MA2025-5

MARINE ACCIDENT
INVESTIGATION REPORT

May 29, 2025

JTSB Japan Transport Safety Board

The objective of the investigation conducted by the Japan Transport Safety Board in accordance with the Act for Establishment of the Japan Transport Safety Board is to determine the causes of an accident and damage incidental to such an accident, thereby preventing future accidents and reducing damage. It is not the purpose of the investigation to apportion blame or liability.

RINOIE Kenichi
Chairperson
Japan Transport Safety Board

Note:

This report is a translation of the Japanese original investigation report. The text in Japanese shall prevail in the interpretation of the report.

《Reference》

The terms used to describe the results of the analysis in "3. ANALYSIS" of this report are as follows.

i) In case of being able to determine, the term "certain" or "certainly" is used.

ii) In case of being unable to determine but being almost certain, the term "highly probable" or "most likely" is used.

iii) In case of higher possibility, the term "probable" or "more likely" is used.

iv) In a case that there is a possibility, the term "likely" or "possible" is used.

MARINE ACCIDENT INVESTIGATION REPORT

Vessel type and name: Container Vessel CONTSHIP UNO
IMO number: 9379026
Gross tonnage: 9,940 tons

Vessel type and name: Cargo vessel Izumi Maru
Vessel number: 140283
Gross tonnage: 499 tons

Accident type: Collision
Date and time: August 24, 2023 at around 23:29:15 (local time, UTC+9 hours)
Location: Kii Suido off the northwest coast of Hi-no-Misaki, Wakayama Prefecture
Around 312° true bearing 7.3 nautical miles from the Kii Hi-no-Misaki Lighthouse.
(approximately 33°57.8′N, 134°57.1′E)

April 30, 2025
Adopted by the Japan Transport Safety Board

Chairperson RINOIE Kenichi
Member ITO Hiroyasu
Member UENO Michio
Member SODA Hisako
Member TAKAHASHI Akiko

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SYNOPSIS

< Summary of the Accident >

The container vessel CONTSHIP UNO (hereinafter referred to as "Vessel A"), with the master and 17 crew members aboard, was sailing southbound toward Keelung Port, Taiwan. Meanwhile, the cargo vessel Izumi Maru (hereinafter referred to as "Vessel B"), with the master and 4 crew members aboard, was sailing northwest toward Mizushima Port, Okayama Prefecture. On August 24, 2023, at around 23:29, the two vessels collided in Kii Suido, off the northwest coast of Hi-no-Misaki, Wakayama Prefecture, causing Vessel B to capsize.

As a result, two crew members of Vessel B died, and three sustained serious injuries. Vessel A sustained damage, including a breach to its bow, however, there were no injuries among its crew. Vessel B, adrift in a capsized state, sank at around 02:50 on August 26.

< Probable Causes >

The JTSB concludes that the probable cause of this accident, at night in Kii Suido, where Vessel A was sailing southbound, and Vessel B was sailing northwest is as follows. It is probable that the Second officer of Vessel B (hereinafter referred to as "Officer B_1"), while working at the chart table in the aft of the bridge, did not maintain lookout and did not notice Vessel A until it was too close in range, resulting in delayed action. Meanwhile, Third Officer (hereinafter referred to as "Officer A_1"), assuming that Vessel B would give way to Vessel A according to the navigation rules for a crossing situation, neither confirmed Vessel B's intentions via international VHF radiotelephone nor gave a warning signal, and instead took repeated steering slightly to port and to starboard, missing the chance to avoid collision with Vessel B. As a result, both vessels collided.

It is probable that Vessel B did not maintain lookout, because after the previous watch personnel left the bridge, Officer B_1 was engaged in tasks that should have been completed during the handover, which attributed to a diminished safety awareness regarding navigation and an improper handover of the bridge watch.

It is probable that the Vessel A did not confirm Vessel B's intentions via international VHF radiotelephone or gave warning signals, and instead took action only through repeated slight steering, was due to the ineffective implementation of BRM/BTM on Vessel A.

1 PROCESS AND PROGRESS OF THE INVESTIGATION

1.1 Summary of the Accident

The container vessel CONTSHIP UNO, with the master and 17 crew members aboard, was sailing southbound toward Keelung Port, Taiwan. Meanwhile, the cargo vessel Izumi Maru, with the master and 4 crew members aboard, was sailing northwest toward Mizushima Port, Okayama Prefecture. On August 24, 2023, at around 23:29, the two vessels collided in Kii Suido, off the northwest coast of Hi-no-Misaki, Wakayama Prefecture, causing Izumi Maru to capsize.

As a result, two crew members of the Izumi Maru died, and three sustained serious injuries. The CONTSHIP UNO sustained damage, including a breach to its bow, however, there were no injuries among its crew. The Izumi Maru, adrift in a capsized state, sank at around 02:50 on August 26.

1.2 Outline of the Accident Investigation

1.2.1 Setup of the Investigation

The Japan Transport Safety Board (JTSB) appointed an investigator-in-charge and two other investigators to investigate this accident on August 25, 2023.

1.2.2 Collection of Evidence

August 26 and 27, 2023: On-site investigation and interviews

October 4, 17, 23 and November 28, 2023: Interviews

November 28, 2023: Interviews and collection of documents

August 28, September 22, 27, October 12, 13, 24, November 13, 28, and December 26, 2023, and March 15, April 5, 15, 23, May 28, and August 23, 27, 2024: Collection of documents

1.2.3 Interim Report

On July 25, 2024, the interim report based on the findings of the investigation up to that point was submitted to the Minister of Land, Infrastructure, Transport and Tourism and made public.

1.2.4 Comments of Parties Relevant to the Cause

Comments on the draft report were invited from parties relevant to the cause of accident.

1.2.5 Comments from the Flag State

Comments from the Flag State of the CONTSHIP UNO were received.

2 FACTUAL INFORMATION

2.1 Events Sequence

2.1.1 Navigation Tracks

According to the records by the Voyage Data Recorder[*1] (VDR) of the CONTSHIP UNO (hereinafter referred to as "Vessel A"), the navigation tracks of Vessel A between 23:00-30 on August 24, 2023, were as shown in Appendix Tables 1 and 2.

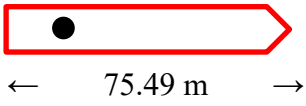
According to the records by the Automatic Identification System[*2] (AIS) received by a private information company (hereinafter referred to as "AIS records"), the navigation tracks of the Izumi Maru (hereinafter referred to as "Vessel B") between 23:00-30 on August 24, 2023, were as shown in Appendix Table 3.

The tracks of Vessel A and Vessel B are illustrated in Figure 1.

The positions for Vessel A VDR records and for Vessel B AIS records indicate the positions of each vessel's GPS antenna.

Vessel A GPS antenna position: approximately 137 m from the bow, 11 m from the stern, 9 m from the port-side, and 15 m from the starboard-side.

Vessel B GPS antenna position: approximately 61 m from the bow, 14 m from the stern, 5 m from the port-side, and 7 m from the starboard-side.



Unless otherwise specified in this report, courses refer to the Course Over the Ground[*3], speeds to the Speed Over the Ground, and bearings to true bearings.

[*1] "Voyage Data Recorder (VDR)" is an instrument that is able to record the position, course, speed, radar information and other data about navigation as well as communication by VHF radio telephone and voices in the bridge

[*2] "Automatic Identification System (AIS)" is a device that each vessel uses to automatically transmit and receive information such as vessel identification code, ship type, name, position, course, speed, destination, and conditions of navigation, and to exchange information with other vessels or land-based navigation aids.

[*3] "Course Over the Ground (COG)" refers to the actual course relative to the ground, accounting for factors such as leeway and tidal currents.

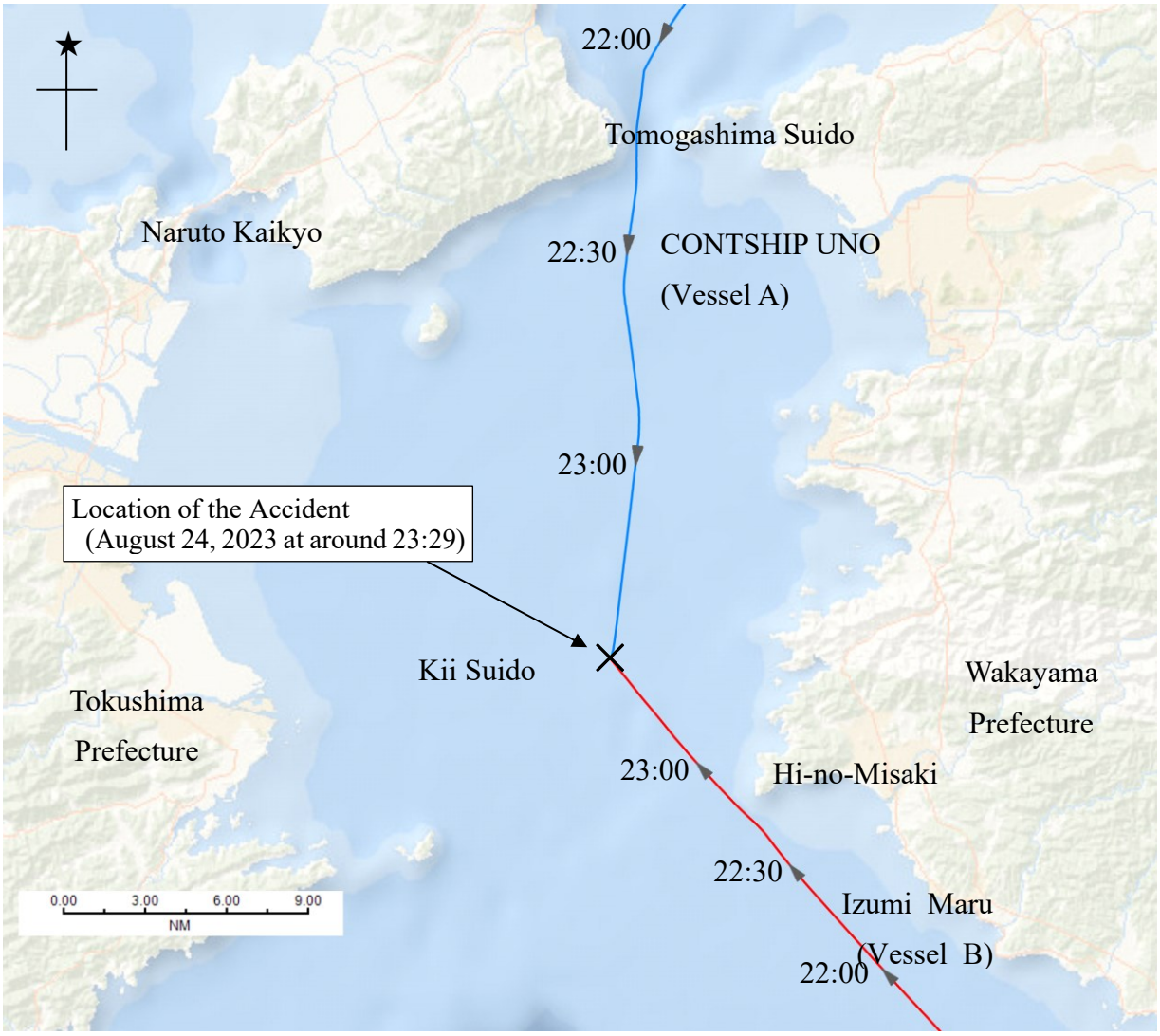


Figure 1: Navigation Tracks

2.1.2 Vessel and Voyage

(1) Particulars of the Vessels

	Vessel A	Vessel B
Vessel number	9379026 (IMO number)	140283
Port of registry	Monrovia, Republic of Liberia	Tokyo, Japan
Owner	SCHLESWIG NAVIGATION CORP.	Izumi Kaiun Co., Ltd.
Charterer	—	Shinto Kaiun Co., Ltd.
Management company	CONTSHIPS MANAGEMENT INC.	—
Class	RINA	—

Gross tonnage	9,940 tons Maximum capacity of 1,118 TEU*4	499 tons
L×B×D	147.87m×23.25m×11.50m	75.49m×12.30m×7.00m
Construction	Steel	Steel
Engine	Diesel	Diesel
Output	9,730kW	1,471kW
Propulsion	1 controllable pitch propeller	1 fixed pitch propeller
Year of build	2007	2006

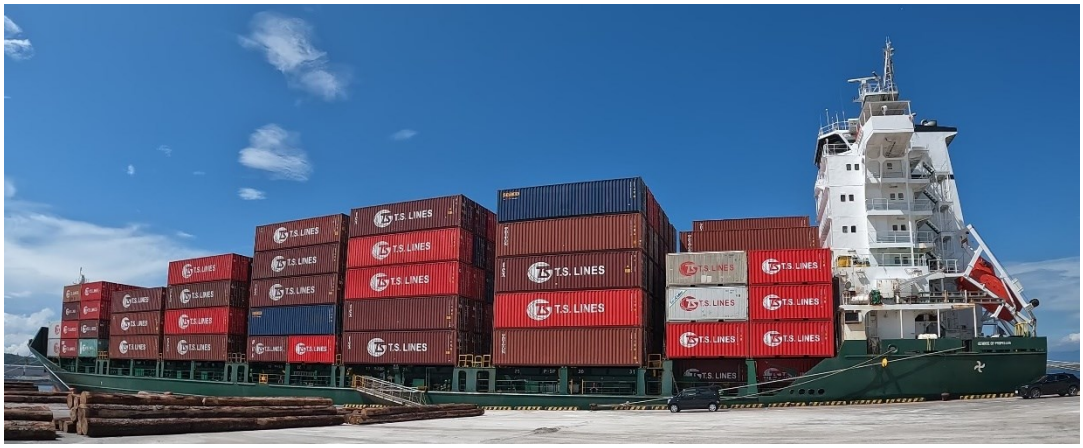


Figure 2: Vessel A

Figure 3: Vessel B (before the accident)

(2) Voyage Information

	Vessel A	Vessel B
Departure port	Osaka, Hanshin Port	Katsunan, Chiba Port

*4 "TEU: Twenty-feet Equivalent Unit" refers to the container quantity in units of one 20-feet container.

Destination	Keelung Port, Taiwan	Mizushima Port, Okayama Prefecture
Cargo	Approx. 4,624t of containers	Approx. 1,115 t of scrap
Draft	Fore: Approx. 5.8 m, Aft: Approx.7.7 m	Fore: Approx. 3.2 m, Aft: Approx.4.5 m
Number of crew members	18	5

2.1.3 Events to the Accident

(1) Vessel A

① During the Master's Presence on the Bridge

Based on statements from the Master of Vessel A (hereinafter referred to as "Master A"), the Third Officer (hereinafter referred to as "Officer A_1"), and the Able seaman (hereinafter referred to as "AB A"), as well as written responses from Officer A_1 and Vessel A VDR records, the progress of Vessel A's navigation from departure to when Master A left the bridge was as follows:

Vessel A departed Osaka, Hanshin Port, around 20:06 on August 24, 2023.

Master A conned the vessel on the bridge, assisted by the Chief Officer (hereinafter referred to as "Officer A_2"), during unberthing operations. After unberthing, Master A instructed AB A, who had come up to the bridge, to serve as an AB A and navigate the passage in the port.

After passing the passages, although it was scheduled for Officer A_1 and AB A to take watch from 20:00, however, conning the vessel by himself until passing through the Tomogashima Suido. After crossing the Osaka Wan Pilotage area[*5], Master A decided to let Officer A_1 gain experience in basic watchkeeping duties, and at around 22:26, he gave the con to Officer A_1.

Vessel A had a steering stand positioned in the center of the bridge, with control seats located on both sides. In front of the starboard-side seat was an X-band radar[*6] (hereinafter referred to as the "starboard radar"), and in front of the port-side seat was an S-band radar[*7] (hereinafter referred to as the "port radar"), for a total of two radars installed (see Figure 13 in Section 2.7). The Vessel A VDR recorded data

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[*5] The "Osaka Wan pilotage area" is one of 34 pilotage areas designated under the Pilotage Act (Act No. 121 of 1949) and its Enforcement Order (Cabinet Order No. 354 of 1964). A boarding and disembarkation point for pilots of this district is located south of Tomogashima Suido.

[*6] "X-band" refers to the radar frequency band that uses the 9,000 MHz range. Compared to the S-band, it has a shorter wavelength and is more effective at capturing reflected waves.

[*7] "S-band" refers to the radar frequency band that uses the 3,000 MHz range. Compared to the X-band, it has a longer wavelength and is better suited for detecting distant targets.

only from the Starboard Radar (with captured images of the radar screen saved at 15-second intervals).

At the time of handover from Master A to Officer A_1, the Starboard Radar was set to a 6 nautical mile (M) range with a north-up[*8] display in an off-center[*9] configuration. Vectors[*10] were set to 6 minutes, and echo trails to 1 minute.

Additionally, the starboard radar displayed a planned course in red, as per the voyage plan, showing a southward heading of 180° from the Tomogashima Suido, with a course alter to 205.8° at approximately 22:26 near 34°00.0′N, 134°58.4′E (see Appendix Figure 1: Vessel A Starboard Radar Screen①).

After giving the con to Officer A_1, Master A remained on the bridge and instructed Officer A_1 to call him immediately if necessary. He then worked on tasks such as checking emails on the PC located at the aft port side of the bridge.

Vessel A continued navigating under the command of Officer A_1, with AB A assigned to a visual lookout. The ship proceeded on autopilot at a heading of approximately 180° and a speed of about 15 knots. At around 22:54, a northbound tanker located about 12 M south of Vessel A called its name via international VHF radiotelephone (hereinafter referred to as "VHF"). Master A, who was on the bridge, responded and agreed to pass port-to-port with the oncoming tanker vessel.

Master A checked the surroundings on the radar and advised Officer A_1 to turn to starboard to ensure the port-to-port agreement with the oncoming tanker was clear and to increase the passing distance from "four vessels crossing the bow from starboard to port" (hereinafter "the four Crossing vessels").

At around 22:56, the starboard radar, using its Target Tracking (hereafter referred to as "TT") function, plotted the four Crossing vessels, and the target information for one of them (TT No. 17) was displayed (see Appendix Figure 1:②).

By 23:03, the starboard radar plotted the oncoming tanker with which Master A had communicated via VHF, displaying its target information (TT No. 75) (see Appendix Figure 1: ③).

After confirming that the autopilot heading had been adjusted to 186° and that there were no other vessels in the vicinity posing navigational obstacles, Master A

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*8 "North-Up" refers to a radar display mode where north is fixed at the top of the screen.

*9 "Off-Center" refers to a radar display mode where the vessel's position is shifted away from the center of the display.

*10 "Vector" refers to a predicted movement line on a radar display based on a vessel's course and speed over a set time.

instructed Officer A_1 to continue monitoring the situation until the risk of close quarter situation with the four Crossing vessels was cleared, as Vessel A was the give-way vessel in relation to them, and told him to call Master A immediately in any case of doubt. Master A then left the bridge at around 23:04.

② After Master A Left the Bridge

According to Vessel A VDR records, the progress of Vessel A's navigation after Master A left the bridge unfolded as follows (see Table 1):

Vessel A continued southward on a course of approximately 187°, with the heading maintained at 186° taking a periodic small rudder angle of 2° to starboard and 1° to port.

At around 23:06, Vessel B entered the radar range, appearing on the starboard radar screen at a distance of approximately 9.3 M (see Appendix Figure 1:④). By approximately 23:23, Vessel B was plotted at a distance of around 2.5 M, and its TT number and vector were displayed (see Appendix Figure 1:⑥). Subsequently, a "BOW CROSS Alert" and "CPA/TCPA Alert"[*11] (hereinafter referred to as "close quarter alert"), were intermittently displayed, as shown in Table 1.

Vessel A VDR records also contained TT information that was not displayed on the starboard radar screen (see Appendix Tables 4 and 5).

After Master A left the bridge at 23:04, the starboard radar remained set to the 6M range until the collision with Vessel B, and there was no movement of the cursor. The information displayed in the target information area continued to show the details of the tanker (TT No. 75) that had been displayed at around 23:03 (see Appendix Figure 1:④ onward).

At around 23:20, Vessel A passed approximately 1 M west of the planned altering course waypoint and continued on a course of approximately 187° (see Appendix Figure 1:⑤). By this time, the four Crossing vessels had all cleared. Among other vessels besides Vessel B, the one that approached Vessel A most closely was a vessel trailing behind the four Crossing vessels (hereinafter referred to as "Vessel C"). Vessel C was not plotted by the starboard radar, and its CPA was approximately 0.4–0.5 M, with its bearing change to port (see Appendix Table 5).

[*11] Terms like "BOW CROSS," "CPA," and "TCPA" are explained in section 2.8.1, "General Information on Radar Usage."

From around 23:26:30, small steers were made in the sequence of starboard, port, starboard, port, and starboard, causing Vessel A's heading to sway port-side and starboard-side as it began a gentle turn to starboard.

At approximately 23:28:35, the rate of turn[*12] of Vessel A began a turn to starboard, and the starboard turn continued. By around 23:29:15, the ship's heading was 212°, with a speed of 14.4 knots, a course of 198.8°, and a rate of turn of +34.7°/min, and the bow collided with the mid-starboard side of Vessel B.

(See Table 1, Figures 1, 4, and 5, Appendix Figure 1, and Appendix Tables 1 and 2.)

Table 1: Operational Progress Based on Vessel A VDR Records (23:05–23:29)

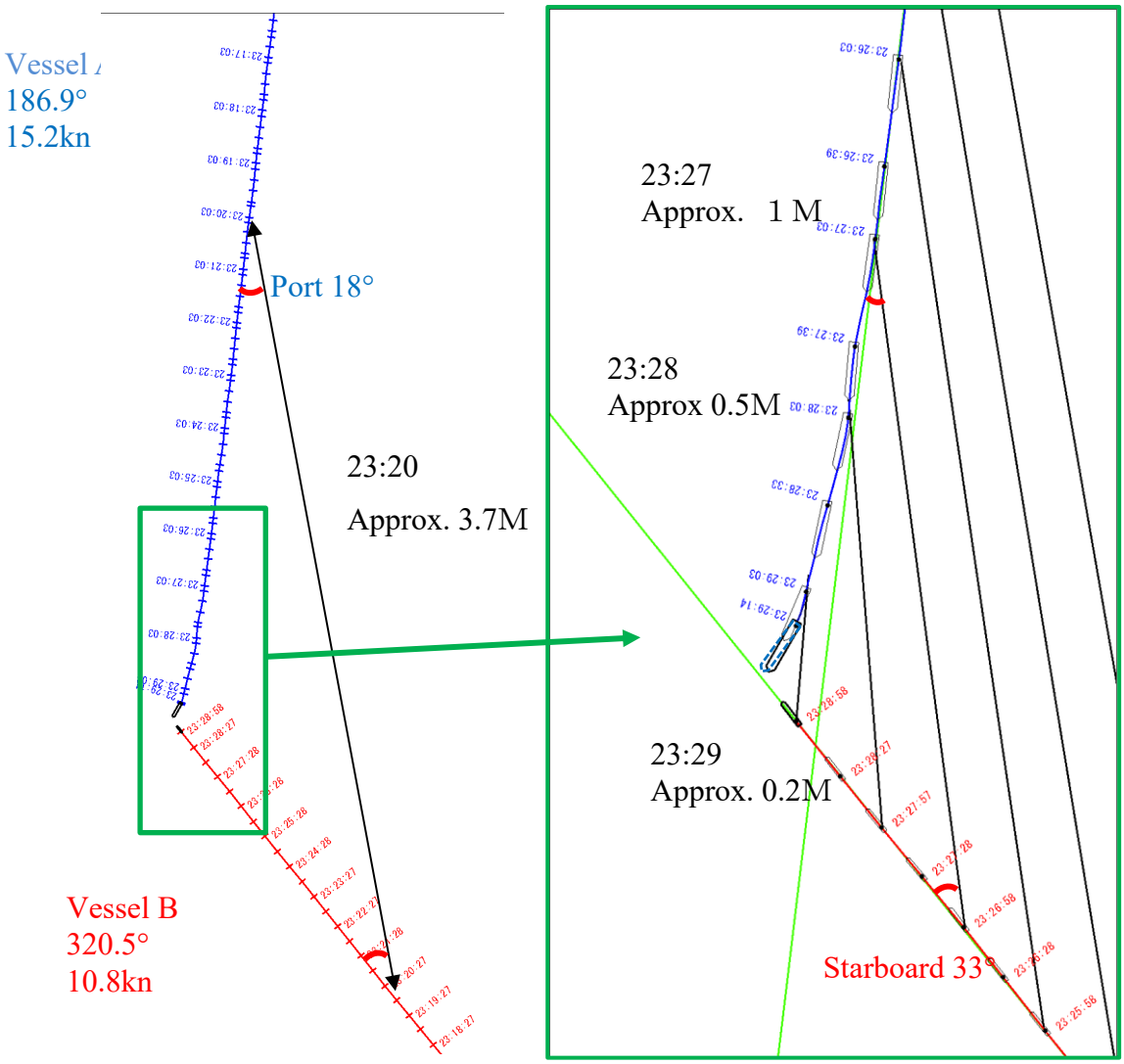
Approx. Time (HH:MM)	Starboard Radar (See Figure)	Distance to Vessel B (M)	Verbal Remarks by Officer A_1	Rudder Angle (°)	COG(°)	Heading (°)
23:06	Vessel B enters range (Appendix Figure 1: ④)	9.3	None	+2 to -1	187	186
23:23.5	Vessel B plotted (Appendix Figure 1: ⑤, ⑥)	2.5	None	Same as above	187	186
23:25	Close Quarter alert displayed briefly (Appendix Figure 1: ⑦, ⑧)	1.8	None	Same as above	188	186
23:26.7	Close Quarter alert displayed (Appendix Figure 1: ⑨)	1.1	None	+4	188	187
23:27	Alert continues (Appendix Figure 1: ⑩)	1.0	Yes	-5	187	188
23:27.5	Alert continues (Appendix Figure 1: ⑪–⑬)	0.8	Yes	+9	192	186

[*12] "Rate of Turn" refers to the angular velocity at which a vessel changes direction. In this report, it is expressed as the number of degrees the bow changes per minute (°/min).

23:28	Alert disappears (Appendix Figure 1: ⑭)	0.6	None	-7	185	192
23:28.5	Close Quarter alert displayed (Appendix Figure 1: ⑮, ⑯)	0.4	None	+12	196	193
23:28.7	Alert continues (Appendix Figure 1: ⑰)	0.3	Yes	Starboard rudder decreasing	193	195
23:29	Alert continues (Appendix Figure 1: ⑱)	0.2	Yes	-5	192	202

* Positive (+) values for rudder angle indicate starboard, and negative (-) values indicate port. Unless explicitly stated otherwise, this applies throughout this report.

Refer to Appendix Figure 1 for the starboard radar, Appendix Table 4 for distances to Vessel B, and Appendix Table 2 for rudder angles, COG, and heading.



*The light green lines indicate the extension of the original planned course.

Figure 4: The Two Ships Approaching Each Other (Based on Vessel A VDR Records and Vessel B AIS Records)

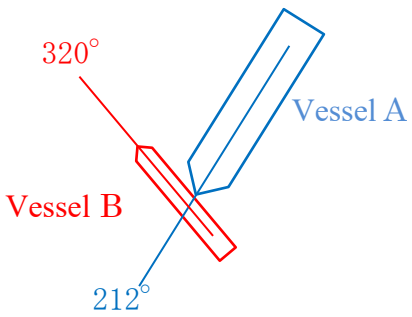


Figure 5: Estimated Collision Circumstances

③ Bridge Audio

According to Vessel A VDR records, information on bridge audio between approximately 23:00 and 23:30 is summarized in Table 2. In addition to the utterances listed in Table 2, machine noises, footsteps, and audio from other ships' VHF communications were recorded. However, no alarm sounds from radar or other devices, nor voices from other individuals, were recorded.

Table 2: Bridge Audio Based on Vessel A VDR Records

Time (HH:MM:SS)	**Audio Record**	**Remarks**
23:03:00-05	Master A: (Unclear) Officer A_1: (Unclear)	Opposite-direction vessel plotted
23:03:23-56	Master A: (Unclear) Officer A_1: (Unclear)	
23:04:00	Door opening/closing sound	Master A leaves the bridge
23:17:48	Unknown speaker (very brief)	Audio very faint
23:26:55-23:27:03	Officer A_1: (Unclear)	Port rudder 5°
23:27:25	Officer A_1: Shit	Starboard rudder 9°
23:28:47	Officer A_1: (Unclear) (Very brief)	Starboard rudder 12° → Reduced
23:28:59	Officer A_1 Oh shit	Port rudder
23:29:15	Impact sound	
23:29:37～	Master A: (Unclear) Officer A_1: (Unclear)	

* Conversations on Vessel A's bridge were conducted in the crew's native language. An interpreter reviewed the audio, however, the content of the speech remains unclear due to poor audio quality. Except for one individual, all crew members of Vessel A were citizens of the Republic of the Philippines. Master A, Officer A_1, and AB A can speak a common language.

(2) Vessel B

Based on the statement of the second officer of Vessel B (hereinafter referred to as "Officer B_1") and Vessel B AIS records, the events were as follows:

Vessel B departed from Katsunan, Chiba Port, Chiba Prefecture, around 16:20 on August 23.

Vessel B's Master (hereinafter referred to as "Master B") was solely in charge of the bridge watch, navigating west-northwest off the coast of Hi-no-Misaki toward the Naruto Kaikyo. The main engine was set to full ahead, and the vessel proceeded on autopilot at a course of approximately 320° and a speed of about 11 kn.

Officer B_1 ascended to the bridge around 23:00 on the 24th and took over the bridge watch from Master B. Upon handover, Master B instructed Officer B_1 to adjust the schedule to align with the planned entry time into the Bisan Seto East Passage, as there was still ample time.

Officer B_1 set the radar to 6M range, north-up, using an off-center display to show approximately 8M ahead of the bow. The vector and echo trail were set to display for 6 minutes each.

Officer B_1 visually checked the surroundings and used the radar to manually plot vessels displayed on the radar screen, confirming CPA, TCPA, BCR, and BCT[*13], etc. Despite the presence of multiple vessels, the traffic was typical for the Kii Suido, and Officer B_1 deemed there were no obstacles to navigation ahead.

According to AIS records, the situation around Vessel B at 23:10 was as shown in Figure 6.

[*13] Terms like "BCR," and "BCT" are explained in section 2.8.1, "General Information on Radar Usage."

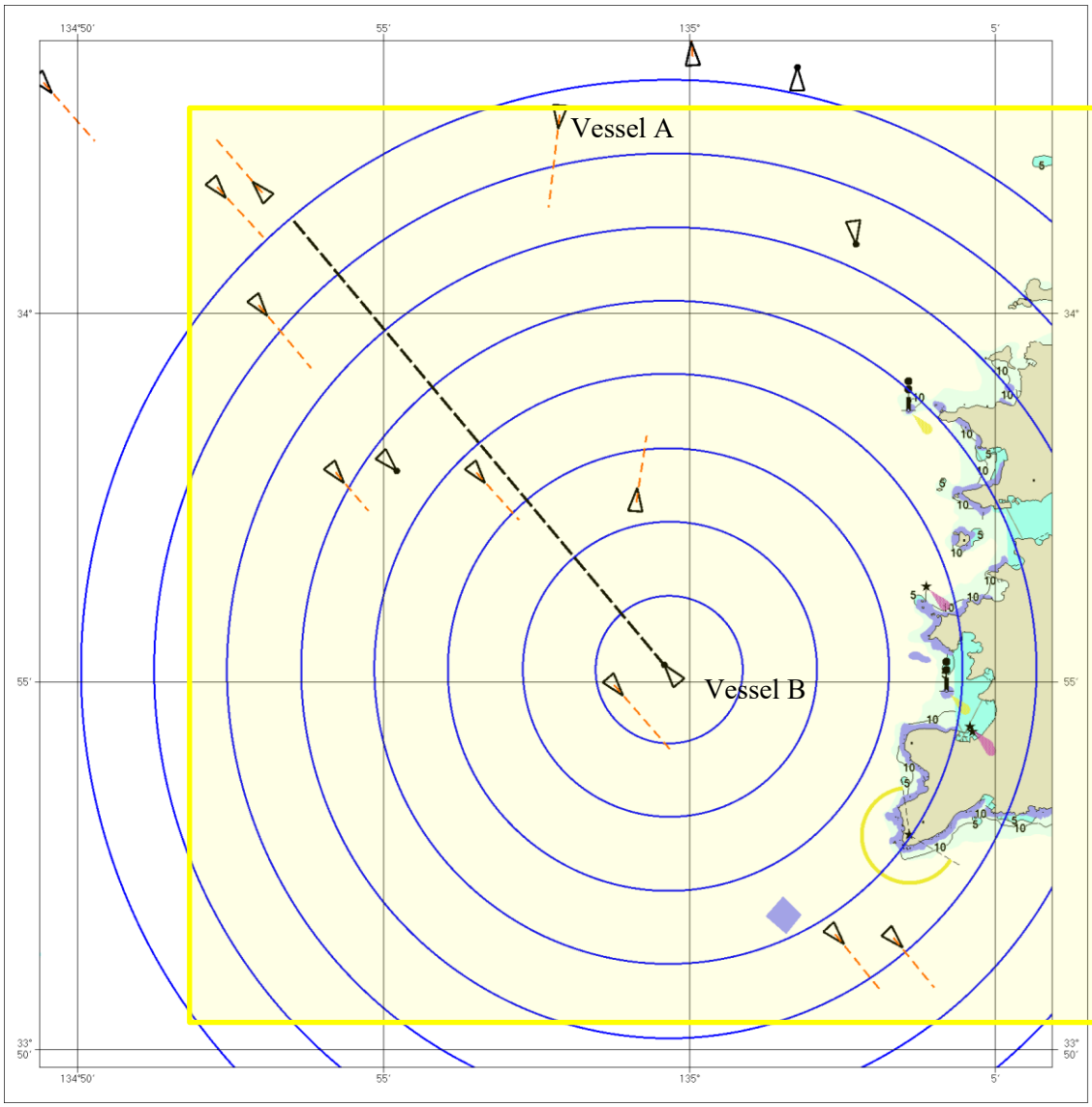


Figure 6: Overview of Vessel B's Surroundings

(A depiction based on AIS records at 23:10, showing concentric circles at 1M intervals centered on the GPS antenna position of Vessel B, with true motion vectors for each vessel displayed over a 5-minute period. The area within the yellow frame represents the radar display range when set to a 6M range off-center, showing up to approximately 8M ahead of the bow.)

Officer B_1 intended to carry out the time adjustment directed by Master B after passing through the planned transit of the Naruto Kaikyo by reducing speed. After Master B left the bridge, Officer B_1 decided to complete the "Navigation Watch Handover Checklist (Deck Department)" (hereinafter referred to as the "Handover Checklist") and verify the distance and speed for the planned route leading to the Bisan Seto East Passage. To do this, he began working at the chart table located at the aft port side of the bridge (see Figure 14 in Section 2.7).

After finishing the work at the chart table, Officer B_1 moved to the steering stand at the center of the bridge. There, he noticed a white light close off the starboard bow above. Reacting immediately, he set the main engine to full astern and switched to manual steering, applying hard port rudder.

Shortly after Officer B_1 applied hard port rudder, before the vessel could decelerate or the effect of the rudder could take hold, Vessel B collided with Vessel A.
(See Figures 1, 4 and 5, as well as Appendix Table 3)

2.1.4 Post-Accident

(1) Vessel A

According to the statements of Master A and Officer A_1, as well as Vessel A VDR records, the situation following the collision with Vessel B unfolded as follows:

While Master A was resting in his room, he felt the impact and immediately went up to the bridge to question Officer A_1. Officer A_1 reported that "Vessel B suddenly crossed our path, leading to the collision."

Master A turned on the ship's lighting, went out onto the port wing, and confirmed that the bow of Vessel A had collided with the starboard midship section of Vessel B, leaving Vessel B caught on Vessel A's bulbous bow.

Master A stopped the main engine, and at approximately 23:34, reported via VHF to the Japan Coast Guard that it had collided with an unidentified vessel (Vessel B) and Vessel B was sinking, requesting rescue.

While on the port wing monitoring Vessel B, Officer A_1 saw it slowly sinking and eventually capsizing.

Vessel A's crew, noting the capsizing of Vessel B, threw a lifebuoy equipped with a self-igniting light overboard.

Upon confirming Vessel B's capsizing, Master A reported the situation again to the Japan Coast Guard via VHF and immediately began rescue operations. Master A instructed Officer A_2, who had arrived on the bridge, to prepare for a search and rescue operation.

Master A observed two individuals clinging to the bilge keel of Vessel B and three others floating on the surface of the sea. Using a searchlight, Master A illuminated the three individuals on the water and instructed the crew to maintain surveillance with the searchlight.

Vessel A launched a rescue boat with Officer A_2 and two other crew members. At around 00:30 on the 25th, the rescue boat retrieved three of Vessel B's crew

members—Officer B_1, the Chief Engineer (hereinafter referred to as “Chief Engineer B”), and the First Engineer (hereinafter referred to as “Engineer B”)—who were clinging to Vessel A’s lifebuoy equipped with the self-igniting light. They confirmed Vessel B’s ship name and that there were a total number of five crew members aboard.

At approximately 01:27, Vessel A transferred the three rescued crew members from the rescue boat to Vessel A. Later, at around 03:30, the three were handed over to a Japan Coast Guard helicopter that had arrived to rescue them.

Vessel A continued the search for the remaining crew members of Vessel B, however, following instructions from the Japan Coast Guard, began navigating towards Wakayama Shimotsu Port in Wakayama Prefecture, where it anchored at around 11:30.

(2) Vessel B

According to the statements of Officer B_1, Chief Engineer B, Engineer B, and the written response from Shinto Kaiun Co., Ltd. (hereinafter referred to as “Company B_1”), the charterer of Vessel B, the situation was as follows:

Officer B_1 struck his face against the navigation instruments and fell due to the impact of the collision. After standing up and putting the main engine in neutral, he checked the collision point and saw that Vessel A's bulbous bow had penetrated almost perpendicularly into the starboard midship section of Vessel B.

Chief Engineer B, who was draining the fuel oil service tank in the engine room at the time of the collision, hit a nearby handrail due to the impact.

While heading to the bridge to assess the situation, Chief Engineer B ascended the external stairs on the port side to the navigation bridge deck and realized that Vessel B had collided with Vessel A. Without entering the bridge, he returned to the engine room, where he noticed flames near the turbocharger exhaust pipe, and then headed back to the bridge to report the fire.

Chief Engineer B encountered Chief Officer (hereinafter referred to as "Officer B_2") and Engineer B in the corridor of the accommodation area and informed them of the fire in the engine room. He then proceeded to the bridge to report the fire to Master B and Officer B_1, and returned to the engine room to conduct initial firefighting.

Together with Engineer B, Chief Engineer B entered the engine room carrying fire extinguishers. However, they saw large amounts of seawater entering through the bow-side central door on the upper deck level of the engine room. Realizing the vessel was sinking, he instructed Engineer B to evacuate and headed back to the bridge himself. By this time, he felt the ship tilting toward the starboard stern.

Believing there was still some time before the ship sank, Chief Engineer B attempted to retrieve the engine logbook from the engine room, however, as he descended the stairs to the engine room, he was engulfed by seawater coming from above.

At around 23:32 on August 24, the safety manager of Company B_1 received a call from Master B via mobile phone reporting that the vessel had collided with another vessel and was flooding. The manager instructed Master B to order all hands to abandon ship immediately.

At approximately 23:35, while Master B, Officer B_1, and Officer B_2 were on the bridge and Engineer B was on the port wing, Vessel B capsized before there was time to put on lifejackets, etc., and prepare for evacuation.

Officer B_1, Chief Engineer B, and Engineer B each surfaced on their own and clung to nearby floating debris. They swam toward the lifebuoy equipped with a self-igniting light thrown by Vessel A and held onto it together while awaiting rescue, and were then rescued by Vessel A's rescue boat. They then transferred to Vessel A, and were airlifted by a Japan Coast Guard helicopter to Kansai International Airport. From there, they were transported by ambulance to hospitals in Izumisano City, Osaka Prefecture.

Vessel B, which was adrift in a capsized state, sank at around 02:50 on August 26.

Officer B_2 was found drifting in the sea north of Okinoshima, Hatsushima Town, Wakayama Prefecture, on August 26 and was confirmed deceased.

Master B was presumed dead after going missing.

2.2 Injuries to Persons

According to Company B_1's written response and Officer B_2's autopsy report, the crew of Vessel B experienced the following injuries as shown in Table 3: two deaths and three severely injured.

Table 3: Status of Vessel B Casualties

Position	Casualty Details
Master B	Death after missing
Officer B_2	Fatally injured (drowned)
Officer B_1	Urethral injury, laceration to the left anterior chest, contusion to the forehead, abrasions on the left lower back and buttocks, dental damage
Chief Engineer B	Left traumatic hemopneumothorax, multiple left rib fractures, fractures of the 2nd and 3rd lumbar transverse processes
Engineer B	Left shoulder dislocation, chest contusion, abrasions on both upper limbs, right thigh contusion, aspiration pneumonia caused by seawater ingestion

2.3 Damage to Vessel

(1) Vessel A

Vessel A sustained buckling and dents to its bulbous bow, along with abrasions extending from the fore end to the base. Additionally, a breach formed on the outer shell plating above the bulbous bow's base, near the portside bow draft marks at approximately 8.3–9.0 meters.

According to the general arrangement plan, the dimensions of the bulbous bow were approximately 5 meters in length from the fore end to the base and about 7.5 meters in height.

At the time of the accident, Vessel A's fore draft was approximately 5.8 meters, and the damage to the bow is estimated to have occurred at a height of about 2.5–3.2 meters above the waterline.

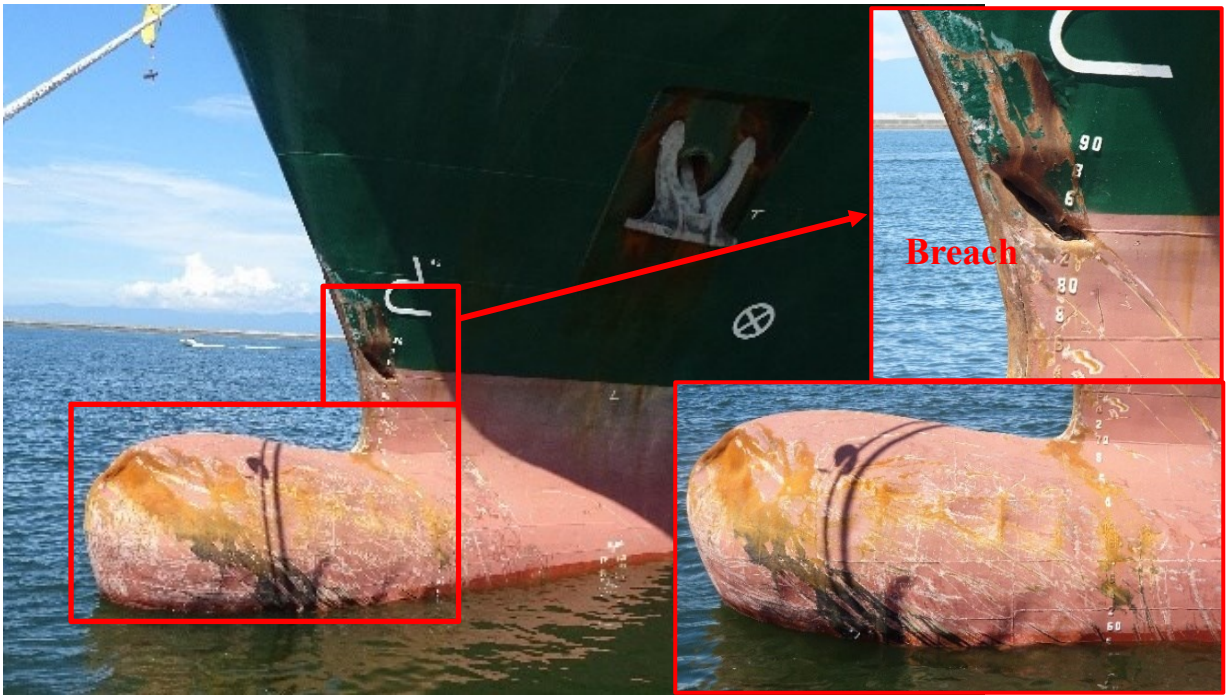


Figure 7: Damage to Vessel A

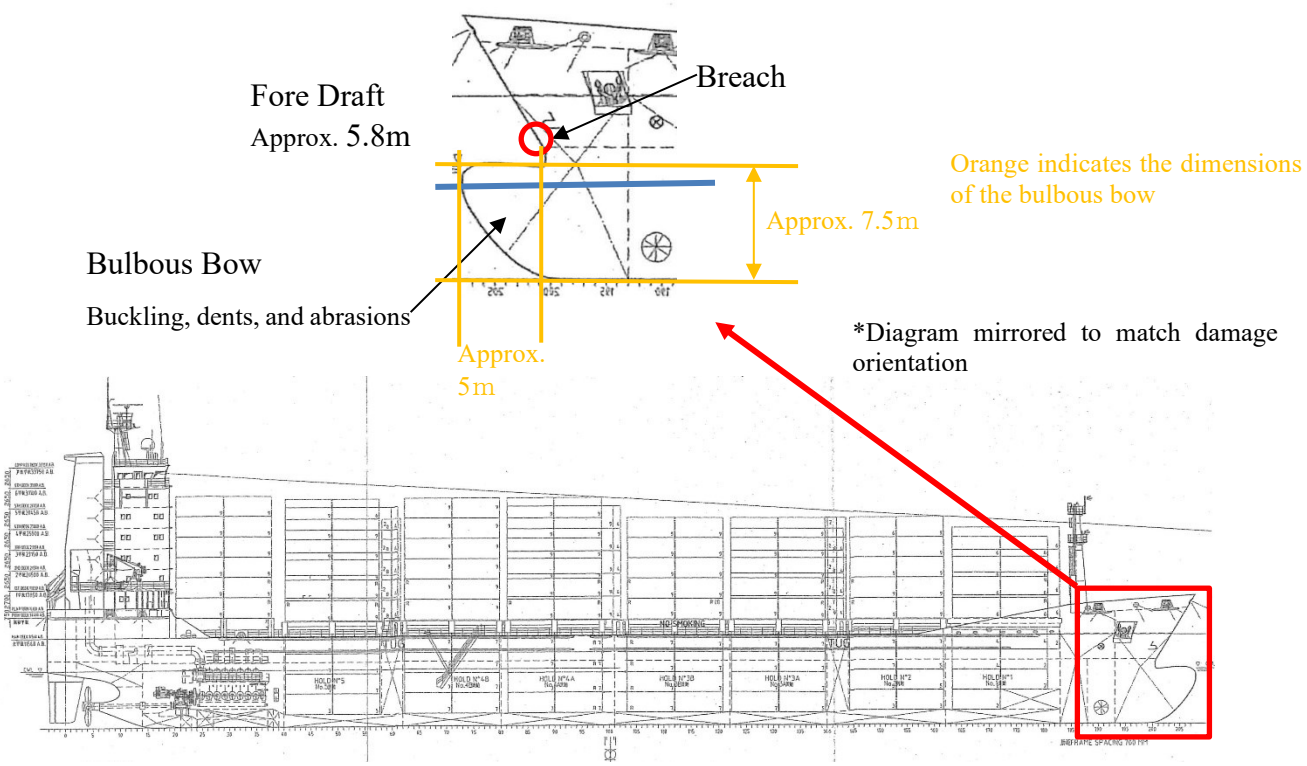
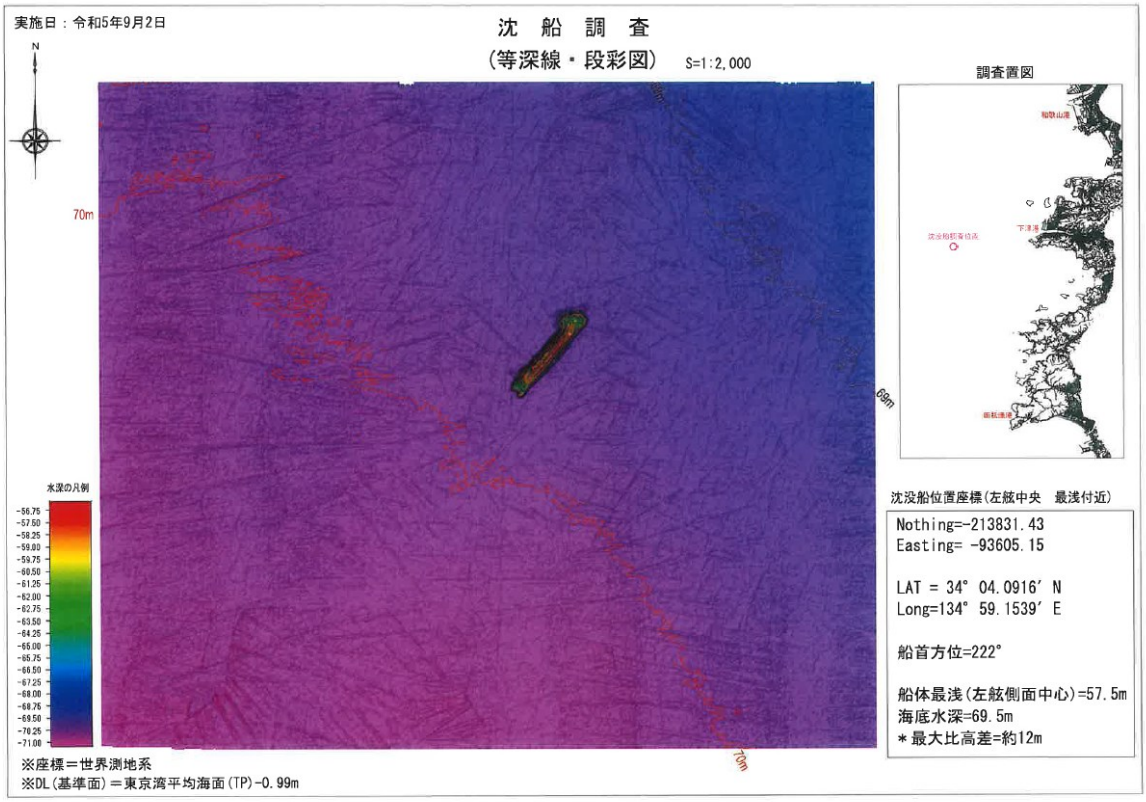


Figure 8: Schematic Diagram of Damage to Vessel A

(2) Vessel B

According to the written response from Company B_1, a salvage company's small ROV (Remotely Operated Vehicle) conducted an inspection into the state of the sunken Vessel B between August 27 and September 12. The inspection report stated the following regarding Vessel B:

Vessel B is resting on the seafloor at a depth of approximately 70 meters, with its bow oriented at about 222° and tilted approximately 115° to the starboard side.



(From the salvage company's sinking status inspection report)

Figure 9: Vessel B's Sinking Status

The damage extends around Fr.50 to Fr.70 (a length of approximately 12 meters along the longitudinal axis of the ship). On the starboard cargo hold side, bulkheads and other structures appear to have collapsed inward toward the cargo hold, with sections peeled back. Additionally, other parts of the ship's structure are damaged and scattered. The damage is believed to be particularly severe near the midship section of the starboard side.

Near Fr.58

Near Fr.70

(From the salvage company's sinking status inspection report)

Figure 10: Damage to Vessel B (Photographed via Small ROV)

Vessel B, with a depth of 7.0 meters, had a draft at the time of the accident at approximately 3.2 meters at the fore and 4.5 meters at the aft, suggesting a midship draft at around 3.8 meters and estimated upper deck height above the waterline at approximately 3.2 meters.

Based on Vessel B's general arrangement plan, draft conditions, and the sinking status inspection report, as well as Vessel A's fore draft, dimensions of its bulbous bow, and damage details, the estimated collision point is illustrated in Figure 11.

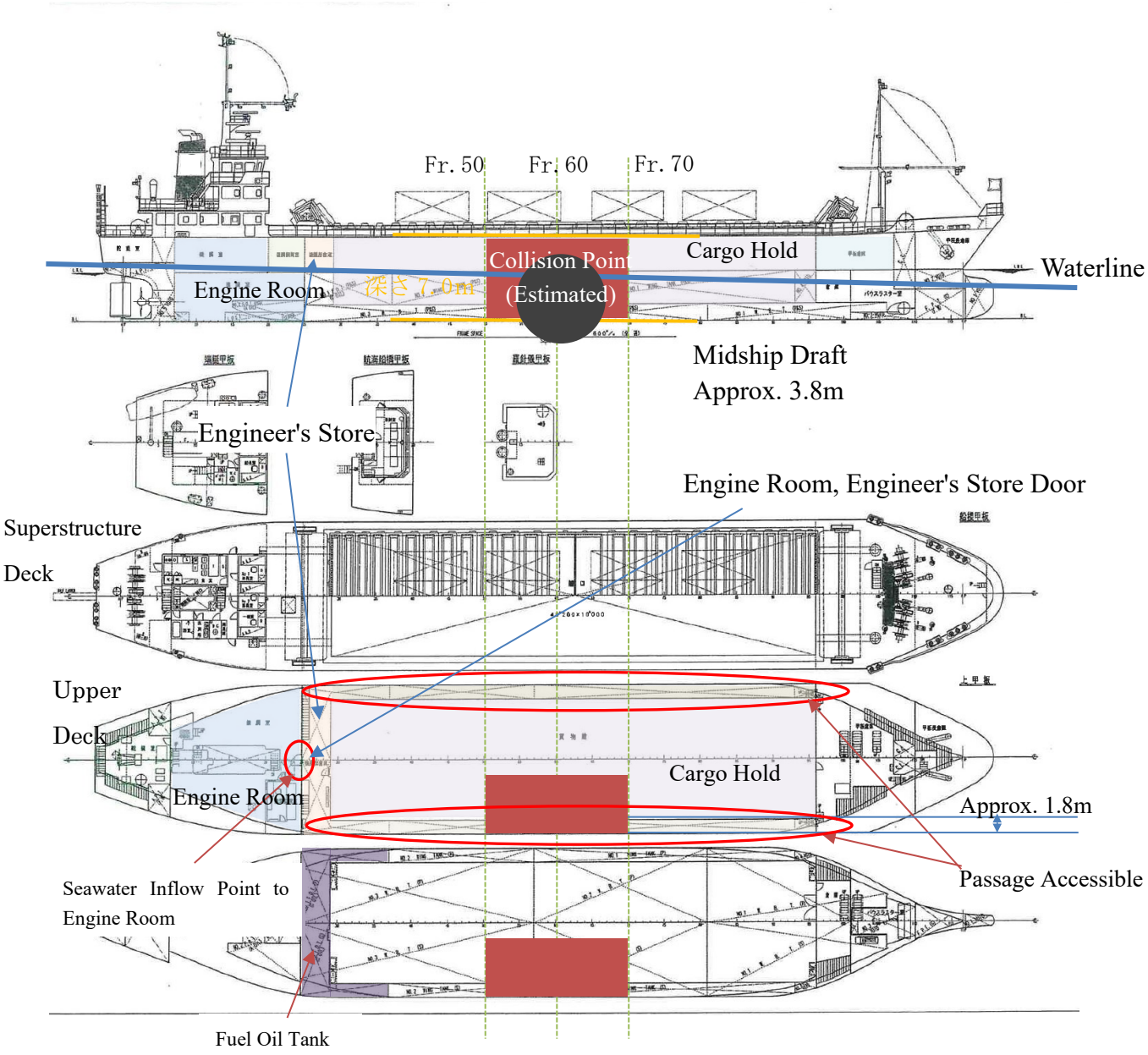


Figure 11: Schematic Diagram of Vessel B's Damaged Area

2.4 Information on the Accident Sea Areas

(1) Description from the Sailing Directions

The Japan Coast Guard's Sailing Directions for South & East Coasts of Honshu (published in March 2020) includes the following information regarding the Kii Suido:

There could be a complicated crossing/access among vessels sailing between Hi-no-Misaki and Naruto Kaikyo, vessels coming S-ward from Tomogashima Suido, vessels sailing from I shima area to Tomogashima Suido and vessels sailing between Wakayama and Tokushima. And in this area, vessels sailing Kii Suido may counter many small vessels sailing from Naruto Kaikyo to Hi-no-Misaki. This comes from the rushing of vessels passing over Naruto Kaikyo at turn of tide.

(2) Maritime Traffic Safety Act

Maritime Traffic Safety Act (Act No. 115 of 1972) and its Enforcement Order (Cabinet Order No. 5 of 1973) stipulate the following regarding the areas of application for the act.

Maritime Traffic Safety Act (Excerpt)

Chapter I. General Provisions

(Purpose of The Law and Applicable Sea Areas)

Article 1.

The purpose of this Law is to ensure the safety of ships' traffic by prescribing special modes of navigation and by effecting control for preventing danger to ships' traffic in the traffic congested areas.

2. This Law shall apply to the sea areas of Tokyo Wan, Ise Wan (Including the sea areas adjacent to the mouth of Ise Wan and those portions of Mikawa Wan which are adjacent to Ise Wan) and Seto Naikai, except such areas as are listed below, and the boundaries between these sea areas and other sea areas (excluding the areas listed below) shall be fixed by the Cabinet Order.

(1) Port areas under the Port Regulations Law (Law No. 174 of 1948);

(2) Port and harbor areas prescribed in Article 2 Paragraph 3 of the Port and Harbor Law (Law No. 218 of 1950) which are other than those under the Port Regulations Law;

(3) Sea areas within fishing ports designated by the Minister of Agriculture, Forestry and Fisheries under Article 5 Paragraph 1 of the Fishing Port Law (Law No. 137 of 1950);

(4) Sea areas along the coast, specified by the Cabinet Order as areas not normally navigated by vessels other than fishing vessels.

Cabinet Order for the Enforcement of the Maritime Traffic Safety Act (Excerpt)

(Boundaries Between Sea Areas Where Maritime Traffic Safety Law is Applicable and Other Sea Areas.)

Article 1.

Boundaries between the sea areas where the Maritime Traffic Safety Law (hereafter referred to as "the Law") is applicable under Article 1 Paragraph 2 (these sea areas will hereafter be referred to as "the applicable sea areas") and other sea areas (excluding those mentioned in each item of the paragraph) shall be as shown in the following table:

Areas Where Applicable Sea Areas Are Located	*Boundaries Between Applicable Sea Areas and Other Sea Areas*
Seto Nai kai	*A line drawn from Kii Hino Misaki Lighthouse (33° 52'55" N,135° 03'40"E) to Kamoda Misaki Lighthouse (33° 50'03"N,134° 44'58"E) and a line drawn from Sada Misaki Lighthouse (33° 20'35"N,132° 54'E) to Seki Saki Lighthouse (33° 16'N, 131° 54'8"E)*

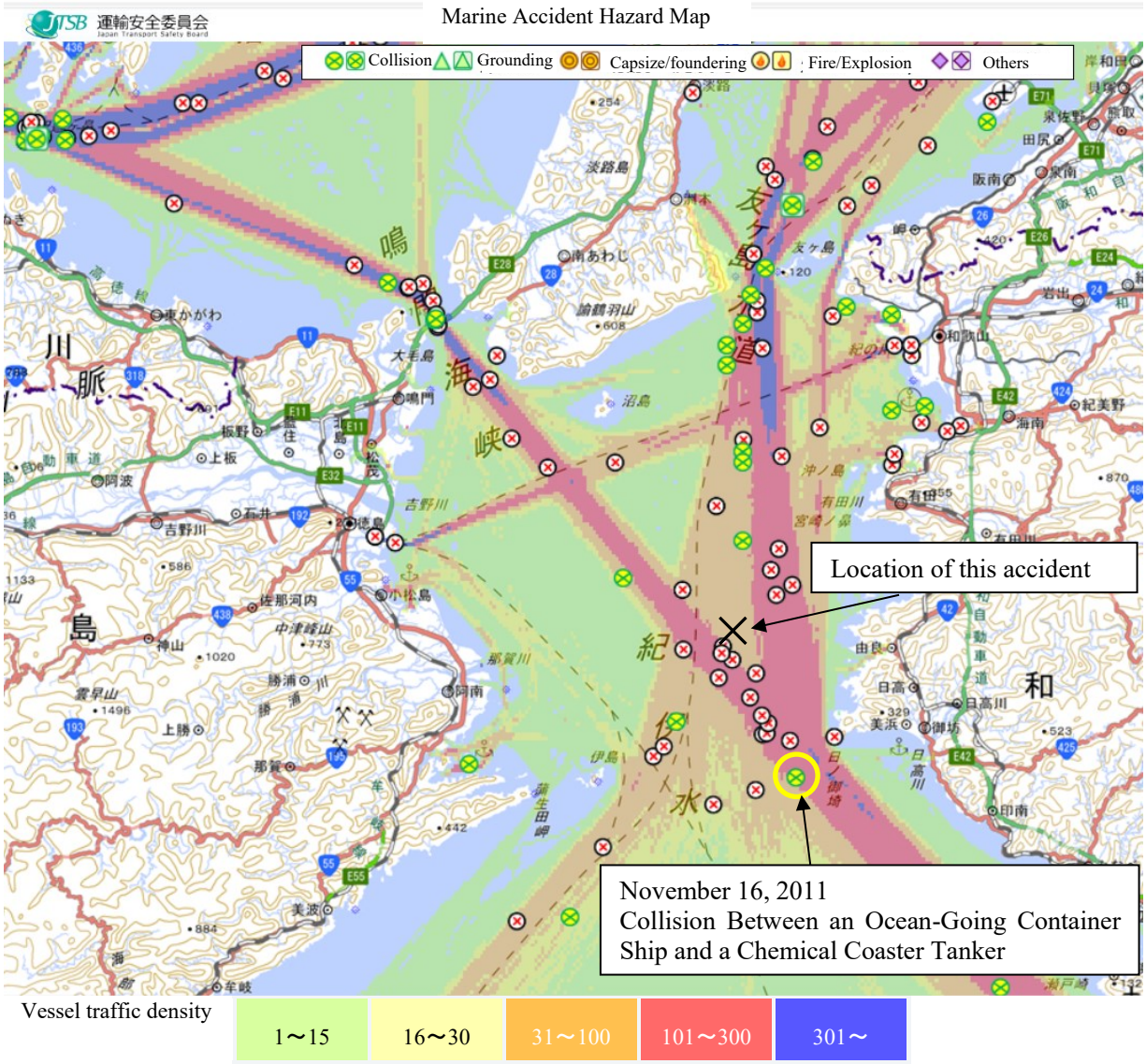
(3) Ship Traffic Density in the Vicinity of Kii Suido

According to the Japan-Marine Accident Risk and Safety Information System (J-MARISIS) on JTSB's website, overlaying AIS data on vessel traffic density and collision accidents involving vessels of 500 gross tonnage or more produced the results shown in Figure 12.

Near the location of this accident, there has been one collision*14 between commercial vessels since the establishment of the JTSB (October 2008), which involved an ocean-going container ship heading from Tomogashima Suido toward Shio-no-Misaki and a chemical coaster tanker heading from Naruto Kaikyo to off Shio-no-Misaki.

White circles with a red "×" (◯) symbol in Figure 12 indicate accidents that occurred prior to October 2008.

*14 Collision Between a Container Ship and a Chemical Tanker (Occurred on November 16, 2011) https://jtsb.mlit.go.jp/ship/rep-acci/2012/MA2012-12-22_2011kb0190.pdf



* A traffic density map, developed by the National Maritime Research Institute, produced by means of calculating the number of vessels passing through a mesh of one minute of latitude by one minute of longitude in 2012 based on AIS information provided by a vessel information company. Colors are used to represent density levels; 1-15, 16-30, 31-100, 100-300, and 301 and above. Please note that the traffic density map does not illustrate the exact traffic volume of vessels equipped with AIS since some data may be lost by the condition of radio propagation and other technical reasons.

Figure 12: Ship Traffic Density and Collision Accident Locations in Kii Suido

(Based on the J-MARISIS from the JTSB Website)

2.5 Weather and Sea Conditions

2.5.1 Observed Data

(1) Observations from Kamoda Special Regional Meteorological Observatory, located approximately 13 M southwest of the accident site, were as follows:

August 24: 23:10: Wind direction WSW, wind speed 3.1 m/s

23:20: Wind direction WNW, wind speed 1.6 m/s

23:30: Wind direction W, wind speed 1.4 m/s

(2) According to the tide tables published by the Japan Coast Guard, the tidal currents of Tomogashima Suido and Naruto Kaikyo before and after the accident were as follows:

① Tomogashima Suido

Slack Time	Maximum Time	Maximum Current	
		Tidal Direction	Tidal Speed
22:58	1:11	Northward	0.7 kn

② Naruto Kaikyo

Slack Time	Maximum Time	Maximum Current	
		Tidal Direction	Tidal Speed
20:54	23:21	Northward	4.9 kn

2.5.2 Data Observed from Vessel A VDR Records

According to Vessel A VDR records, at the time of the accident, the relative wind direction and speed were wind at 22.8 kn from 38° to the port bow (174°) with a heading of 198.8°, a course of 212°, and a speed of 14.4 kn. It is estimated that an east-southeasterly wind with a force of 4 was blowing at the time of the accident.

2.5.3 Observations by Crew

According to the statement of facts prepared by Master A, around 00:00 on the 25th, there was a wind of force 2, with sea state 2, and visibility was good.

According to Officer B_1's statement, the weather at the time of the accident was clear, the sea was calm, and visibility was good.

2.6 Information on Crew Members

(1) Age and Certificate of Competence

① Master A 31 years old

Nationality: Republic of the Philippines

Endorsement attesting the recognition of certificate under STCW regulation I/10: the Master (Issued by Republic of Liberia)

Date of Issue: June 8, 2023

(Valid Date: September 8, 2023)

② Officer A_1 48 years old

Nationality: Republic of the Philippines

Endorsement attesting the recognition of certificate under STCW regulation I/10: the Officer (Issued by Republic of Liberia)

Date of Issue: May 18, 2021

(Valid Date: October 6, 2025)

③ Master B 58 years old

Fourth Grade Maritime Officer (Navigation)

Date of License: May 20, 2009

Date of Issue: April 17, 2023

Date of expiry: May 13, 2028

④ Officer B_1 38 years old

Third Grade Maritime Officer (Navigation)

Date of License: November 24, 2010

Date of Issue: November 23, 2020

Date of expiry: November 23, 2025

(2) Seagoing experience

According to the statements of Master A, Officer A_1, and Officer B_1, as well as the written responses from Company B_1, the details were as follows.

① Master A

Started as a deck cadet in 2011, became an Officer in 2013, served as a Chief Officer from 2016 to 2022, and assumed the position of Master of Vessel A in July of the same year. Additionally, all the vessels he boarded were container feeder vessels[*15] similar to Vessel A.

[*15] A "feeder vessel" refers to a small container ship that transports containers along feeder routes from major ports where large container ships call to other ports.

At the time of the accident, he had no issues with vision, hearing, or other physical conditions and was in good health.

② Officer A_1

Served on various ships as an able seaman from 1998 to 2019, except for three years of shore-based work, and became an Officer on a container feeder vessel in 2019.

He first boarded Vessel A at the Osaka, Hanshin Port on July 31, 2023.

Although he had five years of experience as an able seaman on vessels operated by Japanese shipping companies, he had not navigated Japan's coastal waters since becoming an Officer in 2019. From the time he boarded Vessel A on July 31 until the day before the accident, he was accompanied on the bridge during his watchkeeping by Master A, who provided instruction and supervision.

At the time of the accident, he had no issues with vision, hearing, or other physical conditions and was in good health.

③ Master B

Boarded Company B_1's fleet as an Officer in April 2013 and began serving as Master in June 2014. Since July of the same year, he has been the dedicated Master of Vessel B.

④ Officer B_1

After graduating from school, worked as an ordinary seaman on fishing boats before obtaining a maritime certificate. He served as an Officer on coastal vessels such as 15,000-ton class car carriers and 4,000-ton class container ships, and also had about one year of experience as an Officer on oceangoing vessel.

He first boarded Vessel B as an Officer in September 2022 and subsequently transferred to other vessels of Company B_1's fleet. He boarded Vessel B for the second time on July 19, 2023, took a short leave from August 8 to 18, and rejoined the Vessel at Chiba Port on August 19.

At the time of the accident, he had no issues with vision, hearing, or other physical conditions and was in good health.

2.7 Information on Ship Equipment

2.7.1 Ship Equipment Details

(1) Bridge of Vessel A

Vessel A had a six-level deckhouse on the aft deck, with the bridge located on the topmost level (see Figure 8).

On the bridge, a steering stand was positioned in the center, with control seats arranged on both the port and starboard sides. In front of the starboard-side seat was the starboard radar, on its right side was the Electronic Chart Display and Information System (ECDIS), and on its left were the autopilot control panel, engine telegraph lever, and other equipment. In front of the port-side seat was the port radar and other devices. (see Figure 13).

The AIS transmitter control panel was installed to the left of the port radar, and received AIS information was overlaid on both the port and starboard radars.

The gyrocompass repeaters were installed on both the port and starboard wings, however, they were not installed within the bridge.

At the aft of the bridge's port side were a PC and radio communication devices, while a chart room was located at the aft of the starboard side.

According to Master A’s statement, at the time of the accident, the bow thruster was out of order and could not be used. However, there were no other defects or malfunctions in the hull, machinery, or equipment that would have affected vessel operation during the accident.

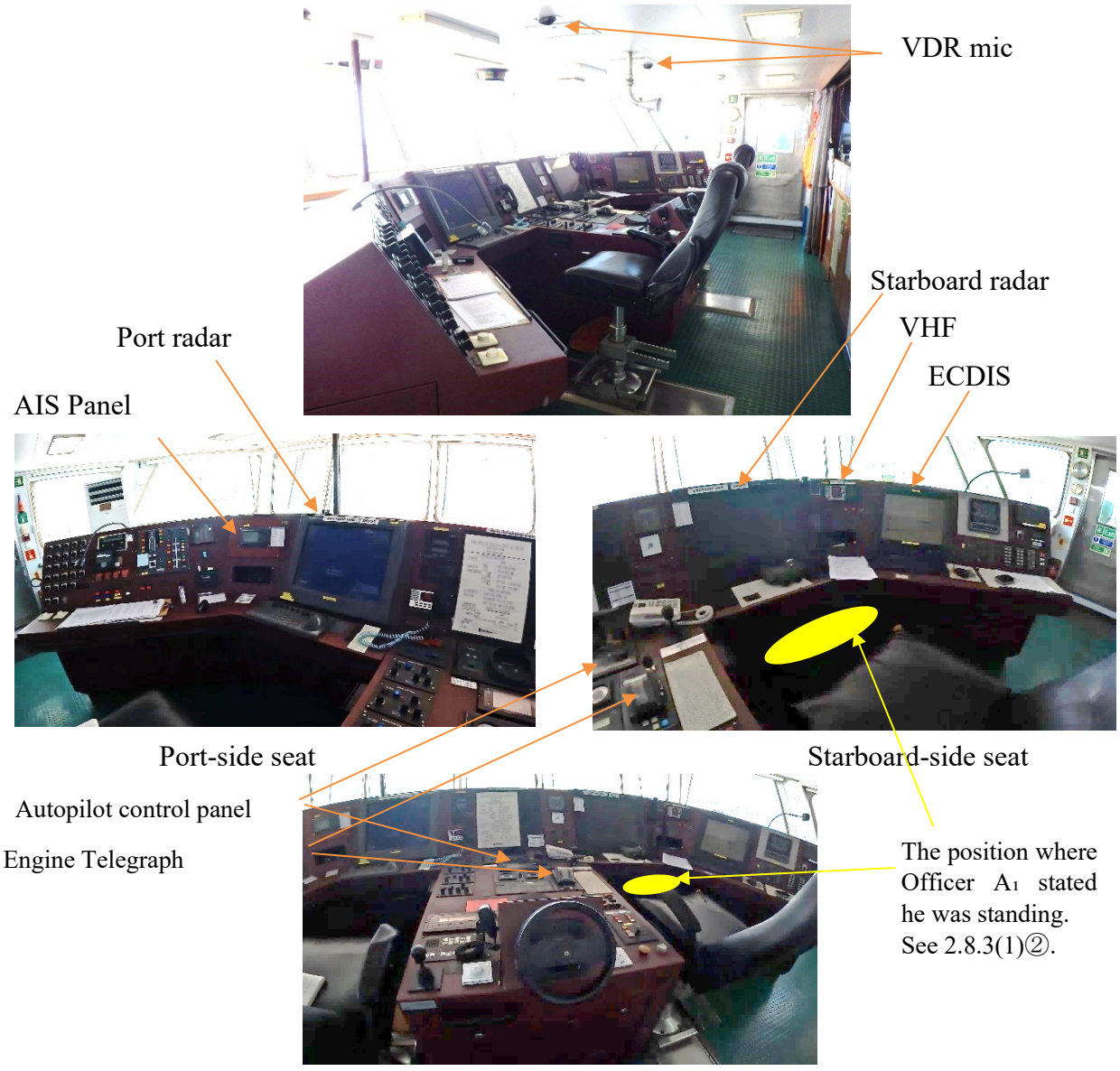


Figure 13: Bridge of Vessel A

(2) Vessel A VDR and Radar

The VDR of Vessel A recorded the own ship's position, heading, course, speed, rate of turn, relative wind direction and speed, main engine RPM, controllable pitch propeller blade angle load ratio, VHF communication audio, bridge audio (two ceiling microphones and two aft ceiling microphones, two channels), wing audio on both sides, starboard radar screen (images captured every 15 seconds), rudder angle (transmitted signal from the steering device), etc.

Vessel A was equipped with navigational instruments such as the ECDIS, starboard radar, and port radar, which could display AIS information, etc., of other vessels.

However, the VDR of Vessel A only recorded the starboard radar information, and AIS information was not recorded.

The starboard radar automatically tracked multiple surrounding vessels, calculating course, speed, and other data, and internally stored this information. When a target vessel was plotted manually or automatically, the radar could instantly display calculation results such as vectors and CPA on the radar screen. At the time of the accident, it had been tracking Vessel B automatically since 22:56, and while the calculated target information was not displayed on the starboard radar screen, it was recorded in Vessel A's VDR (see Appendix Table 4).

(3) Vessel B

Vessel B was a double-deck cargo ship with a single cargo hold below the Superstructure deck and an engine room located at the aft section. A three-layer deckhouse was installed on the Superstructure deck above the engine room, and the bridge was situated on the navigation bridge deck, the uppermost layer.

According to the general arrangement plan and the statement of Chief Engineer B, there was a door in the central upper deck level of the engine room leading to the engineer's store. Additionally, there were passageways connecting the engineer's store to the bow on both port and starboard sides of the cargo hold.

The fuel oil tanks were located below the engineer's store and the aft-side passageways. At the time of the accident, an estimated 51 kl of fuel oil was loaded (see Figure 11).

The bridge had a steering stand at its center, with navigational instruments arranged on both sides. From the starboard side, these included a radar, a main engine remote panel, a GPS plotter above the main engine remote panel, and another radar to the port side of the steering stand.

Additionally, a Class B AIS[*16] transmitter was installed, with received AIS information overlaid on the radar screen. At the time of the accident, the AIS information transmitted by Vessel B was successfully received by the shore station, as shown in Appendix Table 3.

A magnetic compass was installed at the central front of the bridge. A chart table was placed at the aft port side of the bridge, with a VHF radio installed above it.

[*16] "Class B AIS" refers to a device with lower output than the AIS systems required to be installed on certain vessels under international conventions. It limits transmitted and received information to items such as the ship's name, position, speed, course, and type.

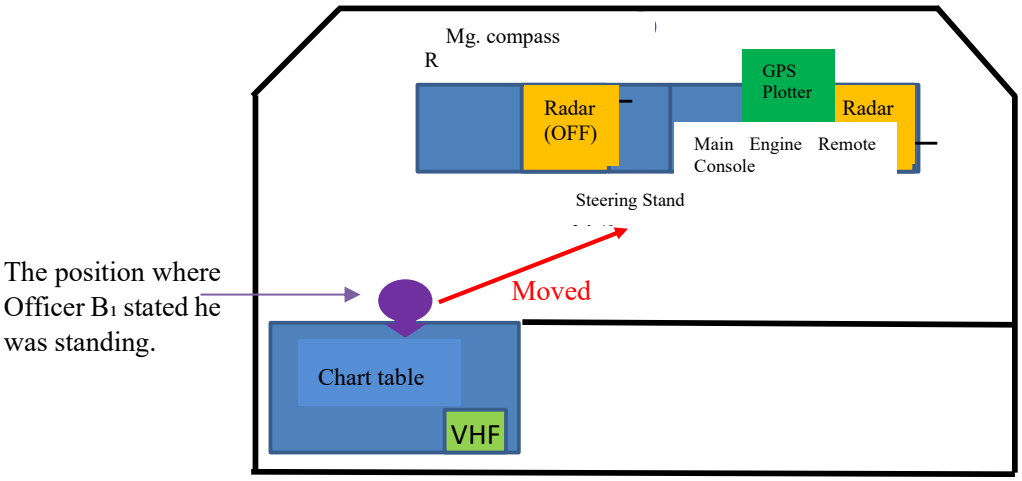


Figure 14: Vessel B's Bridge Layout

2.7.2 Maneuvering Information

(1) Vessel A

According to the Maneuvering Information, the maneuvering ability of Vessel A in a loaded condition was as follows:

① Maneuvering Ability

a. Stopping Distance and Time (from full astern order to complete stop of the vessel):

Speed Before Astern Order	Distance	Time
Full (approx. 14.7 kn)	1,041 m	238 seconds

b. Turning Performance (rudder angle 35°):

Turning Direction	Speed	Advance*17	Transfer*18	Time
Starboard Turn	Approx. 14.7 kn	185 m	242 m	126 seconds
Port Turn	Approx. 14.7 kn	130 m	261 m	102 seconds

② Navigation Speed

Engine Order	Speed
Full	14.7 kn
Half	10 kn
Slow	8 kn
Dead slow	5 kn

*17 "Advance" refers to the longitudinal distance traveled along the original course by the ship's center of gravity from the point of helm application until the ship has turned 90°.

*18 "Transfer" refers to the lateral distance the ship's center of gravity moves away from the original course from the point of helm application until the ship has turned 90°.

(2) Vessel B

According to the sea trial report of Vessel B, the maneuvering ability of Vessel B was as follows:

① Stopping Distance and Time (from full astern order to complete stop of the vessel)

Speed Before Astern Order	Distance	Time
Full (approx. 14.0 kn)	425 m	105 seconds

② Turning Performance (rudder angle 35°):

Turning Direction	Speed	Advance	Transfer	Time
Starboard Turn	Approx. 13.5 kn	177 m	91 m	45.5 seconds
Port Turn	Approx. 13.5 kn	223 m	112 m	56.3 seconds

2.7.3 Bridge Visibility

(1) Vessel A

According to on-site investigations and the plan, visibility from the bridge toward the bow was obstructed by the loaded containers, making the sea surface beyond approximately 270m from the bow a blinded area. However, there were no other obstacles hindering lookout visibility in other directions.

Figure 15: Visibility from Vessel A's Bridge

(2) Vessel B

According to the general arrangement plan and pre-accident photos of the vessel, there were no obstacles hindering lookout visibility from the bridge toward the bow. (See Figures 3 and 11)

2.8 Information on Lookout and Maneuvering

2.8.1 General Information on Radar Use

According to the literature*[19], the practical use of radar is explained as follows (excluding Figure 16, excerpted from the literature):

- Range

  The range refers to the radius of the largest displayed circle on the radar screen. Typically, shorter ranges are used in ports, while longer ranges are utilized for coastal and open sea navigation, depending on the situation. The general guideline for range selection is as follows: Ports: 1.5–3 M, Coastal/inland waters: 3–6 M, Open sea: 6–24 M.

- Measurement of Bearings and Distances

  Using concentric circles and fixed range rings centered on the vessel, approximate distances to targets can be measured.

  For more precise measurements, the following tools are used: ①Cursor, ②Electronic Bearing Line (EBL), and ③Variable Range Marker (VRM).

  ① Cursor

  By moving the cursor over the desired target on the radar screen with a trackball, the bearing and distance from the own vessel to the target are displayed on the radar screen.

  ② EBL (Electronic Bearing Line)

  A straight line (EBL) displayed from the own vessel's position to the end of the range ring on the radar screen can be rotated around the own vessel's position to align with the desired target, and the target's bearing can then be displayed.

  ③ VRM (Variable Range Marker)

  A circle (VRM) centered on the own vessel's position is displayed, and by adjusting the radius of the circle to match the target, the distance is displayed.

- Echo Trail

  Using the echo trail function, the radar displays the position of moving targets over a set past time as a trail. A longer trail indicates a faster-moving target, and the direction of the trail helps predict the target's course.

- Target Plotting

  In lookout duties, the relative movement of other vessels is determined by observing changes in the compass bearing over time, which target plotting is used for.

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[19] *3 "Maritime Instruments: Revised Edition – From Sextants to ECDIS" (Written by Nobukazu Wakabayashi, Revised First Edition Published March 28, 2021).

This involves plotting the movement (position changes) of the same target over time using radar, from which the target's course and speed can be calculated.

- CPA, TCPA, BCR, and BCT

The Closest Point of Approach (CPA) is the point where two vessels are predicted to come closest to each other through plotting. The distance to the closest point of approach is referred to as DCPA (Distance at the CPA), and the time required to reach that point is referred to as TCPA (Time to the CPA). DCPA is often simply referred to as CPA, and radar systems also display the DCPA as CPA.*20

The distance between two vessels when another vessel crosses the fore-and-aft line of the own vessel is called the Bow Crossing Range (BCR), and the time until that point is called the Bow Crossing Time (BCT). BCR is displayed as a positive value for forward distances and a negative value for aft distances.

If negative (time) values appear for TCPA or BCT, it indicates that the closest point or Bow Crossing Situation has already passed, and the other vessel is moving away from the own vessel.

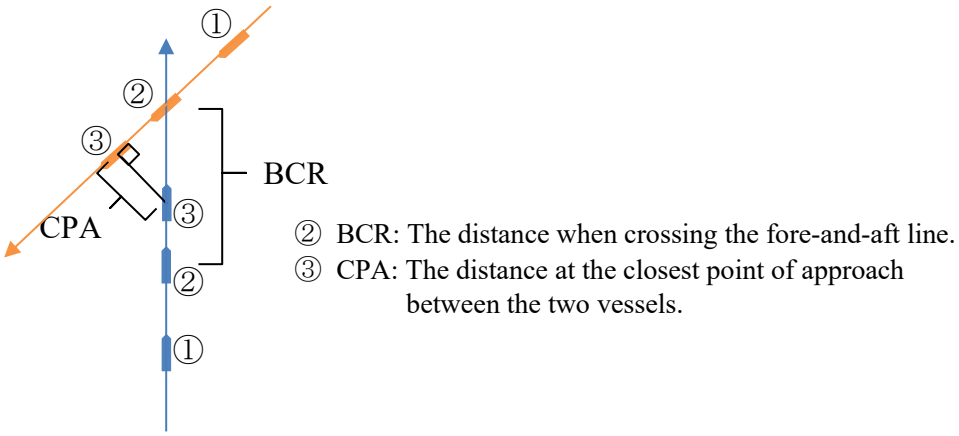


Figure 16: Illustration of CPA and BCR (Created by the JTSB)

- TT (Target Tracking)

The TT function automatically tracks other vessels, etc., (targets) designated on the radar screen. Using movement over the past several minutes, it calculates and displays the target's course, speed, and relative motion in relation to the own vessel, including CPA and TCPA, and displays it on the radar screen.

It continues tracking the target and updating its information as long as it does not lose it.

*20 In this report, the term CPA refers to the closest point of approach distance.

The maximum number of targets that can be tracked simultaneously by TT depends on the radar model, however, Japanese Domestic regulations require the system to track at least 40 targets simultaneously.

- Radar Plotting by TT function

  TT allows for plotting either automatically or manually.

  With automatic plotting, a specified area within an appropriate range in the direction of the vessel is set, and if a target appears in this area, the TT system automatically plots it as a TT target.

  With manual plotting, the desired target is selected by the cursor on the radar screen.

  In both automatic and manual plotting, once a target is plotted, data is calculated, and a motion vector for the target is displayed on the radar screen. Detailed numeric data for the target can be displayed by selecting it with the cursor, showing the information in the target data area of the radar screen.

- Collision Avoidance Criteria and TT Alarms

  The primary purpose of TT is to assess the risk of collision between the own vessel and others. CPA and TCPA values can be used as more objective criteria for determining if risk of collision exists.

  A small CPA value indicates a high likelihood of risk of collision exists if both vessels maintain their courses and speeds. When a target's CPA or TCPA value becomes below preset thresholds, the radar triggers an alarm.

- AIS Target Overlay Functionality

  Radars equipped with the TT function generally support AIS target overlay.

  AIS target positions are displayed on the radar screen as triangle symbols. When selected, the radar displays AIS target information, including bearing, distance, course, speed, CPA, and TCPA, similar to TT.

2.8.2 General Information Regarding Collision Prevention

(1) Regulations under COLREG and Domestic Law

To prevent collisions between vessels at sea, the International Regulations for Preventing Collisions at Sea (COLREG) were established to provide globally uniform rules regarding navigation, communication, and signaling methods that vessels should follow. In Japan, the Act on Preventing Collision at sea (Act No. 63 of 1977) was enacted in compliance with COLREG.

Relevant provisions of this Act related to the accident are provided in the appendix at the end of this document.

(2) Explanation in Literature

① Lookout and Navigation, etc.

The literature[*21] provides the following explanations regarding general information for collision prevention (excerpted below):

- COLREG shall always be adhered to.
- When performing maneuvers to avoid collision, one shall not assume that other vessels are navigating based on responsible and effective judgment.
- It is essential to recognize that options for navigation become extremely limited in situations of close quarter to other vessels. Therefore, such situations should be avoided.
- Particular attention should be paid to the rules on lookout and safe speed. If a vessel cannot alter its course, it will be necessary to adjust speed to avoid collision. The safe speed for navigation as required by COLREG should always be abided by.
- To make it apparent to other vessels using radar that a course has been altered, it is considered necessary to alter the course by at least 30°.
- If either of the two vessels is altering its course, the vector calculated by TT cannot be considered accurate. TT requires at least three minutes of stable course holding to compute the vector.
- The Officer on Watch (OOW) must frequently and accurately check the compass bearing of approaching vessels to make an early determination of risk of collision. The risk of collision can arise even with an apparent change in bearing. Particular caution is required when approaching large vessels, towing vessels, or other vessels at close range.
- The OOW must take early and proactive actions to avoid collision in accordance with the applicable rules and confirm whether the intended effect of these actions has been achieved.
- When the own vessel is the stand-on vessel, the OOW must remain aware of the obligations this entails. If there is doubt about the actions or inactions of the give-way vessel, the OOW must immediately report to the Master, use all means to warn the other vessel, and take necessary action under COLREG.
- The OOW must not hesitate to take actions such as turning or significantly reducing speed to avoid danger.

*21 "Practical Navigator" (Authored by Japan Marine Science Inc., published on September 28, 2015)

・ If there is any doubt, the OOW shall call the Master.

② Communication with Other Vessels via VHF

The literature[*22] provides the following explanations regarding communication with other vessels via VHF (excerpted below):

・ While VHF is primary to exchanging information with external parties, it is also important to understand the effective use of other signals, such as whistles and light signals. Situations often arise where the other vessel does not have VHF equipment or is not monitoring it. In such cases, it is necessary to use whistles or other signals effectively to raise awareness or address doubts about the other vessel's actions.

・ Timing is crucial when exchanging information with external parties via VHF, especially for collision avoidance with other vessels. To achieve effective action to avoid collision, mutual confirmation of intentions must be completed with sufficient time remaining for effective maneuvers. Additionally, it must be assumed that communication attempts might fail or that collision avoidance may need to rely solely on the actions of one's own vessel. Considering this, the appropriate timing for exchanging information can be regarded as the point when the risk of collision is recognized.

2.8.3 Statements from OOW and AB A of Vessel A

(1) Officer A_1

① At the time of the accident, several vessels were in the vicinity, however, the ones requiring attention were the four crossing vessels, which had been plotted by radar before Master A left the bridge (23:04).

Before leaving the bridge, Master A instructed me to increase the distance from the four crossing vessels by altering the course to starboard, and I set the autopilot to a heading of 186°.

② Around 23:20, while standing in front of the starboard radar, AB A, who was on visual lookout, reported the presence of Vessel B on the port bow. This was the first time Vessel B was recognized (see Appendix Figure 1, Vessel A Starboard Radar Screen ⑤).

[*22] "Ship Operation Techniques and Team Management" (Authored by Hiroaki Kobayashi, published on April 10, 2016)

I said thank you to AB A and confirmed on the starboard radar that Vessel B was approximately 25° off the port bow, at a distance of about 3–4 M, traveling at a speed of approximately 10 kn. There was good visibility, allowing visual confirmation of Vessel B's green light (starboard light) and mast light.

As there was still a considerable distance to Vessel B, the course of 186° was maintained until the four crossing vessels passed ahead.

I checked AIS information for Vessel B on the radar, however, the vessel name was not displayed, which was a problem. The AIS only provided data on distance, CPA, and TCPA for Vessel B, making it impossible to call Vessel B via VHF.

③ I confirmed that the distance to Vessel B was 1 M. The BCR with the four crossing vessels were sufficient, and there were no other vessels impeding navigation.

Following the navigation rules for crossing situation vessels, as the stand-on vessel, we maintained our course and speed. It was assumed that Vessel B, as the give-way vessel, would turn to starboard and pass aft of Vessel A.

I continued monitoring Vessel B, and the distance decreased to 0.5 M. Even at that point, it was expected that Vessel B would alter its course to avoid Vessel A. Given Vessel B's small size and maneuverability, it was assumed that a starboard turn would allow it to pass safely aft of Vessel A.

④ Subsequently, the BCR alarm sounded, indicating a change in BCR value from +0.3 M to 0.0 M. If Vessel A maintained its course and speed, Vessel B would collide with the midship section of Vessel A.

When the distance to Vessel B was approximately 0.5–0.6 M, I made a slight starboard turn, while still expecting Vessel B to turn to starboard. However, the slight turn by Vessel A was insufficient to avoid a collision. At a distance of about 0.5 M, I initiated a significant starboard turn, aiming to head toward 250°.

Recognizing that Vessel B was not taking any action to avoid the collision, and with both vessels rapidly closing in on each other, I made an attempt to create distance from Vessel B by altering course rather than wasting time sounding the whistle.

⑤ As Vessel A executed the starboard turn and Vessel B continued its approach without altering course, the collision occurred. Vessel B's starboard midship struck the bulbous bow of Vessel A as Vessel A headed toward 250°.

(2) AB A

While navigating under autopilot, I was conducting a visual lookout and identified Vessel B on the port bow through binoculars, showing a green light (starboard light). I reported this to Officer A_1, who was near the radar.

At the time of the accident, I confirmed a total of five vessels: one on the port side and four on the starboard side ahead of the ship.

After reporting the presence of Vessel B to Officer A_1, I noticed that Officer A_1 was monitoring the radar. I did not operate the radar myself, so I was unaware of the distance to Vessel B, but the Vessel B continued to approach afterward.

Following my report on Vessel B to Officer A_1, Officer A_1 ordered me to switch to manual steering.

I am unaware of the autopilot's set course at the time. After switching to manual steering, Officer A_1 ordered me to starboard rudder 20°. The collision with Vessel B occurred after the rudder angle indicated starboard 20°. Before this, the rudder angle was midship position at 0°.

The only order I received from Officer A_1 was to take starboard 20° under manual steering. No other orders were given.

(3) Officer A_1's Responses to Follow-up Questions

When asked again about the statements mentioned in (1), based on information such as Vessel A VDR records, Officer A_1 provided the following answers:

① From the time AB A reported the presence of Vessel B until the collision, I stood in front of the starboard radar, constantly monitoring it.

② Vessel B was plotted on the starboard radar around 23:20, but was not targeted. For Vessel B AIS information, the target information was displayed on the port radar. Since the port radar could be seen with limited visual access from the starboard radar position, I monitored Vessel B's target information via the port radar. On the radar, close quarter alerts are displayed as flashing in red, accompanied by an audible alert.

③ When the target information for Vessel B was displayed, I recall the BCR being +0.3 M. Subsequently, I focused on visual lookout and do not remember the exact BCR values.

④ While monitoring Vessel B’s movements, I decided to switch to manual steering when the distance was approximately 1 M.

⑤ Around 23:27, I turned to port because the give-way vessel, Vessel B, did not change its course or speed. I hoped this would cause Vessel B’s bearing to change

to starboard. The steering to port was only 2°–3° and lasted a very short time (a few seconds).

Afterward, as the stand-on vessel, I ordered steering to starboard to avoid the collision.

⑥ Before the accident, multiple vessels were in the vicinity, making it impossible to specify Vessel B via VHF using means other than its ship name. Based on my previous experience, Japanese inland vessels generally would not respond to English calls at night, so I assumed Vessel B would not answer if called.

⑦ I did not use the whistle because there were some vessels in the vicinity, and using it might have created confusion to them as well, so I avoided this. While I would not hesitate to use it in restricted visibility conditions, I avoid its use in clear visibility.

Similarly, if I had used light signals, I wouldn't have been able to monitor Vessel B.

⑧ At the time of the accident, there were several crossing situation vessels from the starboard side. Turning starboard would have resulted in firstly approaching these vessels, making it difficult to take usual maneuvering for avoidance of collision.

2.8.4 Statement of OOW of Vessel B (Officer B_1)

① On Vessel B, 23:00 was the standard watch handover time. After arriving on the bridge around 23:00, I adjusted my vision to the dark, changed the radar range and display mode to settings I was comfortable with, and conducted a visual and radar-based assessment of the surroundings.

I manually plotted targets displayed on the radar, recognizing there were crossing situation vessels. However, after confirming CPA, TCPA, BCR, and BCT values, which were displayed as negative (indicating the vessels were moving away from Vessel B), I did not perceive any danger. The radar could overlay AIS information, and I recall noticing the ship name of a container vessel, but I am unsure if I specifically checked Vessel A's information.

② Vessel B was navigating on autopilot during Master B’s watch. Although heading and speed were not usually handed over, Master B would provide information about nearby vessels to watch out for. On the day of the accident, Master B did not mention any vessels requiring attention. I didn’t check the compass, but as Vessel B was navigating from Hi-no-Misaki to Naruto Kaikyo, I

believe the course was around 340°–350°. After completing the handover and engaging in casual conversation, Master B left the bridge around 23:15.

③ As for lookout procedures, I generally detect other vessels within 6 M and assess mutual relations by 3 M. Additionally, I typically maintain a distance of approximately 0.2–0.3 M or more when passing head-on with other vessels.

According to AIS records, Vessel B passed a head-on vessel at a distance of about 0.1 M around 23:21, but he (Officer B_1) was unaware of this situation.

④ Since no vessels were impeding navigation in the vicinity, I was working at the chart table located aft on the port side of the bridge.

During nighttime watches, signing the handover checklist requires light, so such tasks are typically done at the chart table. The chart table is not in a separate room, so I could still look forward by turning around.

Vessel B is equipped with two radars, but during coastal navigation, only the starboard radar is typically used, and this was the case at the time of the accident. This radar flashes a red alert when other vessels approach based on target information, but its auto-plotting function was not activated, and audio alarms were usually muted. I do not know if an alert was displayed during my work at the chart table.

⑤ With prior experience as an Officer on both oceangoing and domestic container ships, I was accustomed to actively using VHF for communication with other vessels. However, I did not use VHF at the time of the accident. The VHF is installed above the chart table, but I did not hear any calls from other vessels. I also did not hear any whistles from other ships.

⑥ The accident occurred just as I had finished my work at the chart table, completed preparations for watch duty, and switched to active bridge watch.

2.9 Information on Class B AIS Transmitted Data Display

According to a response from the manufacturer of Vessel A's AIS transmitter and port radar, the information is as follows:

The AIS transmitter (Class A station) may not display information such as ship names and call signs transmitted by Class B AIS if the device was manufactured in earlier years. However, Vessel A's AIS transmitter and port radar can correctly display Class B AIS information if the firmware[*3] for both devices are updated.

*23 "Firmware" refers to embedded software that controls hardware.

On Vessel A, the firmware of the AIS transmitter was updated in 2022, but the firmware for the port radar was not. As a result, the ship name and other Class B AIS information received were not displayed on the port radar.

The starboard radar is a product from a different manufacturer than that of the port radar. Since Officer A_1 did not confirm Vessel B's AIS information on the starboard radar, it is unclear whether Class B AIS information, such as ship names, would have been displayed there.

2.10 Information on Bridge Watchkeeping Arrangement

(1) Vessel A

According to the statements of Master A, Officer A_1, and AB A, the bridge watchkeeping arrangement on Vessel A was as follows:

① Vessel A operated on a three-shift system with three officers and able seaman . Master A took charge of navigation during port arrival/departure, passage through narrow channels, or in restricted visibility. Officer A_1 and AB A were on duty from 08:00–12:00 and 20:00–24:00.

② Master A noted that it had been four years since Officer A_1 became an officer, and Officer A_1 had been assigned to Vessel A for one month. During this time, as Master A supervised his navigation through narrow channels and congested fishing areas, and judged that Officer A_1 was fully capable, Officer A_1 was entrusted with independent command of navigation during the voyage.

③ Master's standing order

Three days prior to the accident, Master A prepared the following directive (Master's standing order), signed by all three officers, including Officer A_1:

GENERAL : Call the Master immediately in case of any doubt!!

1 The first and foremost duty of the OOW is the keeping of the GOOD LOOKOUT, using all means available, visual, audible and electronic.

3 COLREGs are to be strictly observed. Do not hesitate to use the whistle or engine in obeying these regulations. When altering course for another vessel do so boldly and in sufficient time to let any other vessel be in no doubts as to your intention.

A good Officer when faced with any unusual circumstance, will apply COMMON SENSE AND THE GOOD PRACTICE OF SEAMANSHIP to the situation and

act accordingly. ***If you find yourself thinking about calling the Master then the time has clearly come to do so.***

④ Master's order book

During the voyage, Master A also made the following entries in the Master's order book, which were signed by all three officers, including Officer A_1:

① ABIDE MASTER'S STANDING ORDER

② KEEP CLOSE ATTENTION TO FISHING BOATS, NETS & BUOYS

③ KEEP PROPER LOOKOUT AND AVOID CLOSE QUARTER SITUATION KEEP WIDE BERTH TO OTHER VESSEL

④ MONITOR WEATHER FORECAST

⑤ IF ANY DOUBT, CALL MASTER ANYTIME

(2) VESSEL B

According to the responses from Company B_1 and JFE Logistics Corporation (hereinafter referred to as "Company B_2"), the operator of Vessel B, the bridge watchkeeping arrangement on Vessel B was as follows:

① On Vessel B, the bridge watch was conducted in a three-shift system: Master B was on duty from 07:00–11:00 and 19:00–23:00, Officer B_1 from 11:00–15:00 and 23:00–03:00, and Officer B_2 from 15:00–19:00 and 03:00–07:00.

② On Vessel B, a handover checklist established by Company B_2 was to be carried out during watch handovers. The safety manager of Company B_2 would instruct on the use of checklist during visits to the ship.

③ The handover checklist covered the following "Principles for Watch Handover" outlined in the Navigational Watch Standards (Ministry of Transport Notice No. 704 of 1996). Under Article 3-5 of the Seafarers Act Enforcement Regulations, the Master is required to take measures to ensure proper navigation watch in accordance with these standards (see Figure 17).

Navigational Watch Standards (Ministry of Transport Notice No. 704)

II Standards for Watches During Navigation

1. Deck department Watch Standards

(1)-(2) (Omitted)

(3) Principles for Watch Handover

[1] Officers handing over the watch shall follow the procedures below:

i. Do not leave the bridge until the watch has been appropriately handed over.

ii. If the relieving officer is deemed clearly incapable of conducting the watch, do not hand over the watch and report the situation to the Master.

iii. If safety-related actions to avoid danger are in progress, do not proceed with the handover until those actions are complete.

[2] Officers taking over the watch shall follow the procedures below:

i. Do not take over the watch until your vision has adequately adapted to the lighting conditions.

ii. Confirm the following items during the handover:

a. Instructions and orders from the Master related to navigation.

b. The planned course.

c. The vessel's position, heading, speed, and draft.

d. Weather and sea conditions and their impact on the course and speed.

e. The operating status of navigational and safety equipment.

f. Compass errors.

g. The position and movements of nearby vessels.

h. Expected situations and hazards during the watch.

Navigation Watch Handover Checklist (Deck)

Vassel Name:	Confirmation Stamp/Signature			
Next Voyage Number				
Year/Month/Day				
Handover Start Time				
Handover End Time				
For outgoing watch officer	***In the following cases, do not perform the handover until the relevant actions have been completed or the situation has been resolved.**			
	・When actions are being taken to avoid danger			
	・When other vessels are approaching			
	Check items			
	・Confirm that the anti-drowsiness device is activated.			
	*During departure, the first or second officer should confirm with the Master.			
	・Alcohol level of the incoming watch officer.			
	・Health condition of the incoming watch officer.			
	*If anyone is unfit for duty, inform the Master.			
	Handover items			
	・Speed, current position, course, and deviation from the planned course			
	・Visibility and weather (current and forecasted)			
	・Distance to the next turning point			
	・Condition and impact of tidal and ocean currents			
	・Movements of surrounding vessels (within visual and radar range)			
	・Presence of fishing vessels and their fishing methods			
	・Navigation information such as navigation warnings			
	・Orders and instructions from the Master or chief engineer			
	・Operational status of navigation instruments			
	・Presence of any engine-related alarms			
For incoming watch officer	***The incoming watch officer must report 15 minutes in advance and confirm the following items before taking over the watch.**			
	Chart-related check items			
	・Confirm that the anti-drowsiness device is activated.			
	・Ship's position, course, and speed			
	・Current watch track			
	・Planned route for the current watch and the two hours after its end			
	・Navigational markers and landmarks for the current watch and the two hours after its end			
	・Navigational and potential hazards for the current watch and the two hours after its end			
	Orders and instructions from the Master			
	・Night order book (Master 's order book)			
	・Other orders and instructions by alternative means			
	Weather and sea conditions			
	・Tidal and ocean currents during the current watch and for the two hours after its end			
	・Current and forecasted weather and sea conditions			
	・Current visibility			
	・Navigation warnings			
	・Safety of deck personnel engaged in tasks			
	Situational awareness via visual and radar observations			
	・Check surrounding conditions via visual and radar observations			
	・Confirm navigational markers and objects visually and with radar			
	・Monitor the movements of other vessels visually and with radar			
	Compass checks			
	・Inspect the readings of the master compass and steering repeater			
	・Compare the readings of the steering repeater with other navigational instrument repeaters			
	・Compare the readings of the steering repeater and magnetic compass			
	***At night, do not take over the watch until your eyesight has fully adjusted to the dark conditions.**			

Figure 17: Vessel B Handover Checklist

Officer B_1 provided the following statement regarding bridge watch duty on Vessel B:

① Officer B_1 stated that during regular bridge watch handovers, he would ascend to the bridge shortly before the scheduled shift time, and after arriving, the outgoing Master B would observe the surrounding conditions and Officer B_1's health while engaging in casual conversation. Master B would leave the bridge 20–30 minutes after the scheduled shift time.

② When taking over the bridge watch from Master B, unless there were specific circumstances, the handover was generally limited to simple remarks like "We're heading toward such-and-such cape, thanks" without detailed discussions on heading, speed, etc. Although the handover checklist includes an item for verifying alcohol level, no measurements were taken. However, drinking alcohol onboard was not practiced.

The handover checklist was filled out later during his watch and he considered it a meaningless task. He felt that the checklist's implementation was not an urgent duty and should not have been prioritized at the time of the accident.

2.11 Information on BRM/BTM

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 (STCW) addresses watchkeeping arrangement and principles to be observed. These are stipulated in the STCW Code under Watchkeeping Principles in General, as follows:

STCW Code Part A Section Ⅷ/2 Watchkeeping arrangements and principles to be observed

Part 3 - Watchkeeping Principles in General

8 Watches shall be carried out based on the following bridge and engine-room resource management principles:

.1 proper arrangements for watchkeeping personnel shall be ensured in accordance with the situations;

.2 any limitation in qualifications or fitness of individuals shall be taken into account when deploying watchkeeping personnel;

.3 understanding of watchkeeping personnel regarding their individual roles, responsibility and team roles shall be established;

.4 the master, chief engineer and officer in charge of watch duties shall maintain a proper watch, making the most effective use of the resources available, such as information, installations/equipment and other personnel;

.5 watchkeeping personnel shall understand functions and operation of installations/equipment, and be familiar with handling them;

.6 watchkeeping personnel shall understand information and how to respond to information from each station/installation/equipment;

.7 information from the stations/installations/equipment shall be appropriately shared by all the watchkeeping personnel;

.8 watchkeeping personnel shall maintain an exchange of appropriate communication in any situation; and

.9 watchkeeping personnel shall notify the master/chief engineer officer/officer in charge of watch duties without any hesitation when in any doubt as to what action to take in the interest of safety.

The term "Bridge Resource Management" or "Bridge Team Management"[*24] (hereinafter referred to as "BRM/BTM"), as stipulated in this provision, is explained in literature (same as [*21]) as follows:

BRM/BTM is a practical management method aimed at achieving safe navigation through the systematic use of all available resources (both human and material) on the bridge. This is done by the bridge team members (all personnel on the bridge) operating under clear standards (such as navigation plans, various regulations, and company/Master policies) while establishing an efficient organizational structure.

[*24] The terms "BRM" and "BTM" vary depending on related regulations or the training institutions in each country. In this report, they are collectively referred to as BRM/BTM.

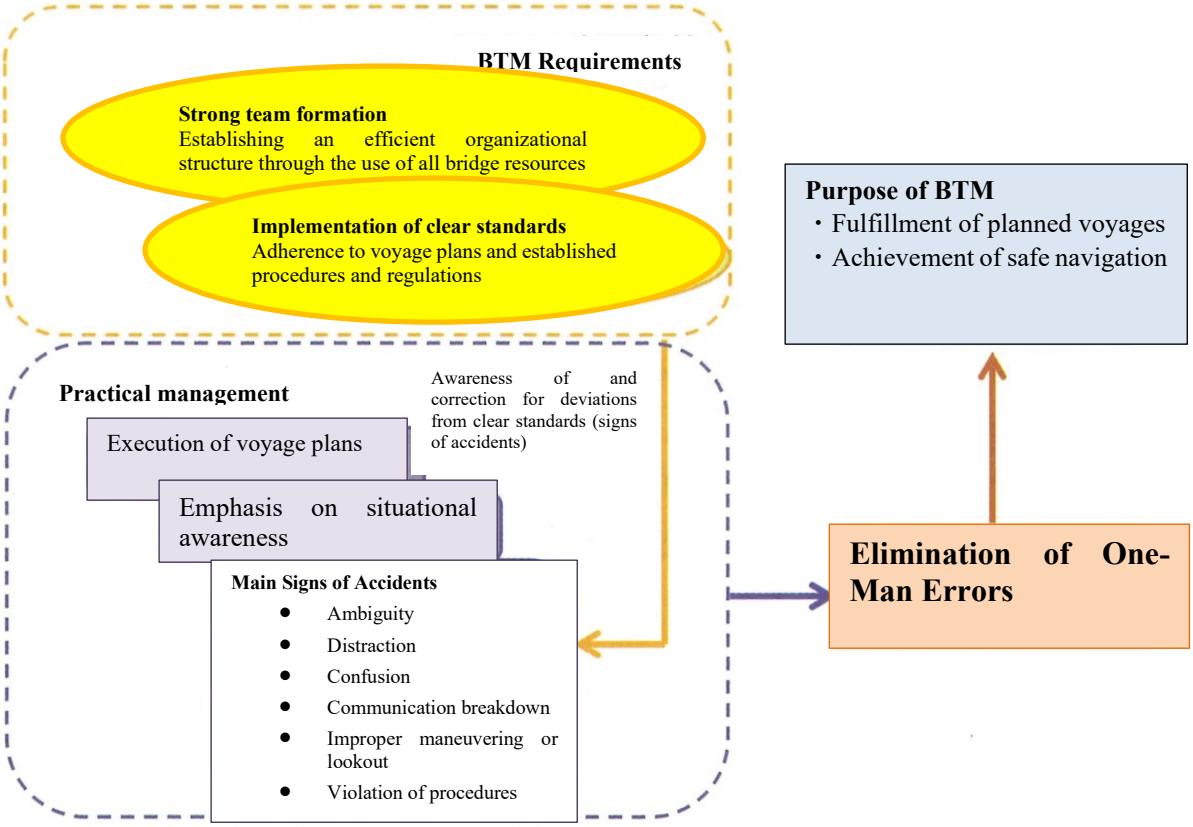


Figure 18: Concept of BRM/BTM (quoted from literature [*21])

2.1.2 Information on Vessel B's Safety Management

(1) Company B_1, as the charterer under a bareboat charter agreement with the shipowner, assumed shipowner responsibilities, including ship maintenance, management, and crew allocation. Meanwhile, Company B_2, under a time charter agreement with the shipowner, handled Vessel B's operational tasks and established the rule for safety management related to coastal shipping.

(2) The rule for safety management included the following provisions for safety education and training:

Chapter 14: Safety Education, Training, Internal Audits, etc.

(Safety Education)

Article 49: The safety management supervisor and operational manager must regularly provide clear and specific safety education to operational support personnel, shipowners, crew members, safety management personnel, and internal auditors. This education should ensure thorough understanding of the rule for safety management (including operational and accident-handling standards, limited to navigation management), relevant laws such as the

Seafarers Act and the Collision Prevention Act, and other necessary safety measures.

Education for crew members should be carried out as much as possible during ship visits and other activities.

2. Shipowners must also provide education to crew members in accordance with the preceding clause.

3. Operational managers and shipowners should research navigational situations, marine accidents, and other incident cases (hazardous events without accompanying damage) and incorporate this information into crew education, either periodically or with the aforementioned training.

(Drills)

Article 50: When the Master conducts legally mandated drills, they must report the implementation status to the operational manager and shipowner.

Emergency steering drills must be conducted once every three months, and rescue drills in enclosed spaces must be conducted once every two months.

(Training)

Article 51: The safety management supervisor and operational manager, with the support of top management, must ensure the implementation of at least one training session per year on accident handling. The training should simulate practical scenarios involving accidents that require a company-wide response. Drills specified in the previous article may be conducted alongside this training.

(Records)

Article 52: When operational managers and shipowners provide the education specified in the preceding three articles, they must record the details. When shipowners conduct the education, they must report the content to the operational manager, who must then record an outline of it.

(3) Company B_2 conducted safety education for Company B_1 and the crew of Vessel B during safety meetings held at the time of Vessel B's docking and during ship visits.

When Vessel B entered dock in April 2022, a safety conference was held with the participation of Company B_1 and the owner of Vessel B, with the themes of preparation and response to voyage plans, sailing at a safe speed, appropriate deployment of bridge personnel, and confirmation work by pointing and calling and repeating, as safety education for the crew of Vessel B, and safety-related documents were distributed to

Vessel B. In addition, Captain B or Company B_1 requested that crew members who were unable to attend the safety conference be informed.

When visiting Vessel B (six times since January 2023), the operation management assistant and others confirmed with Captain B that safety-related documents were prepared on the bridge and that notices of compliance were posted.

(4) Company B_2 created an annual safety policy and activity plan, distributed monthly priority activity items to each vessel, and encouraged heightened safety awareness aboard each ship.

(5) On Vessel B, all crew members participated in monthly safety education sessions, onboard safety and health committee meetings, and drills, each lasting 30 minutes. During the safety and health committee meetings, priority activity items instructed by Company B_2 were reviewed. Records were created based on the provisions of Article 52 of the rule for safety management, with all crew members signing these records.

According to these records, the implementation status of safety education, onboard safety and health committee meetings, and drills was as shown in Table 4:

Table 4: Records of Safety Education, Onboard Safety and Hygiene Committee Meetings, and Drills on Vessel B

Date	Safety Education	Onboard Safety and health Committee	Drill
Jan. 4, 2023	10:30-11:00	Collision Prevention 10:00-10:30	Emergency Steering 11:00-11:30
Feb. 1, 2023	13:30-14:00	Grounding Prevention 13:00-13:30	Rescue from Enclosed Spaces 14:00-14:30
Mar. 7, 2023	08:00-08:30	Preventing Issues with Fishing Boats 08:30-09:00	Emergency Steering 09:00-09:30
Apr. 3, 2023	08:00-08:30	Enhanced Ship Maintenance, Safety of Crews 08:30-09:00	Oil Pollution Prevention 09:00-09:30
May 2, 2023	09:00-09:30	Safe Navigation in Fog, Equipment Maintenance	Fire and Flood Protection

		09:30-10:00	10:00-10:30
Jun. 2, 2023	09:30-10:00	Pollution Prevention from Oil Spills and Waste 09:00-09:30	Oil Pollution Prevention 10:00-10:30
Jul. 6, 2023	09:00-09:30	Enhanced Typhoon countermeasures 08:30-09:00	Emergency Steering 09:30-10:00
Aug. 5, 2023	08:30-09:00	Dragging anchor Prevention 09:00-09:30	Rescue from Enclosed Spaces 09:30-10:00

(6) On Vessel B, drills conducted under Article 14-3, Paragraph 2 of the Seafarers Act (Act No. 100 of 1947) are required by Article 3-4, Paragraph 8 of the Seafarers Act Enforcement Regulations to include emergency steering drills at least once every three months and rescue drills from enclosed spaces at least once every two months. According to Vessel B's drill records, since January 2023, rescue drills from enclosed spaces were conducted in February and August 2023, and emergency steering drills were conducted in January, March, and July 2023, thereby not following the requirements of the Enforcement Regulations.

(7) Records of safety education, onboard safety and health committee meetings, and drills were reported monthly to Companies B_1 and B_2 in accordance with Article 52 of the rule for Safety Management.

(8) When Company B_2 was asked to explain the reported drill records from the JTSB, it stated that vessels under its operational management were required to conduct essential and important drills, such as emergency steering drills and rescue drills from enclosed spaces as stipulated by laws and the rule for safety management, as well as fire and flood protection drills and oil pollution prevention drills. The specific content of these drills was entrusted to the shipowners, who were familiar with the skills and experience of the crew members.

(9) At Company B_1, handovers were carried out by handover documents during crew changes. After both the outgoing and incoming crew members signed the handover document, it was subject to post-confirmation stamps by the Master and the Head of the Ship Department. However, the crew handover document template submitted to the

JTSB already bore the stamp of the Head of the Ship Department. When Company B_1 was asked to explain this discrepancy from the JTSB, the company replied that the submitted document was a sample held by the company, and in practice, unstamped templates were used.

(10) On Vessel B, Officer B_1 stated that he had never read safety management-related files kept on the bridge, had not received safety education such as training sessions, and had never participated in any drills.

3 Analysis

3.1 Situation of the Accident Occurrence

3.1.1 Course of the Events

(1) Progress of lookout and maneuvering after Master A left the bridge on Vessel A:

According to the Vessel A VDR records (Appendix Tables 1 and 2), the statements of Officer A_1 and AB A, as well as Officer A_1's written responses (sections 2.1.3(1) and 2.8.3(1)–(3)), the events are as follows:

① After Master A left the bridge at around 23:04, Officer A_1 and AB A remained on the bridge. Officer A_1 assumed command of navigation, and AB A performed visual lookout duty.

② It is highly probable that Vessel A navigated south through Kii Suido on autopilot, with periodic rudder angles ranging from 2° starboard to 1° port. The vessel's heading was stabilized 186°, with a course of 186.9° and speed of 15.2 kn (averaged from 23:05 to 23:25).

③ Officer A_1 stated first sighting Vessel B at around 23:20 after being informed by AB A and confirmed a distance of approximately 3–4 M. However, there were no records of utterances from the bridge audio between 23:19 and 23:22 when the distance to Vessel B was 3–4 M, making it unclear when Vessel B was first sighted.

④ Officer A_1 stated that he checked Vessel B's AIS information on the port radar and observed a BCR of +0.3 M, later changing to 0.0 M. However, since the Vessel A VDR records do not contain data from the port-side radar, the reason for not using the starboard radar despite being positioned in front of it is unclear. Additionally, if neither Vessel A nor Vessel B changed their course or speed, the BCR would not show a distinct change. Therefore, it could not be determined whether Officer A_1 was actually using the port radar to monitor Vessel B.

⑤ It is probable that Vessel B was plotted by the starboard radar at around 23:23, but the Vessel A VDR records show no operation of the starboard radar, indicating Vessel B was automatically plotted when it came within a range of approximately 2.5 M.

⑥ Around 23:25, after Vessel B was automatically plotted, a close quarter alert for Vessel B appeared on the starboard radar when the course shifted to the starboard side at 188°. However, the alert disappeared shortly thereafter as the course shifted to the port side. It is probable that, at this time, the course shifted to the starboard side had been caused by the autopilot’s periodic oscillation, as the rudder angle at

that moment was not significantly different from the previous periodic port and starboard rudder movements.

⑦ At around 23:26:30, when Vessel A's course shifted to the starboard side again at 188°, a close quarter alert for Vessel B reappeared on the starboard radar. Starting at around 23:26:40, contrary to the autopilot's periodic transition to the port side, a 4° starboard rudder was taken. It is likely that Officer A_1 personally adjusted the autopilot's set course to starboard since there is no record of any utterances on the bridge at this time. As a result, Vessel A's course gradually turned to starboard.

⑧ Around 23:27, while the close quarter alert continued, Vessel A took a maximum of 5° of port rudder accompanied by a utterance from Officer A_1. Although there was no record of AB A answering Officer A_1's utterance, it is reasonable to conclude that this was an order directed at AB A. From this time, when the distance to Vessel B was approximately 1 M, it is probable that Vessel A switched to manual steering. Despite the port rudder, the vessel began to turn to port at 23:27:12, but the course continued shifting to starboard until approximately 23:27:30.

⑨ Around 23:27:30, Officer A_1 uttered "shit," and a 9° starboard rudder was taken by Vessel A. This initiated a starboard turn from 23:27:41, though the course continued shifting to port until approximately 23:28. When the course reached around 185°, the close quarter alert for Vessel B briefly disappeared, but the course change to the starboard side triggered by the starboard rudder caused the alert to reappear.

⑩ At approximately 23:28, without any utterances recorded on the bridge, a 7° port rudder was taken again, initiating a port turn at around 23:28:17. By around 23:28:30, a 12° starboard rudder was taken, and from 23:28:35 onward, a starboard turn began with an increasing rate of turn.

⑪ From around 23:28:43, Vessel A's starboard rudder angle began to decrease, and at the same time, Officer A_1 issued a utterance. Around 23:29, Officer A_1 uttered "oh shit," and a port rudder was taken. However, the starboard turn continued, and at approximately 23:29:15, when the heading was approximately 212°, the bow of Vessel A collided with the mid-starboard side of Vessel B at a course of about 198.8° and a speed of approximately 14.4 kn.

⑫ After Master A left the bridge, there was no record of AB A responding to Officer A_1's utterance. Regarding Vessel A VDR bridge audio recordings, based on the position of the microphones installed on the ceiling above the starboard-side and port-side seats of the bridge, it is likely that any verbal made in front of the

starboard radar or steering stand would have been recorded. Therefore, it is probable that no utterances were issued during this time.

Furthermore, while AB A stated he took a rudder 20° to starboard under Officer A_1's order, Vessel A VDR records indicate that steering to both port and starboard was repeatedly performed until collision, with a maximum rudder angle of 12° to starboard during that time.

Based on these factors, it is likely that Officer A_1, not AB A, performed the steering himself at the time of the accident.

(See Figure 19 and Table 5)

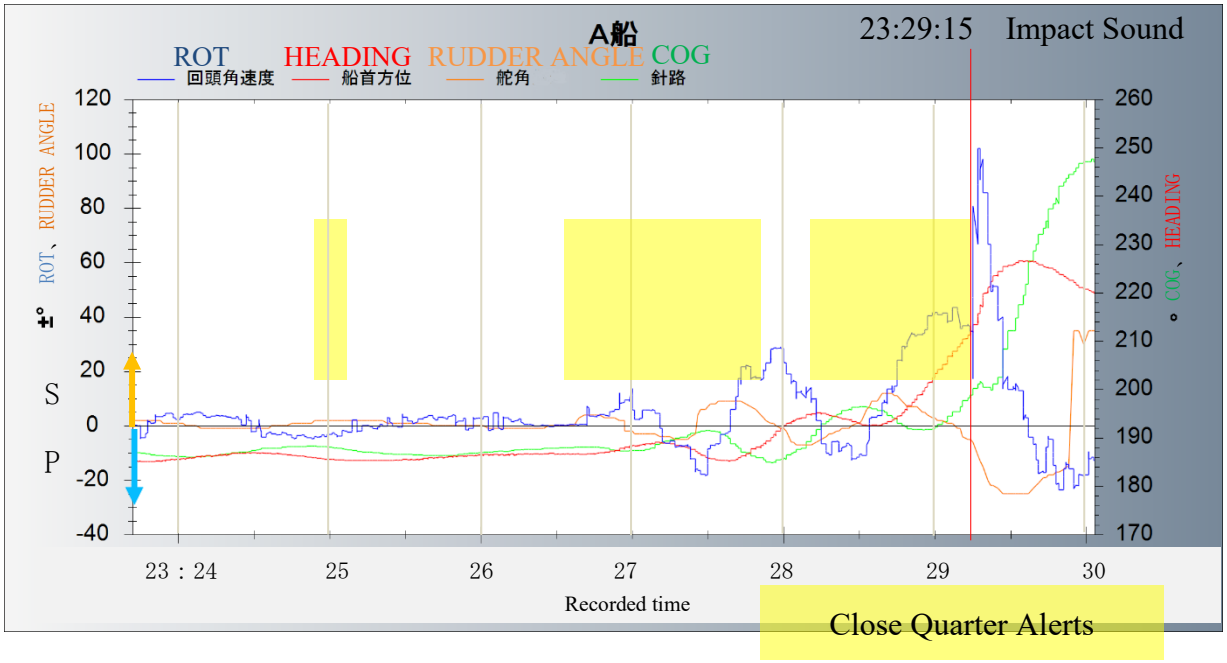


Figure 19: Transition of rate of turn, heading, rudder angle, course over ground, and radar proximity alarm display based on Vessel A VDR records

Table 5: Timeline of Vessel A's navigation based on VDR records

Time hh:mm:ss	Bridge Voice	Rudder Angle (°)	ROT (°/min)	COG (°)	Heading (°)	Distance to "B" (M)	Bearing to "B" (°)	CPA (M)	Close Quarter Alert
23:24:58		2	−3.2	188	186	1.8	171	0.1	Displayed
23:25:13		2	−1.9	187	185	1.7	171	0.1	
23:25:28		1	−0.5	187	185	1.6	171	0.1	
23:25:43		0	2.2	186	186	1.5	172	0.1	
23:25:58		0	3.5	187	186	1.4	172	0.1	
23:26:13		−1	1.5	187	187	1.3	172	0.1	
23:26:29		0	−0.4	188	187	1.2	172	0.1	
23:26:43		4	6.5	188	187	1.1	173	0.1	Displayed
23:26:55	utterance	2	5.9	187	187	1.0	173	0.1	Displayed
23:27:00		−2	13.7	187	188	1.0	173	0.1	Displayed
23:27:12		−4	−1.0	189	189	0.9	174	0.1	Displayed
23:27:19		−5	−7.5	190	188	0.9	174	0.1	Displayed
23:27:25	shit	−3	−12.1	191	189	0.8	174	0.0	Displayed
23:27:30		7	−18.0	192	186	0.8	174	0.0	Displayed
23:27:39		9	−2.1	190	185	0.7	174	0.1	Displayed
23:27:41		9	6.0	189	185	0.7	174	0.1	Displayed
23:27:43		9	17.4	188	186	0.7	175	0.1	Displayed
23:27:59		−1	28.7	185	192	0.6	176	0.1	
23:28:11		−7	14.2	189	195	0.5	178	0.1	Displayed
23:28:15		−5	2.0	192	195	0.5	178	0.1	Displayed
23:28:17		−4	−6.7	193	195	0.5	178	0.1	Displayed
23:28:24		−1	−8.4	195	194	0.4	179	0.0	Displayed
23:28:29		1	−12.1	196	193	0.4	179	0.0	Displayed
23:28:34		7	−5.0	196	193	0.3	179	0.0	Displayed
23:28:35		9	2.8	196	193	0.3	179	0.0	Displayed
23:28:39		12	3.8	196	193	0.3	180	0.0	Displayed
23:28:43		12	13.5	195	193	0.3	180	0.0	Displayed
23:28:47	utterance	9	24.2	193	195	0.3	181	0.1	Displayed
23:28:59	oh shit	3	40.5	192	202	0.2	186	0.1	Displayed
23:29:09		−1	43.4	195	208	0.2	190	0.1	Displayed
23:29:15	Impact	−6	34.7	199	212	0.1	200	0.1	Displayed

* Changes to the starboard side for rudder angle, rate of turn, course over ground, and heading are shown in red, while changes to the port side are shown in blue.

(2) Progress of Lookout and Maneuvering on Vessel B

Based on Vessel B AIS records (Appendix Table 3) and Officer B_1's statements (Sections 2.1.3(2) and 2.8.4), the situation was as follows:

① Around 23:00, Vessel B was navigating northwest in Kii Suido off Hi-no-Misaki, heading towards Naruto Kaikyo at full ahead under autopilot.

② Officer B_1 went up to the bridge around 23:00 and took over watch duties from Master B. He was instructed to adjust timing to align with the scheduled entry into the Bisan Seto East Passage. However, he did not usually perform handovers based on a checklist and did not receive a handover regarding course or speed.

③ Before Master B left the bridge, Officer B_1 adjusted the radar settings and confirmed surrounding vessels visually and via radar, determining there were no obstacles to navigation. Around 23:10, Vessel A was approximately 8 M away. Given the radar was set to a 6 M range with off-center display extending up to 8 M ahead, it is likely that Vessel A's echo image may have either been outside the radar's range or was not perceived as an obstacle to navigation even if it was visible.

④ It is highly probable that Vessel B is estimated to have continued northwest on a course of 320.5° at a speed of 10.8 kn (average values between 23:15 and 23:28) under autopilot after Master B left the bridge.

⑤ During his sole watch, Officer B_1 began working at the chart table on the port side aft of the bridge to prepare a handover checklist and check distances and speeds for the planned navigation route. The radar in use had a TT function that displayed close quarter alerts in flashing red text for approaching vessels but lacked an auto-tracking feature, and audio alarms were muted.

It is probable that Officer B_1 was not maintaining a lookout while working at the chart table, since he did not notice Vessel B passing a vessel head-on at approximately 0.1 M around 23:21.

⑥ Vessel B continued northwest at the original course and speed, closing in on Vessel A. When Officer B_1 noticed Vessel A's light at close range, he set the engine to full astern, switched to manual steering, and took the rudder hard to port, but these measures were ineffective. Around 23:29:15, Vessel B's starboard midship section collided with Vessel A's bow.

3.1.2 Time and Location of the Accident

Based on Vessel A VDR records (Appendix Table 2) and Vessel B AIS records (Appendix Table 3), the following has been estimated:

(1) Time of the Accident

The time of the accident was around 23:29:15 on August 24, 2023, as determined from the recorded impact sound on Vessel A VDR records.

(2) Location of the Accident

The location of the accident was approximately 7.3 M from Kii Hi-no-Misaki Lighthouse on a bearing of 312°, based on the positions of Vessel A and Vessel B at the time of the accident.

3.1.3 Injuries and Fatalities

As described in Section 2.2 (Table 3: Status of Casualties on Vessel B), Officer B_2 was killed, Master B was presumed death after missing, and Officer B_1, Chief Engineer B, and Engineer B sustained serious injuries.

3.1.4 Damages

As described in Section 2.3, Vessel A sustained a breach in the bow, buckling and dents in the bulbous bow, and abrasions, while Vessel B suffered catastrophic damage to its mid-starboard section, capsized after the collision, and eventually sank at approximately 02:50 on August 26.

3.1.5 Collision Details

It is highly probable that, based on sections 3.1.1 to 3.1.4, the collision occurred when Vessel A, sailing at approximately 14.4 kn and turning to starboard, collided with Vessel B, sailing at approximately 10.8 kn, and both vessels collided between the bow of Vessel A and the mid-starboard section of Vessel B at a near-perpendicular angle.

3.2 Causal Factors of the Accident

3.2.1 Crew Conditions

As described in section 2.4, Master A, Officer A_1, and Officer B_1 all held valid and lawful qualifications. They had no issues with vision, hearing, or other health concerns, and their overall health condition was good. It is not certain that these factors contributed to the accident.

3.2.2 Vessel Conditions

Regarding the conditions of the hulls, engines, and equipment of Vessel A and Vessel B, Vessel A was unable to use its bow thruster due to a malfunction. However, as described in section 2.5, neither Vessel A nor Vessel B had any faults or defects that influenced the occurrence of the accident.

3.2.3 Weather and Sea Conditions

According to Vessel A VDR records (section 2.5.2), the statement of facts by Master A, and the statement of Officer B_1 (section 2.5.3), the weather near the accident site at the time was clear, with an east-southeast wind of force 4 and clear visibility.

3.2.4 Analysis of the Vessels' Close Quarter Situation

(1) Close Quarter Situation if Both Vessels Continued on the Original Course and Speed.

It is highly probable that, as described in section 3.1.1, until 23:25, when neither Vessel A nor Vessel B had altered their course or speed, Vessel A was on a course of 186.9° at a speed of 15.2 kn, while Vessel B was on a course of 320.5° at a speed of 10.8 kn, both vessels were navigating under autopilot, and based on Vessel B's target information from Vessel A VDR records (Appendix Table 4), the CPA was between 0.0 and 0.2 M.

Since Vessel B was unaware that it was approaching Vessel A and continued navigating without altering its course or speed, and if Vessel A had also maintained its course of 186.9° and speed of 15.2 kn after 23:26, then calculations suggest that around 23:28:50, the GPS antenna of Vessel A and Vessel B would have been approximately 410 meters apart, with Vessel B crossing the bow of Vessel A from the starboard side (a BCR of about 0.2 M for Vessel B as seen from Vessel A). Around 23:29:30, Vessel A would have passed approximately 240 meters aft of Vessel B (a BCR of about -0.1 M for Vessel A as seen from Vessel B).

It is probable that, adjusting for the positions of the GPS antenna on each vessel, Vessel B would have crossed Vessel A's bow at an approximate distance of 270 meters to the starboard side. (See Figure 20.)

It is probable that the CPA values of 0.0–0.2 M and the BCR values of 0.2 or -0.1 M are generally determined as a risk of collision existing, and both Vessel A and Vessel B approached each other without significant changes in bearing, maintaining a risk of collision.

(2) Vessel A’s Turn to Starboard

It is probable that this led to the collision between Vessel A’s bow and Vessel B’s mid-starboard section at a near-perpendicular angle. Although Vessel A and Vessel B were approaching each other without appreciable changes in compass bearing, Vessel B’s bearing changed slightly to the starboard side. As Vessel A’s course shifted to the starboard side, the BCR for Vessel B decreased during this situation, and Vessel A took repeated small-angle steers, gradually turning to starboard.

(3) Relative Positions of Both Vessels if Vessel A Had Steered to Hard Starboard

It is probable that, according to Vessel A's maneuverability data (2.7.2(1)①), when sailing at approximately 14.7 kn and steering to hard starboard (rudder angle of 35°), Vessel A requires a turning radius of 185 meters longitudinally, 242 meters laterally, and 126 seconds to complete a 90° turn. At approximately 23:27:30, Vessel B was about 0.8 M away when Vessel A took a 9° starboard rudder following Officer A_1’s

utterance. If Vessel A had steered to hard starboard at this moment, it could have kept sufficient distance from Vessel B.

Officer A_1 stated that multiple crossing situation vessels were present from the starboard side, and turning to starboard would have resulted in firstly approaching those vessels, making usual maneuvering difficult. However, as described in 2.1.3(1)②, at the time of the accident, the only other vessel besides Vessel B approaching Vessel A was Vessel C, which had a CPA of 0.4–0.5 M and was crossing ahead to the port side, it is probable that there were no other vessels obstructing Vessel A's ability to turn to starboard.

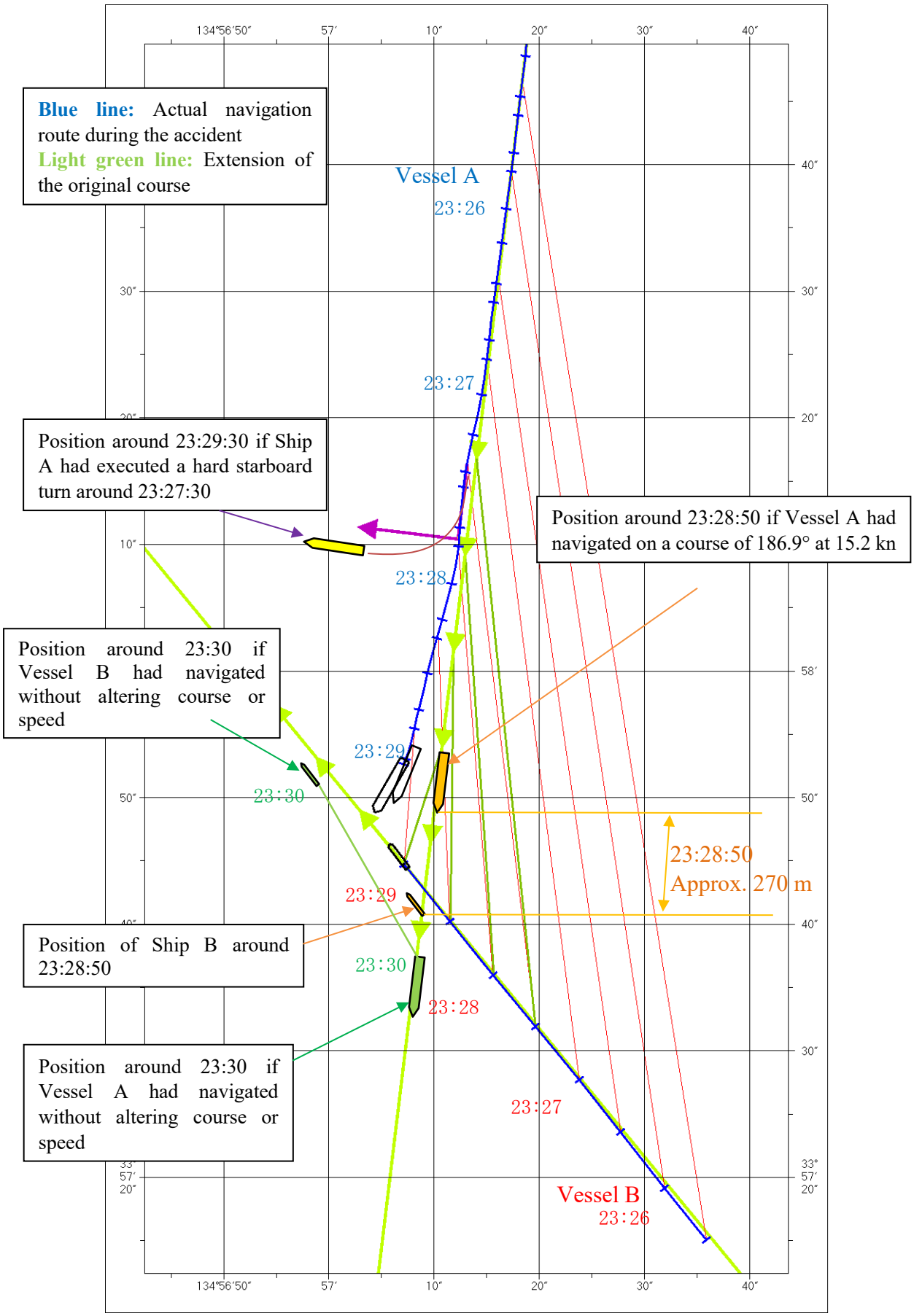


Figure 20: Estimated paths if Vessel A continued on its original course and speed or steered to hard starboard

3.2.5 Analysis of Lookout and Maneuvering Conditions

(1) Vessel A

Based on the descriptions in sections 3.1.1 and 3.2.4, Vessel A VDR records (Appendix Tables 1 and 2), statements by Master A, Officer A_1, and AB A, as well as Officer A_1's written response (2.1.3(1) and 2.8.3(1)–(3)), the lookout and maneuvering conditions aboard Vessel A are assessed as follows:

① While the exact time Officer A_1 first spotted Vessel B cannot be determined, he stated that even with a distance of 0.5 M, he thought Vessel B, as the give-way vessel, could avoid collision by turning to starboard. It is probable that at earlier stages, when the distance to Vessel B was still adequate, he was aware of Vessel B but likely did not perceive it as a significant risk.

It is probable that, consequently, under the presence of multiple vessels in the vicinity, on Vessel A's bridge, systematic observation—such as plotting Vessel B on radar early and monitoring it continuously—was likely not conducted.

② It is likely that, from 23:26 onward, Vessel A repeatedly took small angles of starboard and port steer. Although Officer A_1 stated that the BCR of Vessel B observed on the port side radar changed from +0.3 M to 0.0 M, target information can sometimes be inaccurate when either vessel changes course or speed frequently or when the vessels are at close range, Officer A_1 may have relied on insufficient target information during the repeated turning to starboard and port while the distance with Vessel B decreased.

It is probable that Officer A_1 likely found it difficult to determine if risk of collision existed, as Vessel A was navigating with repeated taking small angle rudder starboard and port, causing its heading and course to be unstable and preventing him from confirming Vessel B's relative position visually or on radar.

③ Although Vessel A's course began altering slightly to starboard around 23:27, subsequent rudder taking—port 5°, starboard 9°, port 7°, starboard 12°—resulted in only a gradual turn to starboard. It is probable that the altered course remained to about 12° from the original course of approximately 186.9° to the collision course of 198.8°, which was insufficient as an action to avoid collision.

It is probable that, as noted in 3.2.4(3), if Vessel A had steered to hard starboard around 23:27:30, Vessel A could have likely maintained a sufficient distance from Vessel B.

④ Officer A_1, as described in ①, likely did not perceive the significant risk of Vessel B and stated that he prioritized steering to avoid a collision with Vessel B

and did not give warning signals (e.g., whistle blasts) to Vessel B. It is probable that approaching close range to Vessel B with a low awareness of risk, as well as the focus on steering away from Vessel B, may have led to a lack of time and mental readiness to give warning signals.

⑤ According to Vessel A VDR records, no utterances from AB A were recorded prior to the accident, and Officer A_1's utterances was very brief. Additionally, as noted in 3.1.1(1)⑫, AB A's statement of steering rudder angles does not align with the rudder angles recorded in Vessel A VDR records.

It is probable that there was a lack of shared information and awareness between Officer A_1 and AB A regarding the situation with Vessel B and the risk of collision with Vessel B, as well as insufficient communication overall.

Despite written instructions in the Master's order book and standing orders, as well as verbal orders from Master A before leaving the bridge directing that Master A be called in case of doubt, Officer A_1 did not report the situation to Master A.

(2) Vessel B

① It is probable that, as described in 3.1.1(2), Officer B_1 completed the handover checklist later rather than during the handover itself. During this time, after Master B left the bridge, Officer B_1 worked at the aft chart table to gather the necessary information for bridge watchkeeping, likely did not maintain his lookout duty.

② It is probable that Officer B_1 likely did not notice the approach of Vessel A due to not maintaining a lookout, the radar's TT function not being set for automatic plotting, the audio alarm being muted, and the absence of any warning signals such as a whistle or a call via VHF.

3.2.6 Analysis of VHF Communications

According to the statements of Officer A_1 and Officer B_1, as well as the response from the equipment manufacturer (2.9), the following points were observed:

(1) Because the firmware version of the port radar on Vessel A was not up to date, it did not display the ship name, call sign, or other information for Vessel B's Class B AIS data. As a result, Officer A_1 was unable to confirm the name of Vessel B and did not attempt to communicate with Vessel B via VHF.

(2) Information exchange via VHF to avoid a collision with another vessel must be conducted with sufficient time in order to be effective. It is probable that Vessel A had a low awareness of risk until it approached Vessel B at a close range, and Vessel

B did not notice Vessel A. Therefore, neither vessel was able to engage in an effective VHF communication exchange with sufficient time.

3.2.7 Analysis of Bridge Watch Arrangement

(1) Vessel A

According to the description in the Sailing Directions published by the Japan Coast Guard (2.4(1)), the area where the accident occurred was one where complex encounter situations arise. Additionally, this area is subject to the application of the Maritime Traffic Safety Act, as it is a traffic-congested area (2.4(2)). The J-MARISIS on the JTSB's website (2.4(3)) indicates that the area between Hi-no-Misaki and Naruto Kaikyo is a high-density traffic area where the courses of ships navigating the area and ships coming south from Tomogashima Suido cross, and several collision accidents have occurred in this area in the past.

Master A stated (2.10(1)) that he judged Officer A_1 to be sufficiently capable. However, according to Master A's statement (2.1.3(1)), even after completing the departure maneuvering, Master A continued to con the vessel until passing through Tomogashima Suido. After crossing the boundary of Osaka Wan pilotage area, Master A attempted to give the con to Officer A_1 for training. After giving the con to Officer A_1, Master A remained on the bridge, responding via VHF communication, advising Officer A_1 to turn to starboard, and confirming the safety of the surroundings before leaving the bridge. Based on these actions, it is probable that Master A had concerns about Officer A_1's skills in the congested area.

It is probable that, as noted in 3.2.5(1), Officer A_1 may have had a low awareness of risk of Vessel B, and it is thought that he did not call Master A or give warning signals such as the whistle, continuing to approach Vessel B while repeatedly taking small-angle starboard and port rudder.

It is probable that, on the bridge, as mentioned in 3.2.5(1)⑤, after Master A left the bridge at 23:04, sufficient communication was not established between Officer A_1 and AB A.

It is probable that, in the complex and high-density traffic night navigation of Kii Suido, Master A's decision to leave the bridge and entrust maneuvering to Officer A_1, whom he had concerns about, Officer A_1 did not call Master A and give warning signals as he continued to approach Vessel B, and the lack of adequate communication between Officer A_1 and AB A, BRM/BTM were not functioning effectively on Vessel A.

(2) Vessel B

According to the response from Company B_1 and the statement of Officer B_1 (2.10(2)), the handover of the bridge watch on Vessel B required the use of a handover checklist established by Company B_2. The incoming watch officer was supposed to review the planned course and other details before taking over the watch. However, it was common practice for the items listed on the handover checklist to not be passed on, and the checklist was typically created later during the watch after the handover. It is possible that this practice is led to have weakened the bridge watch officers' safety awareness and to a decrease in attention to the lookout.

It is probable that, during the accident, Officer B_1 is thought to have been working on obtaining necessary information for the bridge watch from the chart table after the previous OOW left the bridge, and during this time, Officer B_1 did not maintain his lookout duties.

3.2.8 Analysis of Vessel B's Safety Management

According to the response from Company B_1 (2.12), on Vessel B, safety training, drills, etc., were carried out in accordance with Company B_2's rule for safety management, and the details of these activities were recorded and reported to Company B_1.

In accordance with Article 3-4, item (viii) of the Seafarers Act Enforcement Regulations and Article 50 of the rule for safety management, emergency steering drills were required to be conducted at least once every three months, and rescue drills in enclosed spaces at least once every two months. However, according to Vessel B’s drill records, these drills were not carried out within the intervals specified in the regulations. Based on Officer B_1’s statement (2.12(10)), it is probable that safety training and drills on Vessel B were not being conducted properly.

It is probable that Company B_1 could have noticed that the drills were not conducted properly on Vessel B.

Additionally, the "Principles of Watch Handover" set out in the watchkeeping standards required that the handover checklist be implemented to ensure all handover tasks were completed without omission. However, it is probable that, as described in 3.2.7(2), the handover checklist had become a mere formality.

Officer B_1 stated (2.10(2)) that creating the handover checklist was merely a formal task of filling out a document, which he thought was meaningless, and since it was not an urgent task, it should not have been done at the time of the accident. It is probable that even after the accident, Officer B_1 did not recognize the importance of properly conducting handovers.

It is probable that, as a result, safety training and drills were not conducted properly, watch handovers became a mere formality on Vessel B, and safety management was insufficient. Consequently, the safety awareness regarding navigation on Vessel B had become diluted.

3.3 Analysis of Vessel B's Damage and Injuries

3.3.1 Vessel B Damage

It is probable that, the bow of Vessel A collided almost perpendicularly with the midship section of Vessel B's starboard side, based on the drafts and damage conditions of both vessels (2.3, Figures 8 and 11), the bulbous bow of Vessel A caused severe crushing and destruction of Vessel B's starboard hull plating and the starboard bulkhead of the cargo hold.

According to the statement from Chief Engineer B (2.1.4(2)), when he attempted to initiate firefighting in the engine room, he saw seawater flowing in through the door from the engineer's store located centrally and forward on the upper deck level of the engine room. Observing the volume of water ingress, he judged that sinking was unavoidable. Around the same time, he recognized the ship was listing to starboard. Considering that Vessel B capsized approximately five minutes after the collision, it is probable that a large amount of seawater rapidly entered the cargo hold after the collision, causing a gradual starboard list, loss of stability, and eventual capsizing.

According to the general arrangement plan and Chief Engineer B's statement (2.7.1(3)), Vessel B had passageways connecting the engineer's store and the bow on both the port and starboard sides of the cargo hold. It is probable that these passageways may have allowed water ingress to spread from the engineer's store to the engine room.

As described in 2.3(2), Figure 11, and 2.7.1(3), the fuel oil tank on Vessel B was located below the engineer's store and the aft side of the aforementioned passageway. Since the point of impact was the midship section of the starboard side, it is probable that the fuel tank was undamaged and there was no oil spill.

3.3.2 Vessel B Injuries and Fatalities

(1) According to the statements of Vessel B crew members (2.1.3(2)), it was confirmed that both Master B and Officer B_2 were on the bridge after the collision and showed no signs of injuries that would hinder their actions. It is probable that they fell into the water and was either fatally injured or went missing due to the subsequent capsizing of Vessel B. Regarding the situation after the capsizing, Vessel A crew members stated (2.1.4(1)) that they saw two figures clinging to the bilge keel of the capsized Vessel B. However,

there were no further witnesses, and no details on the events following the capsizing could be determined.

(2) According to the statements of Vessel B crew members (2.1.4(2)), Officer B_1 was on the bridge, and Engineer B was on the port wing when Vessel B capsized. It is probable that both sustained severe injuries, possibly from striking their bodies against the ship's structure during the accident. Additionally, it is probable that Chief Engineer B suffered serious injuries either from the impact of the collision or while moving through the submerged ship to escape.

(3) As described in 2.1.4(1), Vessel A crew members contributed to the rescue of three Vessel B crew members. It is probable that, immediately after the accident, they threw self-igniting life buoys to help those adrift, continuously illuminated them with searchlights, and launched a rescue boat to carry out the rescue operations.

3.4 Analysis of the Accident Circumstances

Based on sections 3.1 to 3.3, the factors contributing to the accident are as follows:

(1) Vessel A

① Although Vessel B's echo appeared on the starboard radar around 23:05, Officer A_1 was late to initially recognize Vessel B. Even after recognition, he assumed that Vessel B, as the give-way vessel, would avoid Vessel A. It is probable that, in a situation where multiple vessels were present, he likely showed a low awareness of the risk of Vessel B and did not monitor it continuously.

According to the provisions in Article 5 of the Act on Preventing Collisions at Sea, the OOW shall maintain a proper lookout at all times. Under Article 7, the OOW shall determine whether there is a risk of collision with other vessels using all available means, including early radar detection and systematic observation through continuous monitoring, such as radar plotting.

② It is probable that he neither reported to Master A nor confirmed maneuvering intentions via VHF or gave warning signals such as giving the whistle, although Officer A_1 approached Vessel B with low awareness of the risk, and upon recognizing the risk of collision with Vessel B, focused on steering to increase the distance from Vessel B.

Article 34 of the Act on Preventing Collisions at Sea states that when the intentions or movements of another vessel cannot be understood, or there is doubt about the sufficiency of the actions taken to avoid a collision, the OOW shall

immediately sound at least five short blast, rapid blasts on the whistle (or flashlights in quick succession at least five times).

Furthermore, the OOW shall immediately report to the Master if any doubts arise regarding actions to be taken for the safety of navigation, in accordance with Regulation A-VIII/2, Part 3-8 of the STCW Code.

③ It is probable that , based on points ① and ②, Officer A_1 should have conducted systematic monitoring of Vessel B, confirmed maneuvering intentions via VHF, or gave warning signals at an early stage while maintaining sufficient distance. Additionally, actions to avoid a collision should have been taken earlier.

④ Vessel A, with Vessel B's BCR value being small and in a situation where Vessel B would cross from the port side to the starboard side at a close range to Vessel A's bow if Vessel B did not take any action, repeatedly took small steering to port and starboard starting around 23:27. As a result, it is probable that the course altered to starboard was limited to approximately 12° by the time of the collision, which is considered insufficient as an action to avoid the collision.

Vessel A’s repeated small steering to port and starboard caused Vessel B’s heading and COG to shift slightly to the right with fluctuations to the left and right after 23:27. This resulted in an unstable heading and course, and it is probable that Officer A_1 was unable to confirm Vessel B's relative bearing either visually or on the radar, leaving him unable to determine that a risk of collision existed.

According to Article 17, paragraph (2) of the Act on Preventing Collisions at Sea, a stand-on vessel’s OOW may take immediate action to avoid collision if it becomes apparent that the give-way vessel is not taking appropriate action. Such actions must be made in ample time and large enough as per Article 8.

⑤ There could be complicated traffic conditions in Kii Suido at night, yet Master A left the bridge, delegating navigation to Officer A_1, despite concerns about his ability. Officer A_1 navigated without calling Master A and approached Vessel B without sufficient communication between Officer A_1 and AB A. Consequently, it is probable that the BRM/BTM did not function effectively.

According to the provisions of Section A-VIII/2, Part 3-8 of the STCW Code, the OOW must ensure that all watch personnel understand their individual roles, responsibilities, and the team’s roles. They must maximize the use of available resources, including other personnel, equipment, and information, to maintain an appropriate watch. Additionally, information from equipment and instruments must

be properly shared among all watch personnel, and close communication must be maintained.

(2) Vessel B

① It is probable that Officer B_1, since observing the surroundings while there was enough distance between Vessel A and Vessel B, assumed that although there were multiple vessels navigating around Vessel B, no vessels obstructed the route ahead.

② Officer B_1, thinking there were no vessels obstructing the route, moved to the chart table at the aft and engaged in work there. During this time, it is probable that he did not maintain lookout duties.

Both Vessel A and Vessel B maintained their courses and speeds, continuing to approach each other with a CPA of approximately 0.0–0.2. Officer B_1 could have easily noticed, both visually and on radar, that Vessel A was approaching without appreciable change in compass bearing, and that a risk of collision existed.

Furthermore, while working at the chart table away from the radar, Officer B_1 did not utilize the radar's automatic plotting function, and the radar's audio alarm was muted. It is probable that this contributed to Officer B_1's delay in noticing the close quarter situation of Vessel A.

OOWs are required, under Article 5 of the Act on Preventing Collisions at Sea, to maintain a proper lookout by sight, hearing, and all other available means appropriate to the circumstances at all times.

③ On Vessel B, a handover checklist was supposed to be used during the bridge watch handover, with the incoming officer expected to confirm the planned route and other details before taking over the watch. However, it had become common practice not to go through the checklist during handover and instead complete it later during the watch. It is likely that this weakened the safety awareness of bridge watch officers and contributed to reduced attention to lookout.

Under Article 3-5 of the Maritime Labor Act Enforcement Regulations, the navigation watch standards require officers on watch to complete all necessary tasks, such as confirming the planned route, before completing the handover.

④ On Vessel B, mandatory drills were not conducted at the prescribed intervals, and the handover checklist had become a mere formality. This suggests a diminished awareness of navigation safety.

To ensure safe navigation, adherence to regulations is essential.

4 CONCLUSION

4.1 Probable Cause

The JTSB concludes that the probable cause of this accident, at night in Kii Suido, where Vessel A was sailing southbound, and Vessel B was sailing northwest is as follows. It is probable that Officer B_1, while working at the chart table in the aft of the bridge, did not maintain lookout and did not notice Vessel A until it was too close in range, resulting in delayed action. Meanwhile, Officer A_1, assuming that Vessel B would give way to Vessel A according to the navigation rules for a crossing situation, neither confirmed Vessel B's intentions via VHF nor gave a warning signal, and instead took repeated steering slightly to port and to starboard, missing the chance to avoid collision with Vessel B. As a result, both vessels collided.

It is probable that Vessel B did not maintain lookout, because after the previous watch personnel left the bridge, Officer B_1 was engaged in tasks that should have been completed during the handover, which attributed to a diminished safety awareness regarding navigation and an improper handover of the bridge watch.

It is probable that the Vessel A did not confirm Vessel B's intentions via VHF or gave warning signals, and instead took action only through repeated slight steering, was due to the ineffective implementation of BRM/BTM on Vessel A.

4.2 Other Identified Safety Issues

Additionally, Vessel A's radar and AIS transmitter had not been updated with the latest firmware. As a result, the radar did not display Class B AIS information for Vessel B, such as its name and call sign.

5 SAFETY ACTIONS

This accident occurred at night in Kii Suido, where Vessel A was sailing southbound and Vessel B was sailing northwest. It is possible that the OOW of Vessel B, while working at the chart table in the aft of the bridge, did not maintain lookout and did not notice Vessel A until it was too close in range, resulting in delayed action. Meanwhile, Officer A_1, assuming that Vessel B would give way to Vessel A according to the navigation rules for a crossing situation, neither confirmed Vessel B's intentions via VHF nor gave a warning signal, and instead took repeated steering slightly to port and to starboard, missing the chance to avoid collision with Vessel B. As a result, both vessels collided.

Accordingly, in order to prevent the recurrence of similar accidents and to mitigate damage, the following measures must be implemented.

(1) OOWs shall at all times maintain a proper lookout 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. Especially in traffic-congested areas, they should focus on navigation and avoid engaging in non-priority tasks.

Additionally, OOWs, as well as other person on bridge watch, should use navigational equipment such as radar, ECDIS, and AIS effectively, alongside visual lookout, and promptly call the Master to come to the bridge if there is any doubt.

(2) Masters and officers should ensure proper handover using tools like checklists to communicate essential information such as course, speed, intended route, and surrounding conditions. Outgoing watch officers must remain on the bridge until all necessary information has been passed on, and lookout must also be maintained during handover.

(3) OOWs should consider the possibility that other vessels may not be aware of their ship's presence in close quarter situations. They should use VHF, whistles, or other early means to inform other vessels of their presence and navigation intentions.

(4) OOWs must take action that will best aid to avoid collision, even if their vessel is a stand-on vessel, when close to a give-way vessel and it becomes apparent that the give-way vessel’s actions alone will not prevent a collision. Such actions may include significant course alterations to starboard or speed reductions with ample time and large enough space. If a collision becomes unavoidable despite all efforts, they should promptly use the main engine to reduce speed and adjust maneuvers to avoid near-right-angled collision, and minimize impact and damage.

(5) Shipowners, ship management companies, and operators should ensure the own fleet complies with relevant laws, regulations, company safety manuals, and other directives, and strive to maintain and enhance the safety awareness of crew members.

(6) Shipowners, ship management companies, and masters should educate officers on watch regarding their responsibilities and strengthen BRM/BTM to ensure that appropriate resources are effectively utilized under the circumstances.

(7) Ships using AIS transmitters or radar systems that do not display the names of vessels transmitted by Class B AIS should update their firmware to the latest version, as this may enable such information to be displayed.

5.1 Safety Actions Taken

5.1.1 Safety Actions Taken by Company B_1

Company B_1 visited the vessels involved to inform them about the details of the accident and provided safety guidance.

Additionally, based on this accident, where capsizing occurred without time to prepare life jackets, the company equipped the bridge with life jackets in addition to the legally required equipment.

5.1.2 Safety Actions Taken by Company B_2

Company B_2 issued a document dated August 28, 2023, titled "Request for Compliance During Navigation and Emergency Response," to the vessels involved, ensuring thorough awareness of the following points:

◆***Compliance During Navigation***

1. Maintain continuous and appropriate lookout (detection and monitoring, range selection, blind spot/rear checks).

2. Actively engage in vessel-to-vessel communication (VHF, navigation signals, warning signals).

3. Maintain a safe speed.

4. Report to the Master if concerns arise (congestion, restricted visibility, narrow channel, etc.).

5. Confirm vessel position during scheduled checks or course changes.

6. Be aware of traffic rules, channel conditions, and weather and sea conditions.

7. Avoid over-reliance on autopilot (switch to manual steering as needed).

◆*Emergency Response*

In the event of a serious maritime accident, take actions prioritizing human life saving, such as transmitting distress signals via VHF, calling 118, and making early decisions to abandon ship.

5.1.3 Safety Actions Taken by Vessel A's Owner

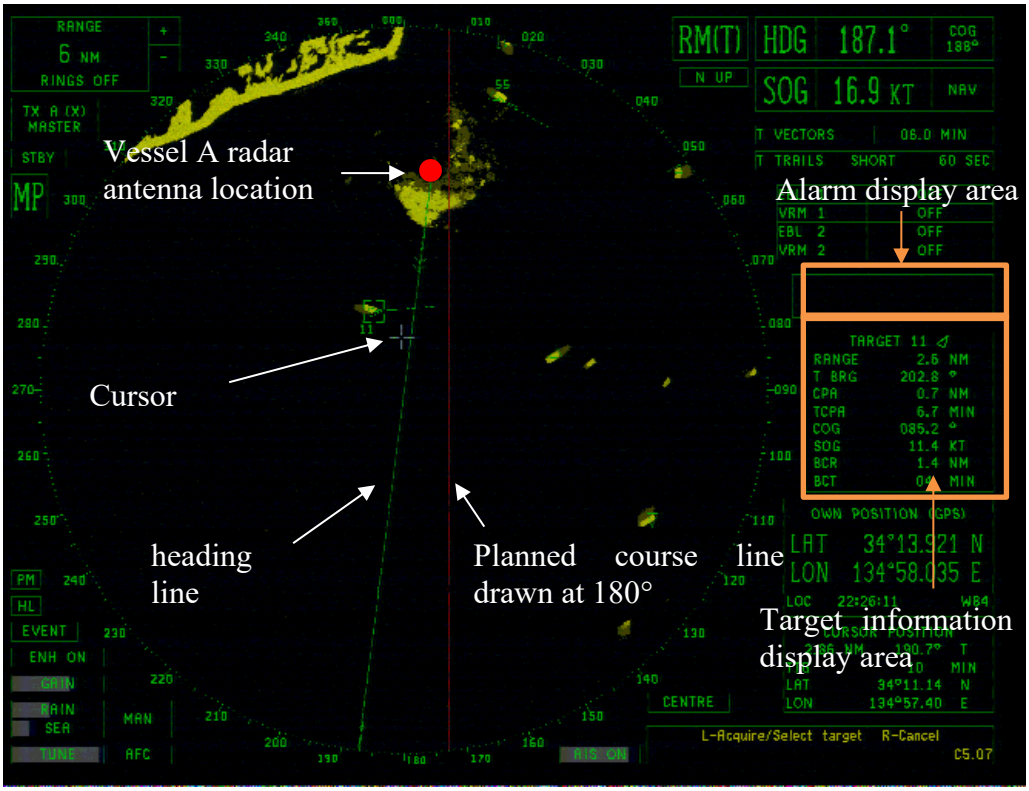
The owner of Vessel A circulated an alert to the vessels under management, communicating the facts of the accident and reiterating the importance of safe navigational practices and the role of OOWs.

5.2 Safety Actions Required

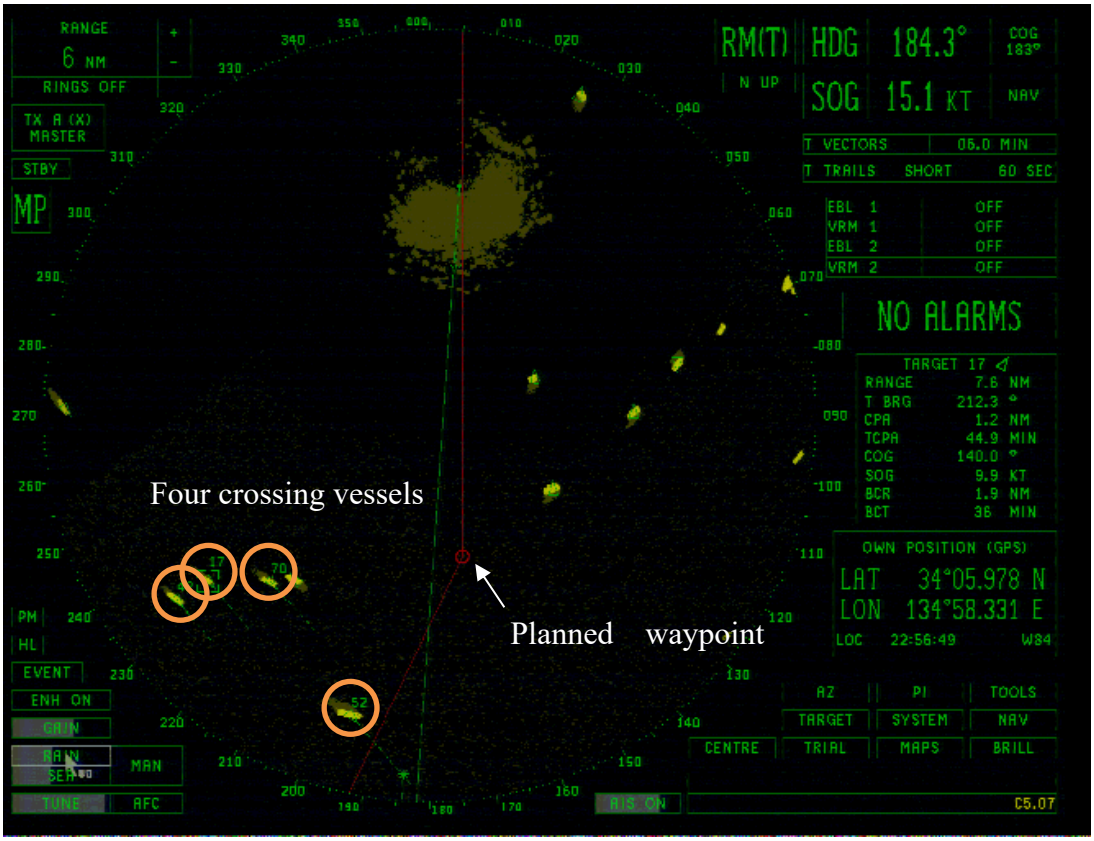
It is desirable that Company B_1 and Company B_2 should strengthen the education and training of crew members on related vessels to maintain and enhance their safety awareness and ensure strict compliance with laws and regulations.

It is desirable that the ship management company of Vessel A should reinforce education and training for the crew of related vessels, as well as strengthen BRM/BTM. Additionally, they should ensure that the firmware of navigation instruments and other equipment is updated to the latest version and that all possible resources to support safe navigation are secured.

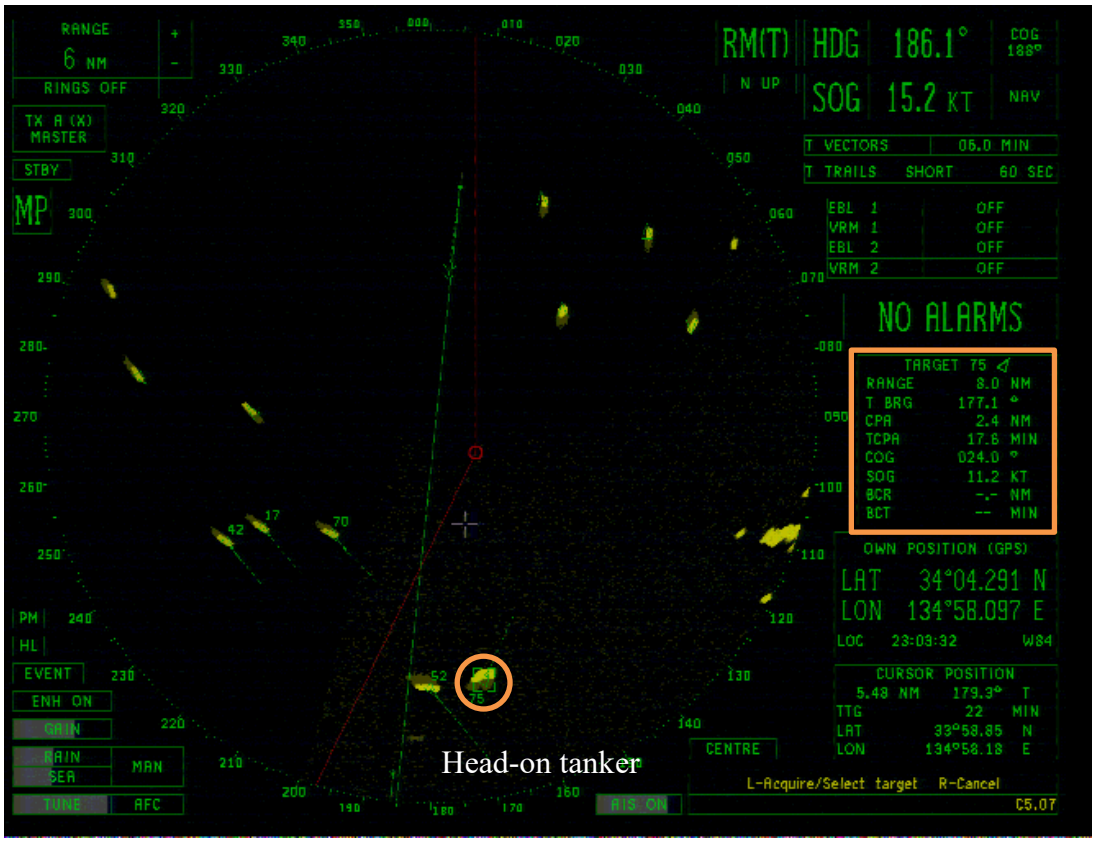
Appendix Figure 1: Screen of Vessel A's Starboard Radar



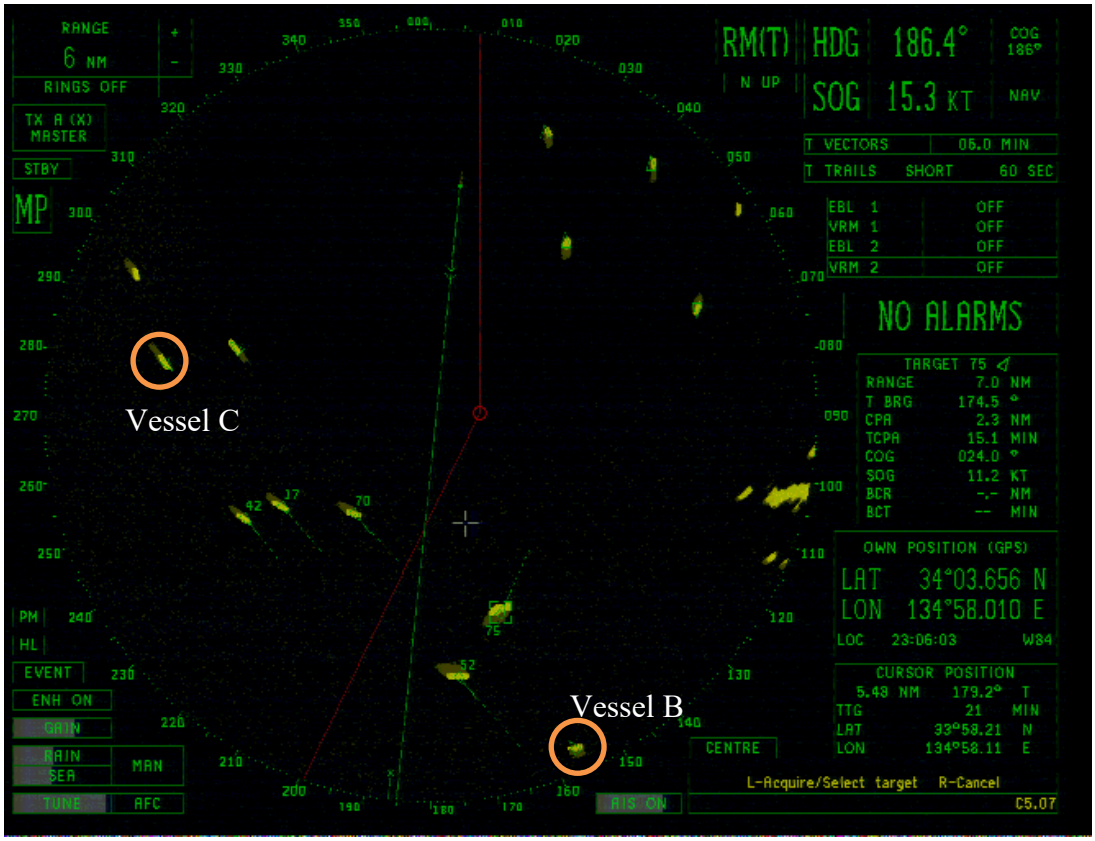
① 22:26:11 (When Master A handed over the watch to Officer A1)



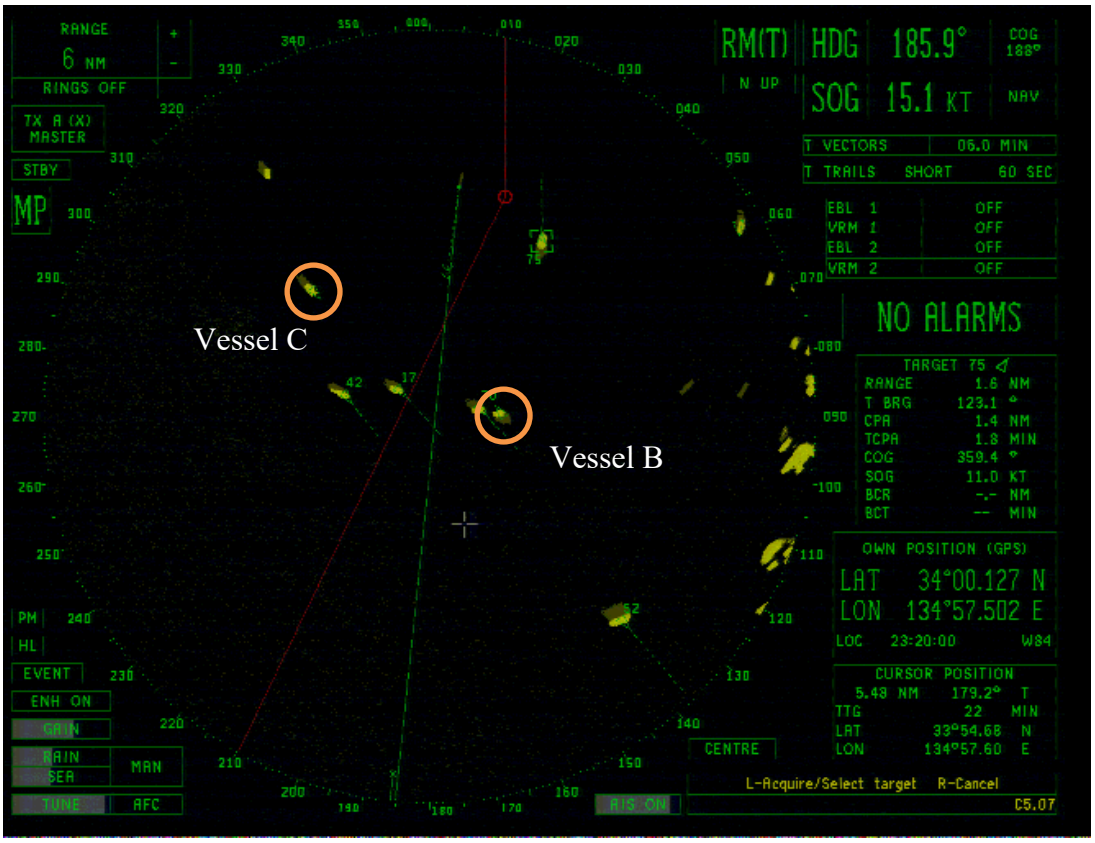
② 22:56:49 (Four crossing situation vessels detected)



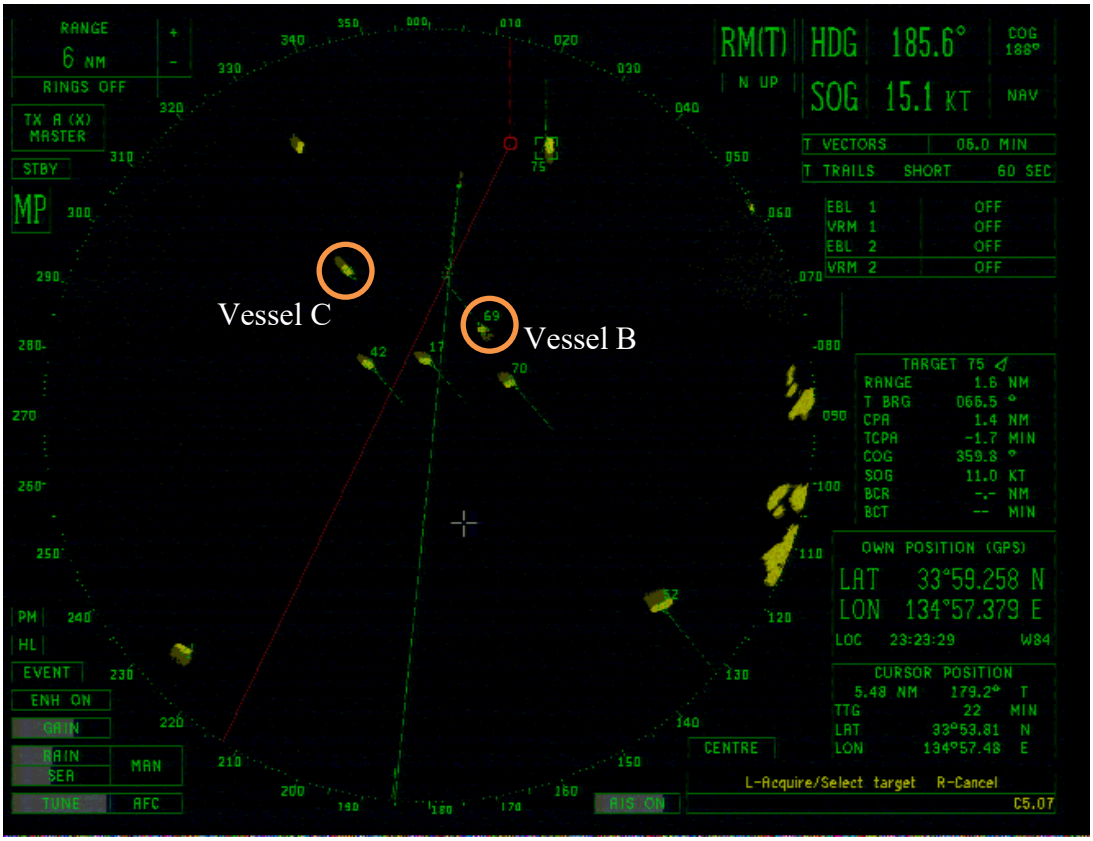
③ 23:03:32 (Head-on tanker detected)



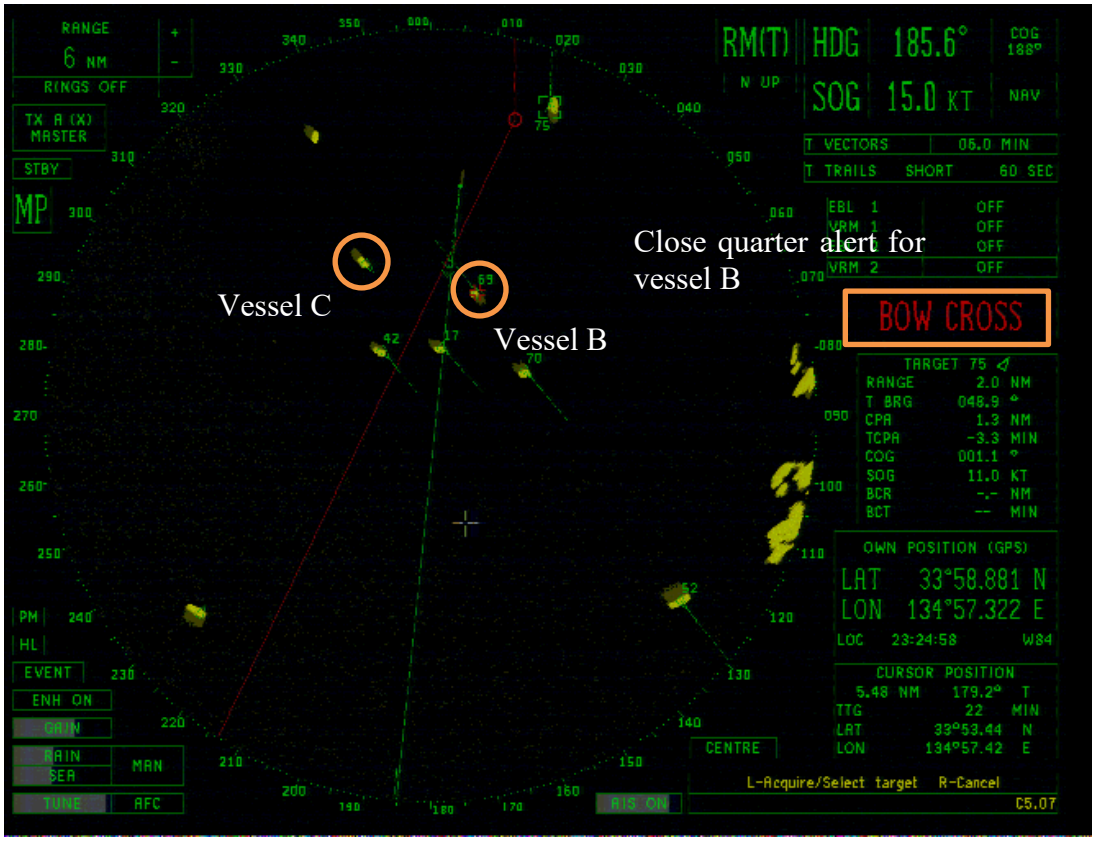
④ 23:06:03 (Vessel B's silhouette enters the range)



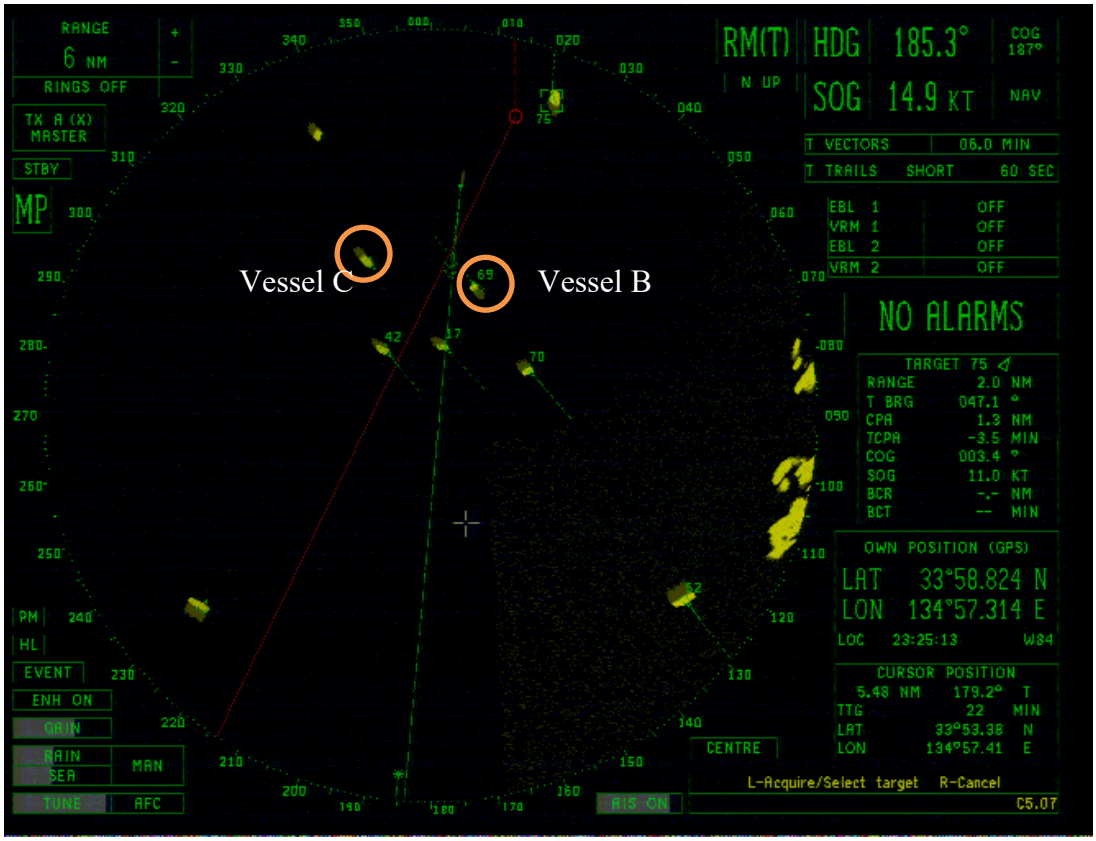
⑤ 23:20:00



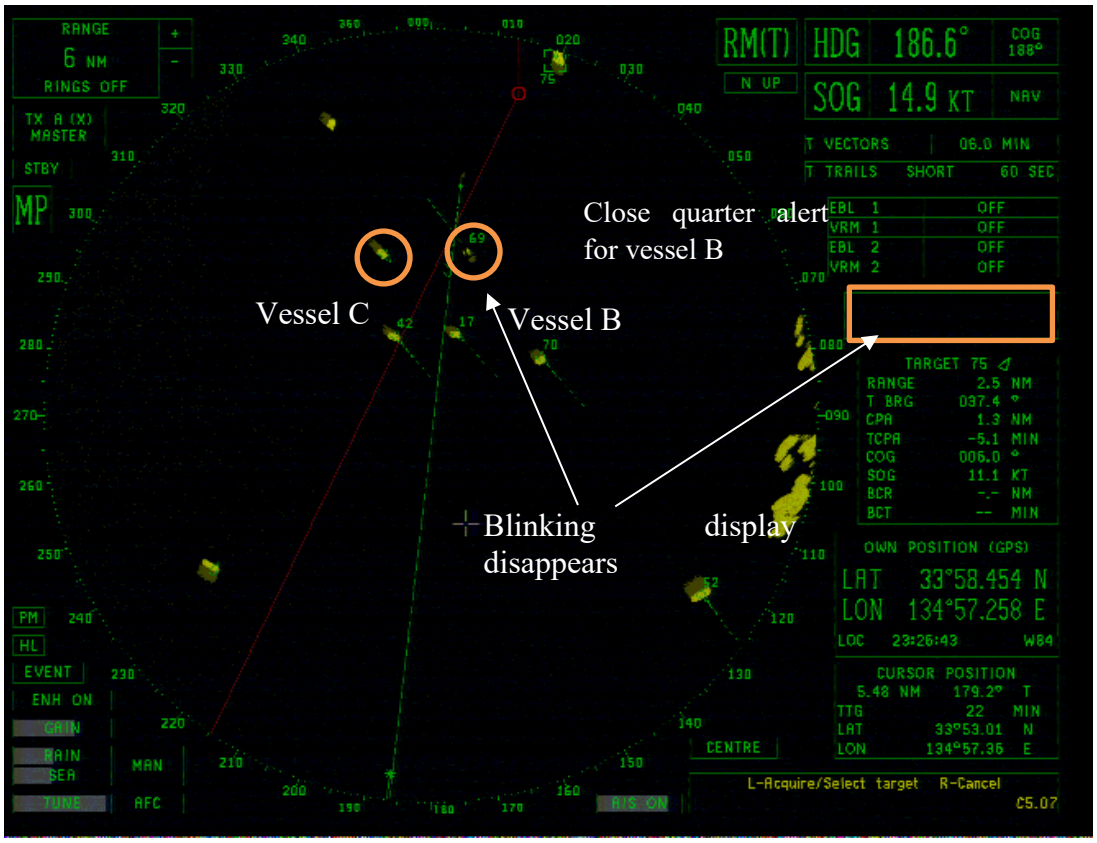
⑥ 23:23:29 (Vessel B detected)



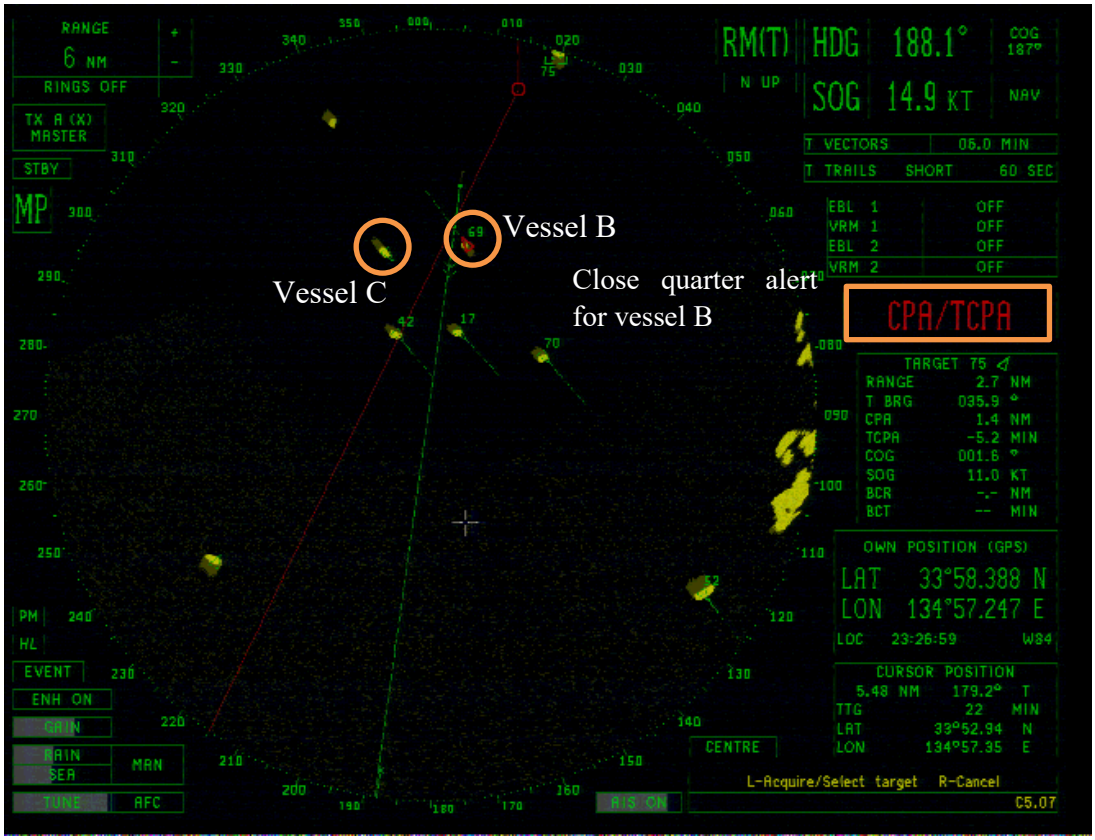
⑦ 23:24:58 (Close quarter alert displayed for Vessel B)



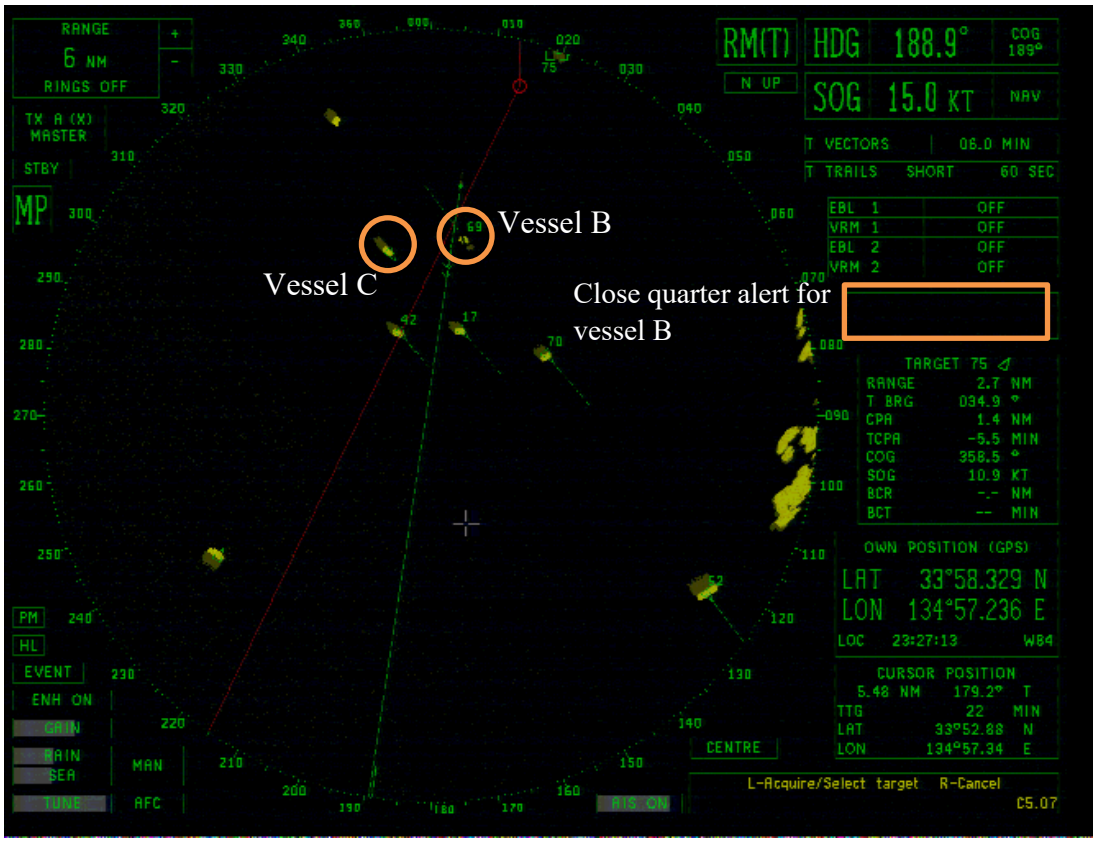
⑧ 23:25:13 (Close quarter alert for Vessel B disappears)



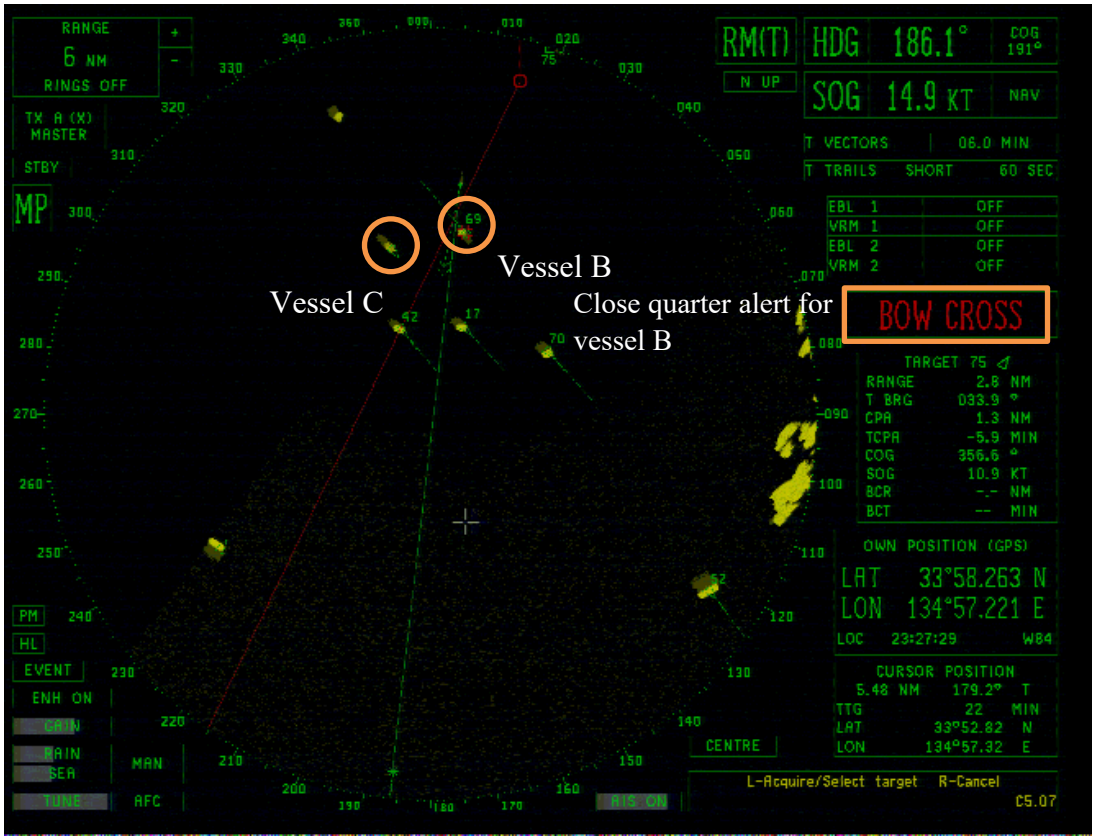
⑨ 23:26:43 (Close quarter alert displayed for Vessel B)



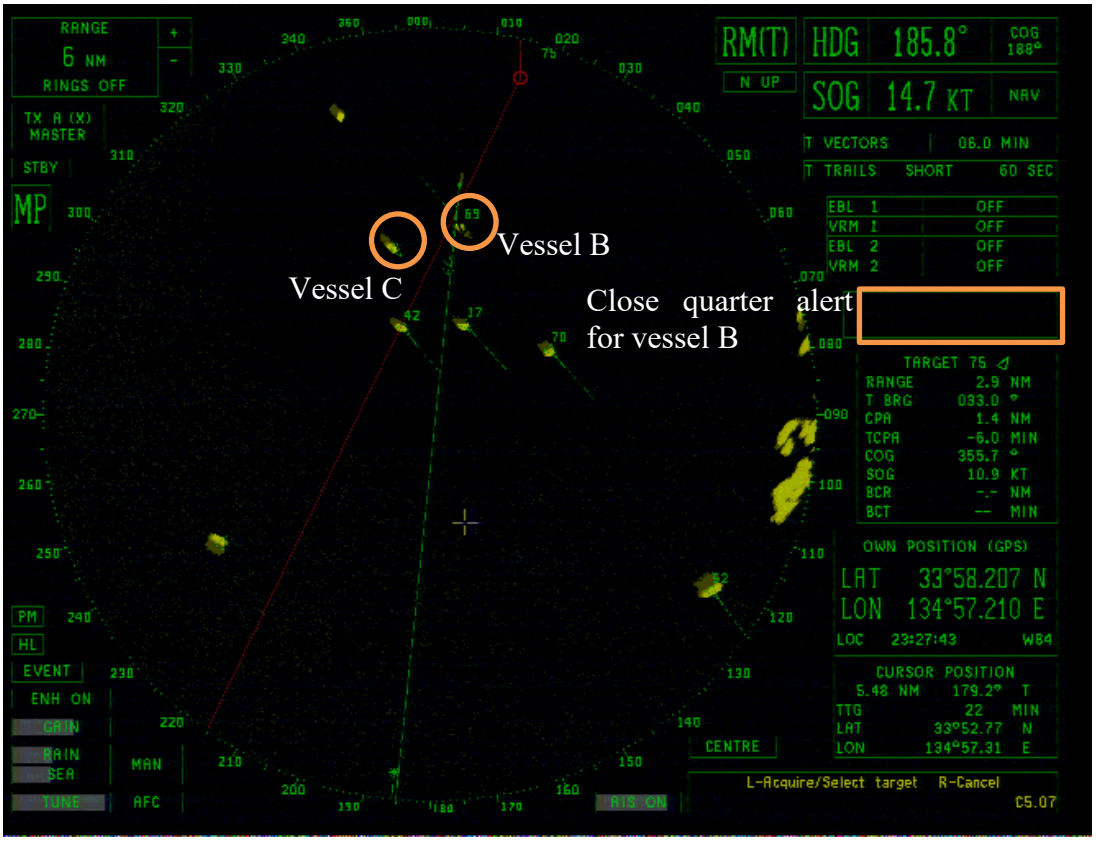
⑩ 23:26:59 (Close quarter alert for Vessel B continues)



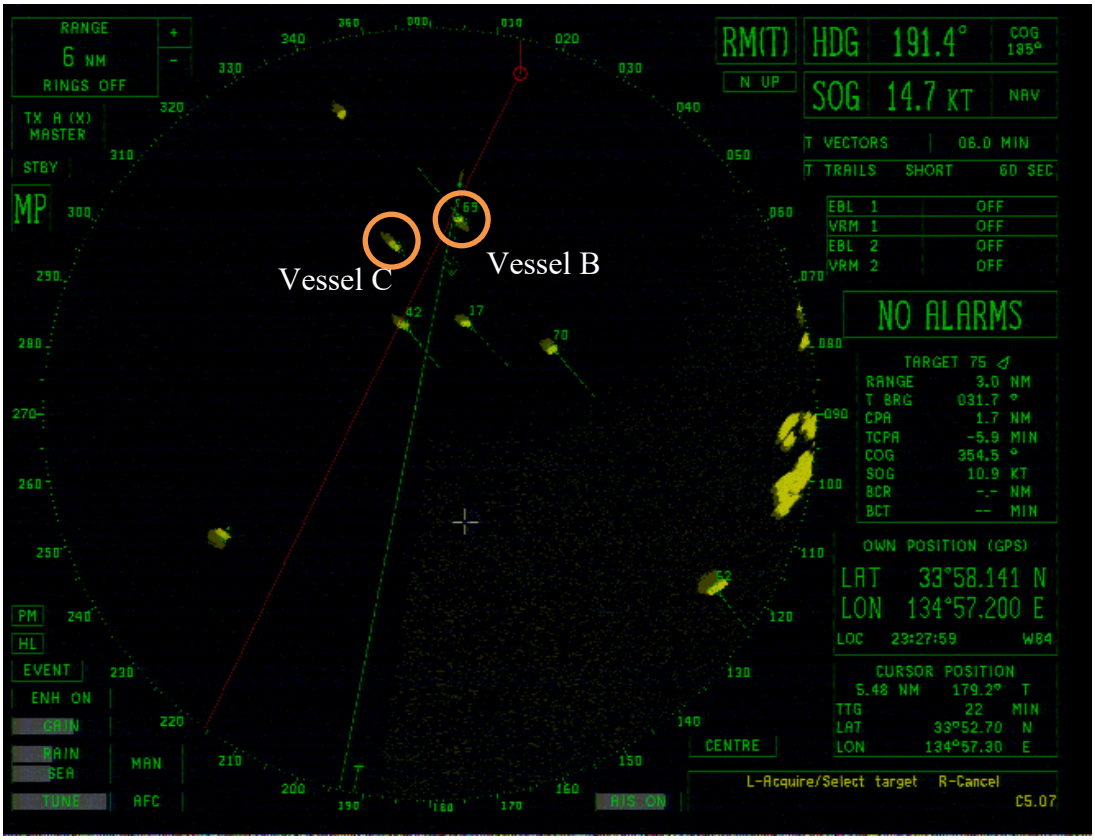
⑪ 23:27:13 (Close quarter alert for Vessel B continues)



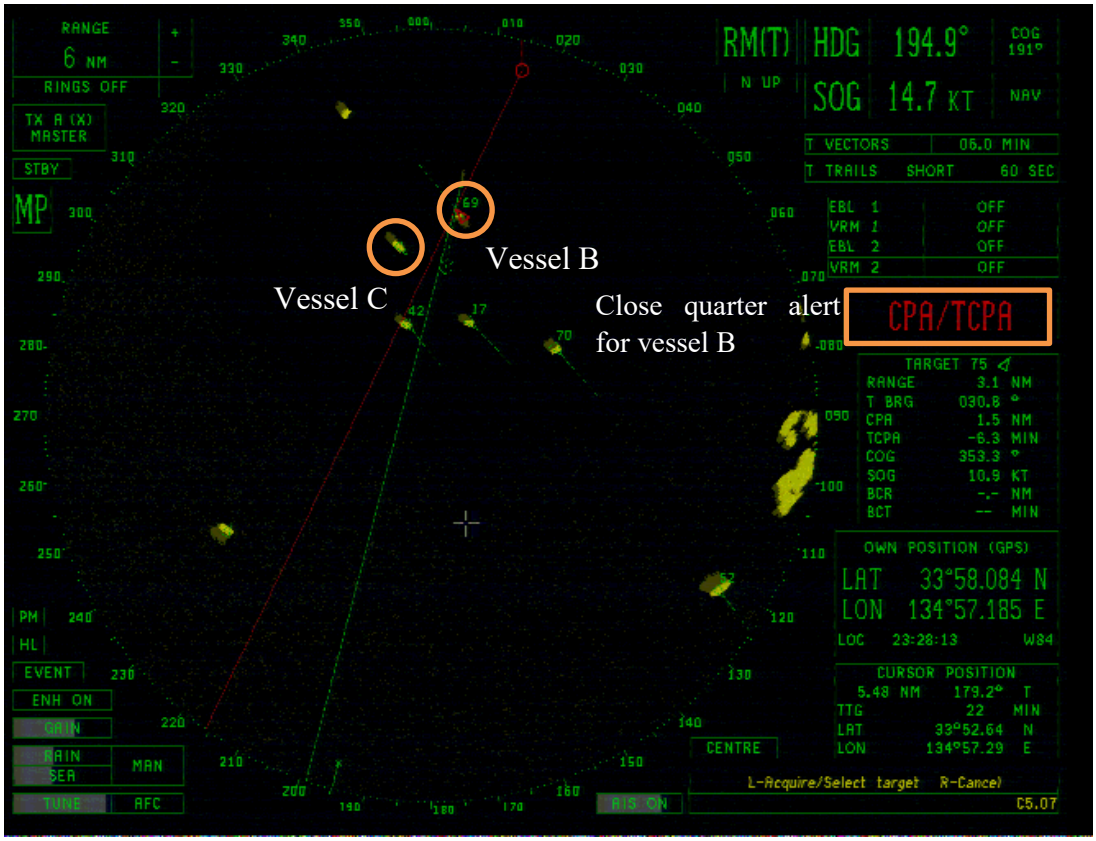
⑫ 23:27:29 (Close quarter alert for Vessel B continues)



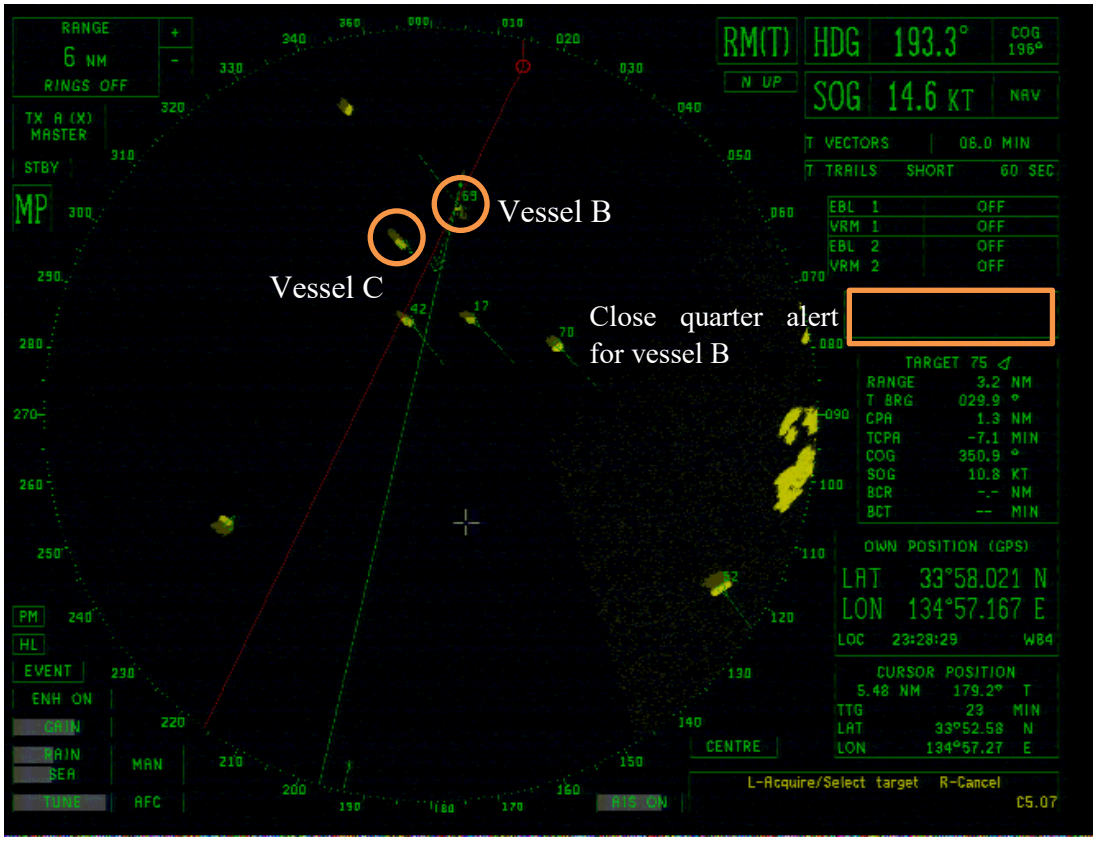
⑬ 23:27:43 (Close quarter alert for Vessel B continues)



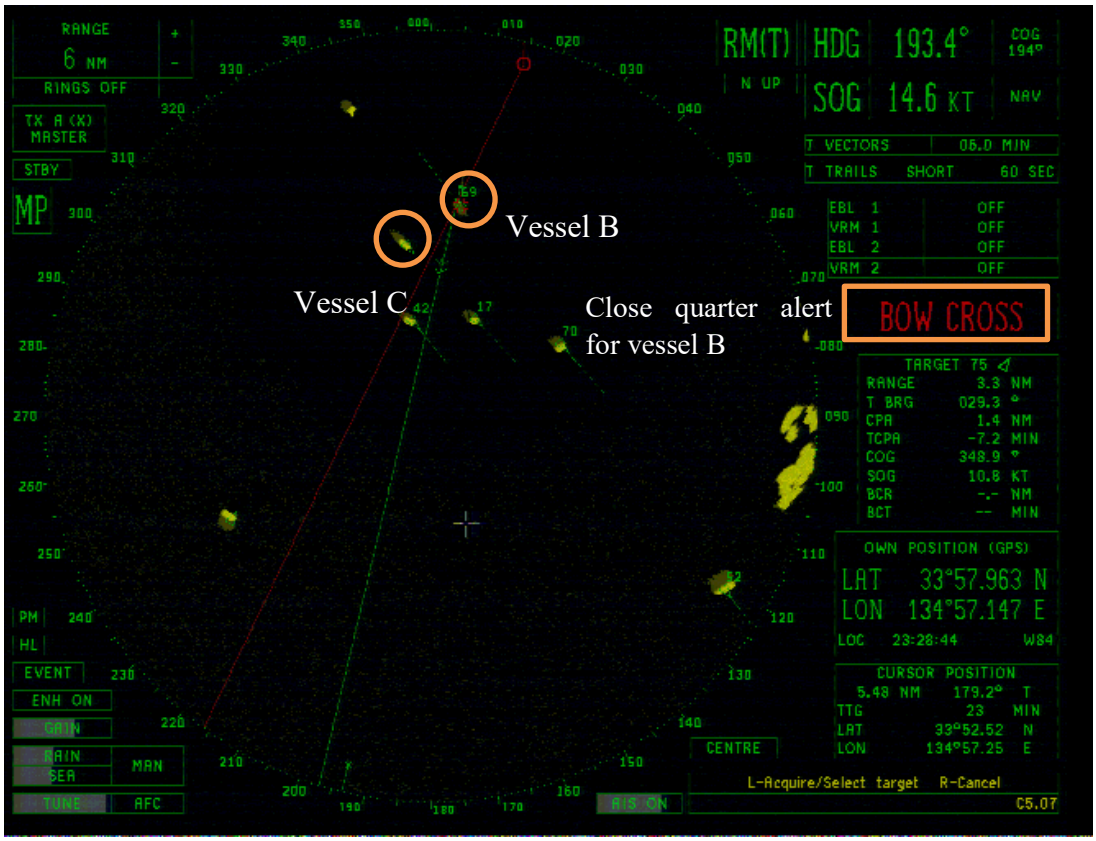
⑭ 23:27:59 (Close quarter alert for Vessel B disappears)



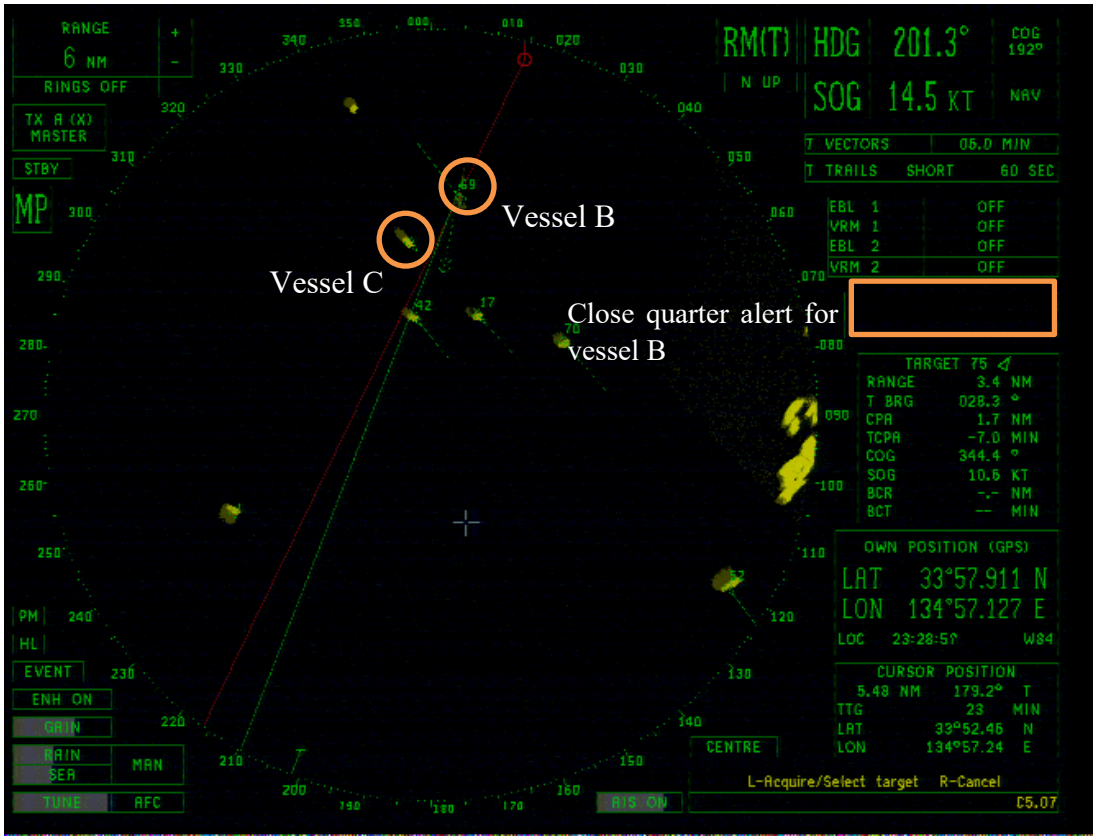
⑮ 23:28:13 (Close quarter alert displayed for Vessel B)



⑯ 23:28:29 (Close quarter alert for Vessel B continues)



⑰ 23:28:44 (Close quarter alert for Vessel B continues)



⑱ 23:28:57 (Close quarter alert for Vessel B continues)

Appendix Table 1: VDR Records of Vessel A (1-Minute Averages)
(23:00-23:30)

Time (hh:mm)	Latitude N (°-′-″)	Longitude E (°-′-″)	COG (°)	SOG (kn)	Heading (°)	ROT (°/min)
23:00	34-05-13.0	134-58-13.9	186.3	15.0	186.1	1.4
23:01	34-04-58.0	134-58-11.7	186.9	15.0	185.5	-0.9
23:02	34-04-42.8	134-58-09.6	187.0	15.0	186.0	-1.0
23:03	34-04-27.4	134-58-07.1	186.4	15.1	185.6	1.4
23:04	34-04-12.4	134-58-05.0	186.8	15.1	185.3	-0.7
23:05	34-03-56.9	134-58-02.9	187.0	15.2	185.9	-0.9
23:06	34-03-41.8	134-58-00.8	186.5	15.3	185.9	1.2
23:07	34-03-26.5	134-57-58.5	186.4	15.3	185.3	0.2
23:08	34-03-11.8	134-57-56.6	187.2	15.3	186.3	-1.4
23:09	34-02-56.0	134-57-54.4	186.5	15.3	186.2	1.2
23:10	34-02-40.6	134-57-52.1	186.7	15.3	185.7	-0.3
23:11	34-02-25.9	134-57-50.2	187.2	15.2	186.3	-1.1
23:12	34-02-10.1	134-57-47.9	186.5	15.2	186.1	1.5
23:13	34-01-55.4	134-57-45.7	187.0	15.1	185.9	0.4
23:14	34-01-40.3	134-57-43.4	187.7	15.1	186.0	-1.9
23:15	34-01-25.0	134-57-41.3	187.2	15.1	186.3	-0.3
23:16	34-01-09.7	134-57-39.0	186.4	15.1	185.9	2.0
23:17	34-00-54.7	134-57-36.8	187.2	15.1	186.0	-1.6
23:18	34-00-39.9	134-57-34.7	186.9	15.1	186.4	-0.1
23:19	34-00-24.5	134-57-32.6	186.3	15.1	185.8	1.4
23:20	34-00-09.5	134-57-30.2	187.5	15.1	186.0	-2.1
23:21	33-59-55.0	134-57-28.3	186.6	15.0	186.2	1.1
23:22	33-59-39.7	134-57-26.0	186.7	15.0	185.4	-0.4
23:23	33-59-24.4	134-57-24.1	186.9	15.0	186.3	-0.3
23:24	33-59-09.4	134-57-21.8	186.6	15.0	185.9	1.8
23:25	33-58-54.3	134-57-19.4	187.7	15.0	185.9	-2.1
23:26	33-58-39.5	134-57-17.3	186.9	14.9	186.3	1.7
23:27	33-58-24.9	134-57-15.0	188.7	14.9	187.7	-0.9
23:28	33-58-10.1	134-57-12.3	189.6	14.7	190.8	7.5

23:29	33-57-55.7	134-57-08.2	196.1	14.0	205.2	33.8
23:30	33-57-48.3	134-57-02.3	234.1	5.9	224.1	6.4

* The vessel's position corresponds to the location of the GPS antenna at each timestamp. Additionally, the ground course, speed, heading, and rate of turn represent the average values over 30 seconds before and after each time point.

Appendix Table 2: VDR Records of Vessel A (Detailed) (After 23:25)

Time (hh:mm)	Latitude N (°-′-″)	Longitude E (°-′-″)	COG (°)	SOG (kn)	Heading (°)	ROT (°/min)	Rudder angle (°)
23:25:00	33-58-54.3	134-57-19.4	188.1	15.0	185.6	-3.2	2
23:25:01	33-58-54.3	134-57-19.4	188.1	15.0	185.6	-3.2	2
23:25:02	33-58-54.0	134-57-19.4	188.0	15.0	185.6	-2.5	2
23:25:03	33-58-53.8	134-57-19.3	187.9	15.0	185.5	-3.3	2
23:25:05	33-58-53.3	134-57-19.3	187.8	15.0	185.4	-3.8	2
23:25:06	33-58-53.0	134-57-19.2	187.7	15.0	185.4	-1.8	2
23:25:07	33-58-52.8	134-57-19.2	187.6	15.0	185.4	-2.0	2
23:25:09	33-58-52.3	134-57-19.1	187.5	14.9	185.3	-2.3	2
23:25:11	33-58-51.8	134-57-19.0	187.4	14.9	185.4	2.1	2
23:25:13	33-58-51.3	134-57-19.0	187.2	15.0	185.3	-1.9	2
23:25:15	33-58-50.8	134-57-18.9	187.1	14.9	185.3	0.0	2
23:25:16	33-58-50.8	134-57-18.9	187.1	14.9	185.3	-0.2	2
23:25:17	33-58-50.3	134-57-18.8	187.0	14.9	185.3	-0.3	2
23:25:19	33-58-49.8	134-57-18.7	186.9	14.9	185.3	-1.2	2
23:25:20	33-58-49.6	134-57-18.8	186.9	14.9	185.3	-0.6	2
23:25:21	33-58-49.3	134-57-18.7	186.8	14.9	185.3	0.6	2
23:25:23	33-58-49.3	134-57-18.7	186.7	14.9	185.3	-0.1	1
23:25:24	33-58-48.6	134-57-18.7	186.7	14.9	185.4	2.9	1
23:25:25	33-58-48.4	134-57-18.6	186.7	15.0	185.4	0.9	1
23:25:27	33-58-47.9	134-57-18.6	186.6	14.9	185.4	-0.1	1
23:25:28	33-58-47.6	134-57-18.5	186.6	14.9	185.4	-0.5	1
23:25:29	33-58-47.3	134-57-18.4	186.6	14.9	185.5	-0.6	1
23:25:31	33-58-46.9	134-57-18.4	186.6	14.9	185.5	3.1	1
23:25:35	33-58-45.9	134-57-18.3	186.5	14.9	185.6	1.6	1
23:25:37	33-58-45.4	134-57-18.1	186.5	14.9	185.7	2.6	1
23:25:39	33-58-44.9	134-57-18.1	186.4	14.9	185.8	3.4	1
23:25:41	33-58-44.4	134-57-18.0	186.4	14.9	185.9	3.7	0
23:25:42	33-58-44.2	134-57-17.9	186.4	14.9	185.9	2.6	0
23:25:43	33-58-43.9	134-57-18.0	186.4	14.9	185.9	2.2	0

23:25:45	33-58-43.4	134-57-17.9	186.4	14.9	186.0	3.2	0
23:25:46	33-58-43.4	134-57-17.9	186.4	14.9	186.0	3.0	0
23:25:47	33-58-42.9	134-57-17.8	186.4	14.9	186.1	2.5	0
23:25:49	33-58-42.4	134-57-17.8	186.4	14.9	186.2	3.7	0
23:25:50	33-58-42.2	134-57-17.7	186.4	14.9	186.2	3.7	0
23:25:51	33-58-41.9	134-57-17.6	186.4	14.9	186.2	1.6	0
23:25:53	33-58-41.5	134-57-17.6	186.6	14.9	186.3	1.8	0
23:25:54	33-58-41.2	134-57-17.6	186.7	14.9	186.3	2.8	0
23:25:55	33-58-40.9	134-57-17.5	186.7	14.9	186.3	-1.6	0
23:25:57	33-58-40.5	134-57-17.5	186.8	14.9	186.4	-0.9	0
23:25:58	33-58-40.2	134-57-17.5	186.8	14.9	186.4	2.6	0
23:25:59	33-58-40.0	134-57-17.4	186.8	14.9	186.5	2.7	0
23:26:00	33-58-39.5	134-57-17.3	186.9	14.9	186.5	2.8	0
23:26:01	33-58-39.5	134-57-17.3	186.9	14.9	186.5	2.6	0
23:26:03	33-58-39.0	134-57-17.2	187.0	14.9	186.6	3.3	-1
23:26:04	33-58-39.0	134-57-17.2	187.0	14.9	186.5	-1.7	-1
23:26:05	33-58-38.5	134-57-17.2	187.1	14.9	186.5	-1.4	-1
23:26:07	33-58-38.0	134-57-17.0	187.2	14.9	186.6	4.7	-1
23:26:08	33-58-38.0	134-57-17.0	187.3	14.9	186.6	-1.1	-1
23:26:09	33-58-37.5	134-57-17.0	187.3	14.9	186.6	-1.3	-1
23:26:11	33-58-37.0	134-57-16.9	187.2	14.9	186.7	2.9	-1
23:26:12	33-58-37.0	134-57-16.9	187.3	14.9	186.7	2.3	-1
23:26:13	33-58-36.5	134-57-16.8	187.4	14.9	186.7	1.5	-1
23:26:15	33-58-36.5	134-57-16.8	187.5	14.9	186.7	2.2	-1
23:26:16	33-58-35.8	134-57-16.7	187.5	14.9	186.8	2.6	-1
23:26:17	33-58-35.5	134-57-16.7	187.6	14.9	186.8	1.0	-1
23:26:19	33-58-35.1	134-57-16.6	187.6	14.9	186.7	0.5	-1
23:26:20	33-58-34.8	134-57-16.6	187.6	14.9	186.7	0.4	-1
23:26:21	33-58-34.6	134-57-16.5	187.6	14.9	186.7	0.2	-1
23:26:23	33-58-34.1	134-57-16.5	187.6	14.9	186.7	-0.1	-1
23:26:24	33-58-33.8	134-57-16.4	187.6	14.9	186.7	0.0	-1
23:26:25	33-58-33.6	134-57-16.3	187.7	14.9	186.7	0.2	-1
23:26:27	33-58-33.1	134-57-16.3	187.8	14.9	186.7	0.1	0
23:26:29	33-58-32.6	134-57-16.2	187.8	14.9	186.8	-0.4	0

23:26:31	33-58-32.1	134-57-16.1	187.9	14.9	186.7	0.3	0
23:26:33	33-58-31.6	134-57-16.0	188.0	14.9	186.7	0.2	0
23:26:34	33-58-31.6	134-57-16.0	188.0	14.9	186.7	0.0	0
23:26:35	33-58-31.1	134-57-16.0	188.0	14.9	186.7	0.3	0
23:26:37	33-58-30.6	134-57-15.8	188.0	14.9	186.7	0.6	0
23:26:38	33-58-30.4	134-57-15.8	188.1	14.9	186.7	0.5	2
23:26:39	33-58-30.1	134-57-15.8	188.1	14.9	186.7	0.3	3
23:26:41	33-58-30.1	134-57-15.8	188.1	14.9	186.6	0.5	4
23:26:42	33-58-29.4	134-57-15.7	188.1	14.9	186.6	0.4	4
23:26:43	33-58-29.1	134-57-15.6	188.1	14.9	186.7	6.5	4
23:26:45	33-58-28.7	134-57-15.6	188.1	14.9	186.8	3.6	4
23:26:46	33-58-28.4	134-57-15.5	188.1	14.9	186.8	3.4	4
23:26:47	33-58-28.1	134-57-15.5	188.1	14.9	186.9	3.7	4
23:26:49	33-58-27.7	134-57-15.4	188.0	14.9	187.0	4.1	3
23:26:51	33-58-27.4	134-57-15.3	187.9	14.9	187.0	3.6	3
23:26:53	33-58-26.7	134-57-15.3	187.5	14.9	187.2	5.3	3
23:26:55	33-58-26.2	134-57-15.2	187.4	14.9	187.4	5.9	2
23:26:57	33-58-25.7	134-57-15.1	187.3	14.9	187.8	8.6	2
23:26:59	33-58-25.1	134-57-15.1	187.3	14.9	188.1	9.5	-2
23:27:00	33-58-24.9	134-57-15.0	187.4	14.9	188.3	13.7	-2
23:27:01	33-58-24.7	134-57-15.0	187.4	14.9	188.4	5.7	-3
23:27:03	33-58-24.1	134-57-14.9	187.4	14.9	188.5	2.4	-3
23:27:04	33-58-24.1	134-57-14.9	187.4	14.9	188.5	2.8	-3
23:27:05	33-58-23.6	134-57-14.8	187.4	14.9	188.7	5.8	-3
23:27:07	33-58-23.1	134-57-14.7	187.6	14.9	188.8	5.7	-3
23:27:08	33-58-22.9	134-57-14.7	187.8	14.9	188.9	5.6	-3
23:27:09	33-58-22.6	134-57-14.6	188.0	14.9	189.0	5.6	-3
23:27:11	33-58-22.6	134-57-14.6	188.7	14.9	189.1	4.5	-4
23:27:12	33-58-21.8	134-57-14.5	188.9	15.0	189.1	-1.0	-4
23:27:13	33-58-21.6	134-57-14.4	189.2	15.0	189.0	-6.3	-4
23:27:15	33-58-21.2	134-57-14.3	189.4	14.9	188.8	-6.4	-4
23:27:17	33-58-20.6	134-57-14.2	189.6	14.9	188.7	-5.6	-5
23:27:19	33-58-20.2	134-57-14.1	189.9	15.0	188.4	-7.5	-5
23:27:21	33-58-19.6	134-57-13.9	190.2	14.9	188.2	-7.5	-5

23:27:22	33-58-19.2	134-57-13.8	190.6	14.9	187.9	-6.9	-5
23:27:23	33-58-19.2	134-57-13.8	190.6	14.9	187.9	-7.7	-4
23:27:25	33-58-18.7	134-57-13.7	190.9	14.9	187.5	-12.1	-3
23:27:26	33-58-18.7	134-57-13.7	191.1	14.9	187.2	-15.8	4
23:27:27	33-58-18.2	134-57-13.6	191.2	14.9	186.8	-16.5	6
23:27:29	33-58-17.7	134-57-13.4	191.4	14.9	186.4	-17.9	6
23:27:30	33-58-17.5	134-57-13.4	191.5	14.9	186.0	-18.0	7
23:27:31	33-58-17.2	134-57-13.3	191.5	14.9	185.8	-8.4	8
23:27:33	33-58-17.2	134-57-13.3	191.4	14.9	185.6	-7.2	8
23:27:34	33-58-16.4	134-57-13.1	191.3	14.9	185.5	-6.6	9
23:27:35	33-58-16.2	134-57-13.0	191.2	14.9	185.4	-6.3	9
23:27:37	33-58-15.8	134-57-12.9	190.7	14.9	185.3	-3.1	9
23:27:38	33-58-15.5	134-57-12.9	190.4	14.9	185.3	-2.8	9
23:27:39	33-58-15.2	134-57-12.8	189.9	14.8	185.2	-2.1	9
23:27:41	33-58-14.8	134-57-12.8	188.8	14.8	185.4	6.0	9
23:27:42	33-58-14.5	134-57-12.7	188.3	14.7	185.6	10.8	9
23:27:43	33-58-14.3	134-57-12.7	187.9	14.7	185.9	17.4	9
23:27:45	33-58-13.8	134-57-12.7	187.1	14.7	186.3	21.6	8
23:27:47	33-58-13.3	134-57-12.6	186.9	14.7	186.8	21.7	7
23:27:49	33-58-12.9	134-57-12.6	186.3	14.7	187.7	18.2	6
23:27:51	33-58-12.4	134-57-12.5	185.9	14.7	188.1	17.7	4
23:27:52	33-58-12.4	134-57-12.5	185.9	14.7	188.5	17.4	3
23:27:53	33-58-11.9	134-57-12.5	185.4	14.7	188.9	20.3	2
23:27:55	33-58-11.3	134-57-12.4	185.0	14.7	189.5	23.2	1
23:27:56	33-58-11.1	134-57-12.4	184.9	14.7	190.1	28.3	1
23:27:57	33-58-10.8	134-57-12.4	185.0	14.7	190.7	28.6	0
23:27:59	33-58-10.8	134-57-12.4	185.4	14.7	191.5	28.7	-1
23:28:00	33-58-10.1	134-57-12.3	185.6	14.7	192.0	28.5	-1
23:28:01	33-58-09.8	134-57-12.3	185.9	14.7	192.6	23.1	-2
23:28:03	33-58-09.4	134-57-12.2	186.5	14.7	193.1	19.1	-6
23:28:04	33-58-09.1	134-57-12.1	186.8	14.7	193.4	16.1	-6
23:28:05	33-58-08.9	134-57-12.1	187.0	14.7	193.8	16.1	-7
23:28:07	33-58-08.4	134-57-12.0	187.6	14.7	194.0	12.3	-7
23:28:09	33-58-08.1	134-57-11.9	187.9	14.7	194.2	10.3	-7

23:28:11	33-58-07.4	134-57-11.8	189.2	14.7	194.8	14.2	-7
23:28:13	33-58-06.9	134-57-11.6	190.5	14.7	195.0	9.9	-6
23:28:15	33-58-06.5	134-57-11.5	191.8	14.6	195.1	2.0	-5
23:28:17	33-58-05.9	134-57-11.3	192.9	14.6	195.0	-6.7	-4
23:28:18	33-58-05.7	134-57-11.2	193.4	14.6	194.8	-10.1	-3
23:28:19	33-58-05.5	134-57-11.2	193.8	14.6	194.6	-10.8	-3
23:28:21	33-58-05.0	134-57-11.0	194.4	14.6	194.5	-5.9	-2
23:28:22	33-58-05.0	134-57-11.0	194.8	14.6	194.3	-5.9	-2
23:28:23	33-58-04.6	134-57-10.9	195.0	14.6	194.1	-9.3	-1
23:28:25	33-58-04.6	134-57-10.9	195.6	14.6	194.0	-7.5	-1
23:28:26	33-58-03.8	134-57-10.6	195.8	14.6	193.9	-6.4	-1
23:28:27	33-58-03.6	134-57-10.6	196.0	14.6	193.7	-7.4	0
23:28:29	33-58-03.6	134-57-10.6	196.3	14.6	193.4	-12.1	1
23:28:30	33-58-02.8	134-57-10.3	196.3	14.6	193.2	-11.5	1
23:28:31	33-58-02.6	134-57-10.2	196.4	14.6	193.0	-10.3	2
23:28:33	33-58-02.1	134-57-10.1	196.4	14.6	192.7	-11.0	6
23:28:34	33-58-01.9	134-57-10.0	196.3	14.6	192.6	-5.0	7
23:28:35	33-58-01.7	134-57-09.9	196.2	14.6	192.6	2.8	9
23:28:37	33-58-01.2	134-57-09.8	196.0	14.6	192.6	3.2	9
23:28:39	33-58-00.7	134-57-09.6	195.7	14.6	192.7	3.8	12
23:28:40	33-58-00.7	134-57-09.6	195.7	14.6	192.9	8.4	12
23:28:41	33-58-00.3	134-57-09.5	195.3	14.6	193.1	8.6	12
23:28:43	33-57-59.8	134-57-09.3	194.6	14.6	193.4	13.5	12
23:28:44	33-57-59.8	134-57-09.3	194.2	14.6	193.7	13.0	11
23:28:45	33-57-59.3	134-57-09.2	193.9	14.6	194.1	14.5	11
23:28:47	33-57-58.9	134-57-09.1	193.0	14.6	194.6	24.2	9
23:28:48	33-57-58.7	134-57-09.0	192.6	14.5	195.3	29.2	8
23:28:49	33-57-58.4	134-57-08.9	192.3	14.5	195.9	29.1	7
23:28:51	33-57-58.4	134-57-08.9	191.9	14.5	196.7	34.4	7
23:28:52	33-57-57.7	134-57-08.8	191.8	14.5	197.4	33.8	7
23:28:53	33-57-57.5	134-57-08.7	191.7	14.5	198.1	33.1	7
23:28:55	33-57-57.0	134-57-08.5	191.7	14.5	199.0	33.4	5
23:28:56	33-57-56.7	134-57-08.4	191.6	14.5	199.7	33.9	5
23:28:57	33-57-56.5	134-57-08.3	191.7	14.5	200.6	35.3	4

23:28:59	33-57-56.0	134-57-08.2	191.8	14.5	201.6	40.5	3
23:29:00	33-57-55.7	134-57-08.2	191.9	14.5	202.4	41.0	3
23:29:01	33-57-55.4	134-57-08.1	192.2	14.5	203.5	41.6	2
23:29:03	33-57-55.0	134-57-08.0	192.8	14.5	204.3	40.8	2
23:29:05	33-57-54.5	134-57-07.8	193.3	14.5	205.3	41.5	1
23:29:07	33-57-54.1	134-57-07.7	194.5	14.5	206.9	38.6	1
23:29:09	33-57-53.6	134-57-07.5	195.4	14.5	208.1	43.4	-1
23:29:10	33-57-53.6	134-57-07.5	195.4	14.5	208.9	37.4	-1
23:29:11	33-57-53.1	134-57-07.3	196.4	14.5	209.7	35.8	-4
23:29:13	33-57-52.6	134-57-07.1	197.7	14.5	210.6	36.8	-5
23:29:14	33-57-52.6	134-57-07.1	198.3	14.5	211.3	36.5	-5
23:29:15	33-57-52.2	134-57-06.8	198.8	14.4	212.0	34.7	-6
23:29:17	33-57-51.7	134-57-06.7	200.2	14.4	213.5	66.7	-11
23:29:18	33-57-51.5	134-57-06.5	201.1	14.4	215.7	102.0	-13
23:29:19	33-57-51.3	134-57-06.4	201.7	14.3	217.5	98.0	-15
23:29:21	33-57-51.0	134-57-06.4	200.5	13.6	220.1	85.7	-20
23:29:22	33-57-50.8	134-57-06.3	200.5	13.6	221.3	66.6	-22
23:29:23	33-57-50.6	134-57-06.2	199.9	12.4	222.5	49.4	-22
23:29:25	33-57-50.5	134-57-06.1	201.1	11.1	223.6	51.2	-23
23:29:27	33-57-50.3	134-57-06.0	202.5	10.6	224.4	40.0	-25
23:29:29	33-57-50.1	134-57-05.8	208.4	9.3	225.4	18.2	-25
23:29:31	33-57-49.9	134-57-05.5	212.1	8.6	225.7	13.4	-25
23:29:32	33-57-49.9	134-57-05.5	212.1	8.6	226.0	13.7	-25
23:29:33	33-57-49.7	134-57-05.4	214.8	8.0	226.3	14.0	-25
23:29:35	33-57-49.4	134-57-05.2	217.5	7.6	226.6	13.0	-25
23:29:36	33-57-49.4	134-57-05.1	219.5	7.4	226.6	4.2	-25
23:29:37	33-57-49.3	134-57-05.1	221.8	7.2	226.6	2.9	-25
23:29:39	33-57-49.1	134-57-04.8	226.6	6.9	226.5	-4.2	-23
23:29:40	33-57-49.1	134-57-04.8	228.6	6.8	226.4	-6.6	-22
23:29:41	33-57-49.0	134-57-04.6	230.0	6.6	226.2	-12.6	-21
23:29:43	33-57-49.0	134-57-04.4	232.1	6.5	225.8	-16.6	-19
23:29:44	33-57-48.9	134-57-04.3	233.3	6.4	225.4	-17.3	-19
23:29:45	33-57-48.8	134-57-04.2	234.8	6.3	225.2	-7.8	-18
23:29:47	33-57-48.8	134-57-04.2	237.4	6.2	225.1	-5.0	-18

23:29:48	33-57-48.7	134-57-03.8	238.4	6.2	224.8	-14.5	-17
23:29:49	33-57-48.7	134-57-03.8	239.6	6.1	224.3	-21.0	-17
23:29:51	33-57-48.6	134-57-03.6	242.0	6.1	223.7	-23.5	-16
23:29:52	33-57-48.6	134-57-03.4	242.9	6.0	223.4	-15.7	-15
23:29:53	33-57-48.5	134-57-03.3	243.7	5.9	223.0	-14.2	-15
23:29:55	33-57-48.5	134-57-03.1	244.5	5.8	222.5	-15.8	-
23:29:56	33-57-48.4	134-57-02.9	245.0	5.8	222.1	-21.7	-
23:29:57	33-57-48.4	134-57-02.8	245.8	5.8	221.5	-21.9	-
23:29:59	33-57-48.4	134-57-02.6	246.8	5.8	221.1	-18.3	-
23:30:00	33-57-48.3	134-57-02.3	247.1	5.7	220.7	-18.1	-

* The vessel's position corresponds to the location of the GPS antenna at each timestamp. The recorded values are the ones closest to each whole second, and if no record exists within ±0.5 seconds of a whole second, they are not included.

Appendix Table 3: AIS Records of Vessel B

Time (hh:mm)	Latitude N (°-′-″)	Longitude E (°-′-″)	COG (°)	SOG (kn)
23:00:28	33-53-48.7	135-01-03.8	317.8	10.5
23:00:57	33-53-52.5	135-00-59.8	317.6	10.5
23:01:28	33-53-56.4	135-00-55.4	317.8	10.6
23:01:57	33-54-00.2	135-00-51.3	317.8	10.6
23:02:27	33-54-04.1	135-00-47.0	318.6	10.4
23:03:28	33-54-12.1	135-00-38.4	318.0	10.7
23:03:57	33-54-15.9	135-00-34.4	319.3	10.7
23:04:27	33-54-19.9	135-00-30.1	319.5	10.7
23:04:57	33-54-24.0	135-00-26.0	320.0	10.7
23:05:28	33-54-28.1	135-00-21.7	318.6	10.6
23:05:58	33-54-32.2	135-00-17.5	320.4	10.8
23:06:31	33-54-36.6	135-00-12.9	319.2	10.8
23:06:58	33-54-40.3	135-00-09.0	318.0	10.8
23:07:27	33-54-44.4	135-00-04.7	319.8	10.9
23:07:58	33-54-48.5	135-00-00.4	318.3	10.8
23:08:27	33-54-52.4	134-59-56.3	318.9	10.9
23:08:57	33-54-56.5	134-59-52.2	320.4	10.8
23:09:28	33-55-00.9	134-59-48.0	322.7	10.8
23:09:57	33-55-05.0	134-59-44.1	321.1	10.9
23:10:27	33-55-09.2	134-59-40.0	320.2	10.8
23:10:57	33-55-13.4	134-59-36.0	321.3	10.9
23:11:28	33-55-17.9	134-59-31.5	320.6	10.8
23:11:57	33-55-21.8	134-59-27.7	319.5	10.9
23:12:28	33-55-26.1	134-59-23.4	320.5	11.0
23:13:27	33-55-34.4	134-59-15.3	320.5	10.9
23:13:57	33-55-38.7	134-59-11.1	319.9	10.9
23:14:29	33-55-43.1	134-59-06.7	318.5	10.9
23:14:57	33-55-46.9	134-59-02.7	320.1	10.9
23:15:27	33-55-51.3	134-58-58.4	320.3	10.9
23:15:57	33-55-55.3	134-58-54.4	319.2	10.8
23:16:29	33-55-59.6	134-58-50.0	319.7	10.7

23:16:57	33-56-03.5	134-58-46.0	319.3	10.8
23:17:29	33-56-07.8	134-58-41.6	318.1	10.8
23:17:59	33-56-11.9	134-58-37.3	318.4	10.8
23:18:27	33-56-15.8	134-58-33.5	320.3	10.8
23:18:58	33-56-20.2	134-58-29.1	320.9	10.8
23:19:27	33-56-24.1	134-58-25.3	320.7	10.8
23:19:57	33-56-28.4	134-58-21.0	319.0	10.9
23:20:27	33-56-32.5	134-58-17.0	320.6	10.9
23:20:57	33-56-36.9	134-58-12.8	322.4	10.8
23:21:28	33-56-41.1	134-58-08.7	321.7	10.8
23:21:57	33-56-45.2	134-58-04.8	321.6	10.7
23:22:27	33-56-49.4	134-58-00.8	320.3	10.8
23:22:57	33-56-53.7	134-57-56.7	321.3	10.9
23:23:27	33-56-57.9	134-57-52.7	321.7	10.9
23:23:57	33-57-02.1	134-57-48.6	319.1	10.8
23:24:28	33-57-06.5	134-57-44.3	320.6	11.0
23:24:57	33-57-10.7	134-57-40.1	321.2	10.9
23:25:28	33-57-15.1	134-57-35.9	321.1	10.8
23:25:58	33-57-19.2	134-57-31.9	321.3	10.8
23:26:28	33-57-23.6	134-57-27.7	321.5	10.8
23:26:58	33-57-27.7	134-57-23.8	322.7	11.0
23:27:28	33-57-32.0	134-57-19.6	319.6	10.9
23:27:57	33-57-36.0	134-57-15.6	320.1	10.9
23:28:27	33-57-40.2	134-57-11.5	322.1	11.0
23:28:58	33-57-44.8	134-57-07.1	322.4	11.0
23:29:27	33-57-46.9	134-57-03.4	236.4	8.3
23:29:57	33-57-45.1	134-57-00.3	235.7	5.1
23:30:29	33-57-43.7	134-56-57.4	249.3	5.7
23:30:57	33-57-43.0	134-56-54.6	260.7	4.7
23:31:27	33-57-43.1	134-56-52.2	269.8	3.7
23:31:57	33-57-43.3	134-56-50.0	279.8	3.1
23:32:28	33-57-43.6	134-56-48.4	289.9	2.5
23:33:27	33-57-44.6	134-56-46.1	302.3	2.0

* The vessel's position corresponds to the location of the GPS antenna at each timestamp. Note that the simplified AIS installed on Vessel B does not transmit heading or rate of turn data.

Appendix Table 4: Target Information on Vessel B from Vessel A's VDR Records

Time (hh:mm)	Distance to "B" (M)	Bearing to "B" (°)	SOG of "B" (kn)	COG of "B" (°)	CPA (N)	TCPA (min.)
22:56	13.08	168.0	10.3	316.9	1.2	33.0
22:57	12.69	168.1	10.4	316.7	0.4	32.7
22:58	12.30	168.1	10.4	316.3	0.5	31.7
22:59	11.94	168.2	10.3	317.3	0.2	31.0
23:00	11.55	168.2	10.5	317.8	0.2	29.8
23:01	11.09	168.3	10.6	317.7	0.3	28.5
23:02	10.76	168.3	10.5	318.2	0.2	27.7
23:03	10.38	168.3	10.6	317.6	0.1	26.6
23:04	9.98	168.3	10.7	319.4	0.2	25.1
23:05	9.55	168.4	10.7	319.3	0.2	24.0
23:06	9.17	168.4	10.8	319.8	0.1	22.9
23:07	8.79	168.5	10.9	319.0	0.3	21.9
23:08	8.54	168.5	10.8	318.3	0.1	21.5
23:09	7.96	168.6	10.8	321.8	0.1	19.8
23:10	7.56	168.6	10.9	320.7	0.1	18.8
23:11	7.16	168.6	10.9	320.8	0.1	17.9
23:12	6.77	168.7	11.0	320.0	0.1	16.9
23:13	6.35	168.7	10.9	321.0	0.1	15.8
23:14	5.95	168.7	10.9	319.2	0.2	14.9
23:15	5.55	168.8	10.9	320.1	0.1	13.9
23:16	5.15	168.9	10.8	319.5	0.1	13.0
23:17	4.74	169.0	10.8	318.6	0.2	12.0
23:18	4.34	169.2	10.8	319.7	0.1	10.9
23:19	3.95	169.3	10.8	320.4	0.1	9.9
Recorded Time (hh:mm:ss)	The above values are averages recorded over one minute starting from each minute's 00 seconds. The following are all recorded values.					
23:20:04	3.72	169.4	10.9	319.0	0.1	9.4
23:20:11	3.70	169.4	10.9	319.0	0.1	9.3

23:20:18	3.64	169.4	10.9	319.0	0.1	9.2
23:20:26	3.58	169.4	10.9	320.6	0.1	9.0
23:20:33	3.54	169.4	10.9	320.6	0.2	8.8
23:20:40	3.48	169.5	10.9	320.6	0.2	8.7
23:20:47	3.46	169.5	10.9	320.6	0.2	8.6
23:20:54	3.40	169.6	10.9	320.6	0.1	8.5
23:21:01	3.35	169.6	10.8	322.4	0.1	8.4
23:21:09	3.30	169.6	10.8	322.4	0.1	8.3
23:21:16	3.25	169.6	10.8	322.4	0.1	8.1
23:21:24	3.19	169.6	10.8	322.4	0.0	8.0
23:21:31	3.15	169.6	10.8	321.7	0.0	7.9
23:21:38	3.09	169.7	10.8	321.7	0.0	7.8
23:21:45	3.07	169.6	10.8	321.7	0.1	7.7
23:21:52	3.02	169.6	10.8	321.7	0.1	7.6
23:22:00	2.96	169.7	10.7	321.6	0.1	7.4
23:22:06	2.92	169.8	10.7	321.6	0.1	7.3
23:22:13	2.89	169.8	10.7	321.6	0.1	7.2
23:22:20	2.83	169.8	10.7	321.6	0.1	7.1
23:22:27	2.78	169.8	10.8	320.3	0.1	7.0
23:22:34	2.74	169.9	10.8	320.3	0.1	6.9
23:22:40	2.68	169.9	10.8	320.3	0.2	6.7
23:22:47	2.66	169.9	10.8	320.3	0.1	6.7
23:22:53	2.60	170.1	10.8	320.3	0.1	6.5
23:23:00	2.56	170.1	10.9	321.3	0.1	6.4
23:23:07	2.51	170.1	10.9	321.3	0.1	6.3
23:23:13	2.48	170.1	10.9	321.3	0.1	6.2
23:23:20	2.44	170.2	10.9	321.3	0.1	6.1
23:23:26	2.38	170.1	10.9	321.7	0.0	6.0
23:23:33	2.34	170.2	10.9	321.7	0.1	5.8
23:23:39	2.31	170.2	10.9	321.7	0.1	5.8
23:23:46	2.26	170.2	10.9	321.7	0.1	5.6
23:23:54	2.21	170.3	10.9	321.7	0.1	5.5
23:24:00	2.17	170.4	10.8	319.1	0.1	5.4
23:24:06	2.11	170.4	10.8	319.1	0.2	5.3

23:24:13	2.08	170.5	10.8	319.1	0.1	5.2
23:24:19	2.04	170.5	10.8	319.1	0.1	5.1
23:24:26	1.98	170.7	10.8	319.1	0.1	5.0
23:24:33	1.95	170.6	11.0	320.6	0.1	4.9
23:24:40	1.91	170.7	11.0	320.6	0.1	4.8
23:24:47	1.85	170.8	11.0	320.6	0.1	4.6
23:24:54	1.79	170.8	11.0	320.6	0.1	4.5
23:25:01	1.75	171.0	10.9	321.2	0.1	4.4
23:25:07	1.72	171.0	10.9	321.2	0.1	4.3
23:25:14	1.67	171.1	10.9	321.2	0.1	4.2
23:25:21	1.62	171.2	10.9	321.2	0.1	4.1
23:25:28	1.57	171.3	10.8	321.1	0.1	4.0
23:25:35	1.53	171.3	10.8	321.1	0.1	3.8
23:25:42	1.51	171.6	10.8	321.1	0.1	3.7
23:25:48	1.45	171.7	10.8	321.1	0.1	3.6
23:25:55	1.40	171.8	10.8	321.1	0.1	3.5
23:26:02	1.36	171.8	10.8	321.3	0.1	3.4
23:26:09	1.31	171.9	10.8	321.3	0.1	3.3
23:26:15	1.28	172.0	10.8	321.3	0.1	3.2
23:26:22	1.23	172.2	10.8	321.3	0.1	3.1
23:26:29	1.18	172.4	10.8	321.5	0.1	3.0
23:26:36	1.13	172.6	10.8	321.5	0.1	2.9
23:26:42	1.09	172.8	10.8	321.5	0.1	2.7
23:26:49	1.05	173.0	10.8	321.5	0.1	2.6
23:26:56	1.00	173.2	10.8	321.5	0.1	2.5
23:27:03	0.96	173.2	11.0	322.7	0.1	2.4
23:27:10	0.91	173.5	11.0	322.7	0.1	2.2
23:27:18	0.85	173.8	11.0	322.7	0.1	2.1
23:27:24	0.80	173.8	11.0	322.7	0.0	2.0
23:27:31	0.76	173.9	10.9	319.6	0.0	2.0
23:27:38	0.71	174.3	10.9	319.6	0.1	1.8
23:27:45	0.69	174.6	10.9	319.6	0.1	1.7
23:27:52	0.63	175.1	10.9	319.6	0.1	1.6
23:27:58	0.57	176.2	10.9	320.1	0.1	1.4

23:28:05	0.55	176.6	10.9	320.1	0.1	1.3
23:28:12	0.50	178.1	10.9	320.1	0.1	1.2
23:28:18	0.48	178.7	10.9	320.1	0.1	1.2
23:28:24	0.42	179.3	10.9	320.1	0.0	1.1
23:28:30	0.39	179.2	11.0	322.1	0.0	1.0
23:28:36	0.33	179.1	11.0	322.1	0.0	0.9
23:28:43	0.31	180.0	11.0	322.1	0.0	0.8
23:28:49	0.26	182.4	11.0	322.1	0.1	0.6
23:28:55	0.23	184.0	11.0	322.1	0.1	0.5
23:29:01	0.18	186.7	11.0	322.4	0.1	0.4
23:29:08	0.16	189.8	11.0	322.4	0.1	0.3
23:29:14	0.11	200.2	11.0	322.4	0.0	0.2
23:29:22	0.07	222.0	11.0	322.4	0.1	0.1

Appendix Table 5: Target Information on Vessel C from Vessel A's VDR Records

Recorded Time (hh:mm)	Distance to "C" (M)	Bearing to "C" (°)	SOG of "C" (kn)	COG of "C" (°)	CPA (M)	TCPA (min.)
23:15	3.77	236.0	13.0	139.5	0.5	19.3
23:16	3.58	235.7	13.0	139.5	0.5	18.6
23:17	3.39	235.2	12.9	139.5	0.4	17.7
23:18	3.20	234.8	12.9	139.8	0.5	16.7
23:19	3.01	234.3	12.8	139.9	0.4	15.7
23:20	2.82	233.7	12.8	139.5	0.4	14.8
23:21	2.64	233.1	12.8	139.3	0.5	13.5
23:22	2.46	232.4	12.9	139.5	0.4	12.9
23:23	2.27	231.5	12.9	139.1	0.5	11.5
23:24	2.08	230.4	12.9	139.5	0.5	10.6
23:25	1.89	229.2	12.8	139.0	0.5	9.6
23:26	1.70	227.6	12.9	139.5	0.5	8.6
23:27	1.51	225.4	12.8	139.6	0.5	7.6
23:28	1.33	222.2	12.8	139.7	0.6	6.0

* Each value represents the average recorded over one minute starting from each minute's 00 seconds.

Appendix : The Act for Preventing Collisions at Sea (Abstract)

Chapter I GENERAL

(Purpose)

Article 1

This law, in accordance with the provisions of the International Regulations for Preventing Collisions at Sea, 1972, as annexed to the 1972 Convention on the International Regulations for Preventing Collisions at Sea, establishes the necessary rules concerning navigation to be followed by vessels, the lights and shapes to be displayed, and the signals to be made. Its purpose is to prevent collisions between vessels at sea and thereby ensure the safety of maritime traffic.

Chapter II CONDUCT OF VESSELS

Section I – CONDUCT Of VESSELS IN ANY CONDITION OF VISIBILITY

(Application)

Article 4

Rules in this section apply in any condition of visibility.

(Lookout)

Article 5

Every vessel shall at all times maintain a proper lookout 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.

(Safe speed)

Article 6

Every vessel shall at all times proceed at a safe speed so that she can take proper and effective action to avoid collision and be stopped within distance appropriate to the prevailing circumstances and conditions.

In determining a safe speed the following factors shall be among those taken into account.

By all vessels:

(i) *the state of visibility;*

(ii) *the traffic density including concentrations of fishing vessels or any other vessels;*

(iii) *the manoeuvrability of the vessel with special reference to stopping distance and turning ability in the prevailing conditions;*

(iv) *at night the presence of background light such as from shore lights or from back scatter of her own lights;*

(v) *the state of wind, sea and current, and the proximity of navigational hazards;*

(vi) *the draught in relation to the available depth of water*

additionally, by vessels with operational radar:

(vii) *the characteristics, efficiency and limitations of the radar equipment;*

(viii) *any constraints imposed by the radar range scale in use;*

(ix) *the effect on radar detection of the sea state, weather and other sources of interference;*

(x) *the possibility that small vessels, ice and other floating objects may not be detected by radar at an adequate range;*

(xi) *the number, location and movement of vessels detected by radar;*

(xii) *the more exact assessment of the visibility that may be possible when radar is used to determine the range of vessels or other objects in the vicinity.*

(Risk of Collision)

Article 7

1 Every vessel shall use all available means appropriate to the prevailing circumstances and conditions to determine if risk of collision exists.

2 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.

3 Assumptions shall not be made on the basis of scanty information, especially scanty radar information.

4 In determining if risk of collision exists the following considerations shall be among those taken into account:

Such risk shall be deemed to exist if the compass bearing of an approaching vessel does not appreciably change;

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.

5 If there is any doubt such risk of collision exists shall be deemed to exist.

(Action to avoid collision)

Article 8

1 Any action to avoid collision shall be taken in accordance with the rules of this Part and, if the circumstances of the case admit, be positive, made in ample time and with due regard to the observance of good seamanship.

2 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 course and/or speed should be avoided.

3 If there is sufficient sea room, alteration of course alone may be the most effective action to avoid a close-quarters situation provided that it is made in good time, is substantial and does not result in another close-quarters situation.

4 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.

5 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.

Section II – CONDUCT Of VESSELS IN SIGHT OF ONE ANOTHER

(Application)

Article 11

Rules in this section apply to vessels in sight of one another.

(Crossing situation)

Article 15

When two power-driven vessels are crossing so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way and shall, if the circumstances of the case admit, avoid crossing ahead of the other vessel.

(Action by give-way vessel)

Article 16

Every vessel which is directed to keep out of the way of another vessel shall, so far as possible, take early and substantial action to keep well clear.

(Action by stand-on vessel)

Article 17

1 Where one of two vessels is to keep out of the way the other shall keep her course and speed.

2 The latter vessel may however take action to avoid collision by her manoeuvre alone, as soon as it becomes apparent to her that the vessel required to keep out of the way is not taking appropriate action in compliance with these Rules. A power-driven vessel which takes action in a crossing situation in accordance with this Rule to avoid collision with another power-driven vessel shall, if the circumstances of the case admit, not alter course to port for a vessel on her own port side.

3 When, from any cause, the vessel required to keep her course and speed finds herself so close that collision cannot be avoided by the action of the give-way vessel alone, she shall take such action as will best aid to avoid collision.

Chapter IV EQUIPMENT FOR SOUND SIGNALS

(Manoeuvring and warning signals)

Article 34

1-4 (Omitted)

5 When vessels in sight of one another are approaching each other and from any cause either vessel fails to understand the intention 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.

6-8 (Omitted)

Chapter V SUPPLEMENTARY RULES

(Special circumstances with immediate danger)

Article 38

1 In construing and complying with these Rules due regard shall be had to all dangers of navigation and collision and to any special circumstances with immediate danger, including the limitations of the vessels involved.

2 Which may make a departure from these Rules necessary to avoid immediate danger.

(Responsibility)

Article 39

Nothing in these Rules shall exonerate any vessel, or the owner, master or crew thereof, from the consequences of any neglect to comply with these Rules or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case.