arising from the occurrence, the Companies of CS and AS had taken the following safety actions.

4.1 CS' Company

4.1.1 Immediate

- Onboard safety meeting along with training session of the bridge team conducted by the Company's Quality Health Safety and Environment Superintendent, among others, includes BRM, bridge manning level (BML), maintaining a proper lookout, compliance with COLREGs.
- The bridge team of CS involved in the incident was relieved and sent for refresher training (Bridge Team Management Level 2) at the Company's training centre; and
- Safety Flash of the incident and navigational campaigns with a key focus on the contributory causes of the occurrence and BRM conducted across the fleet.

4.1.2 Medium term

- The office initiated an anonymous survey and navigation campaign across all vessels in the fleet to identify and address the difficulties and underlying causes in maintaining BML, BRM, and collision avoidance.
- Findings and feedback from the incident were included as case study in the Bridge Team Management course; and
- New Risk Assessment "Navigation in Singapore/Malacca Straits" contributory causes and analysis of the occurrence has been included and prepared as an addendum to risk assessment – before transiting the Singapore and Malacca Strait.

4.1.3 Long term

- Post-incident, seminars/workshops carried out to engage all staff ashore and at sea. This staff engagement with incident feedback form will be continued till 12 months post-incident date, with an increased focus on unsafe behaviours leading to such incidents and the promotion of the 'Challenge and Response' culture.
- Existing regime of VDR reviews to be enhanced for better monitoring of near misses, safety culture and compliance of bridge manning level

during critical passages.

- Case study and lessons learnt to be developed as a computer-based training in the online 'Learning Management System'. This would be assigned to each deck officers for completion prior assignment on board the vessel; and
- All vessels in the fleet to conduct risk assessment (NAV 003 as revised and NAV 003A) each time prior transiting Singapore/Malacca Strait, and should the residual risk be high and above, vessel to engage the office for review for additional control measures that need to be initiated to mitigate the risk.

4.2 AS' Company

4.2.1 The Health Safety Quality Environment Manager conducted the following:

- Reviewed and amended the SMS¹¹³ procedures to prohibit the use of deck lights during hours of darkness while underway.
- Reviewed SMS procedures on individual Risk Assessment for transiting Singapore Strait.
- Alert and Lessons Learn report circulated to the fleet.
- Navigational audit conducted on voyage by the Port Captain to include Bridge Team Management

4.2.2 The Training Manager had prepared and developed:

- A simulator case study utilising data from the VDR for training purposes, which among others, includes:
 - Simulation of the incident in a bridge simulator.
 - A case study with the attending Masters and Officers for discussion and in-depth studies of the incident, and
 - Assessment of the bridge team reactions.
- Navigational Competence Assurance System, which among others:
 - Competencies for Deck Officers career development,
 - Detailed Assessment Requirements per rank, and

¹¹³ Section 6.3.4.4 of the vessel's Navigation Procedures Manual.

- Surveillance requirements of Training Centres providing BTM/BRM and ship handling courses.

4.3 Pilot Office

- 4.3.1 After the incident, the Pilot Office had issued reminders to Masters and respective agents, for ships coming to Singapore to proceed to the respective Pilot boarding grounds for embarking Pilot.

5 SAFETY RECOMMENDATIONS

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

5.1 For the Company of CS

5.1.1 To ensure that the passage plan is made so that the vessel crosses the general direction of traffic flow at right angles when arriving from the west for PWBGA. **[TSIB-RM-2020-031]**

5.1.2 To ensure that Pilot is received at the designated Pilot boarding ground and passage plan executed accordingly. **[TSIB-RM-2020-032]**

5.2 For the Company of AS

5.2.1 To ensure the planned passage is executed for the embarkation of Mooring Master to take place at the designated boarding area to minimise encounter with inbound vessels embarking Pilot at the designated Pilot boarding ground. **[TSIB-RM-2020-033]**