

MA2010-5

**MARINE ACCIDENT
INVESTIGATION REPORT**

May 28, 2010



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.

Norihiro Goto
Chairman,
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.

MARINE ACCIDENT INVESTIGATION REPORT

Vessel type and Name: Fishing vessel DAIEI-MARU No.11

Fishing vessel registration number: NS1-1045

Gross tonnage: 135 T

Accident type: Capsize

Date and time: About 08:05 hours, April 14, 2009 (local time, UTC+ 9 hours)

Location: Off the west of Hirado Island, Hirado City, Nagasaki Prefecture
About 243° true, 9.1 nautical miles from Ikitsuki Bridge Light (C1 light)
(approximately 33° 17.0' N, 129° 16.6' E)

May 20, 2010

Adopted by the Japan Transport Safety Board

Chairman Norihiro Goto

Member Tetsuo Yokoyama

Member Tetsuya Yamamoto

Member Toshiyuki Ishikawa

Member Mina Nemoto

1 PROCESS AND PROGRESS OF THE INVESTIGATION

1.1 Summary of the Accident

On April 14, 2009, while proceeding off the west of Hirado Island, Hirado City, Nagasaki Prefecture for a fishing ground in the East China Sea, boarded by a master, a fishing chief and 20 other crew members, the fishing vessel Daiei-maru No.11 capsized at about 08:05 and foundered at about 08:30.

Among the 22 crew members, 11 crew members died and one crew member went missing, while 10 other crew members were rescued and were all hospitalized because of their symptoms like fever and pneumonia.

Daiei-maru No.11 was salvaged afterward, and the fishing vessel was totally destroyed.

1.2 Outline of the Accident Investigation

1.2.1 Setup of the Investigation

The Japan Transport Safety Board appointed an investigator-in-charge and four other marine accident investigators to investigate the accident on April 14, 2009. In addition, one regional accident investigator participated from Nagasaki Regional Office.

1.2.2 Tests, Research and Cooperation by Other Institutes

The Board obtained the cooperation of the Marine Accident Analysis Center at the National Maritime Research Institute for the analysis of the behavior and vessel maneuvering of roundhaul netters while sailing in adverse weather conditions, and was informed of the criteria and research results on these issues.

1.2.3 Collection of Evidence

April 15 to 17, May 8 to 11 and June 9 to 11, 2009: Interviews

April 15 and 16, May 7 and 9, June 10 and October 1, 2009: On-site investigation

November 6, 9, 12, 19 and 30, 2009: Collection of written replies to the questionnaire

1.2.4 Opinions of Parties Relevant to the Cause

Opinions were invited from parties relevant to the cause of the accident.

2 FACTUAL INFORMATION

2.1 Events Leading to the Accident

2.1.1 Events Leading to the Accident According to the Statements

Events leading to the accident were as follows, according to the statements of the crew on board Daiei-maru No.11 (hereinafter referred to as "the Vessel") and the consort vessels, and the person in charge at Daiei Suisan Co., Ltd. which owned the Vessel (hereinafter referred to as "Company A"), and to the ship's logbook and the radio log of the consort vessels.

(1) Events since departure until reaching the vicinity of the sea area where the accident occurred

At about 07:00, April 14, 2009, a group of 10 roundhaul netters including the Vessel, owned by Company A and consisting of two fleets, decided to depart as scheduled for the fishing ground in the East China Sea, because the weather conditions at Tachiura Fishing Port, Ikitsuki Island, Hirado City, Nagasaki Prefecture were not different from those on ordinary days to go fishing, while it was drizzling, waves were very low and a north to northeast wind was blowing at about 10 m/s.

While the fleet headed by the Vessel consisted of five vessels (hereinafter referred to as “Fleet of the Vessel”) including the Vessel (net boat^{*1}), Daiei-maru No.1 (light boat^{*2}), Daiei-maru No.8 (light boat), Daiei-maru No.38 (fish carrier^{*3}) and Daiei-maru No.58 (fish carrier), while the other fleet consisted of five other vessels (hereinafter referred to as “Fleet of No.23”) including Daiei-maru No.23 (net boat), Daiei-maru No.2 (light boat), Daiei-maru No.15 (light boat), Daiei-maru No.18 (fish carrier) and Daiei-maru No.52 (fish carrier) (hereinafter, the four other vessels composing the Fleet of the Vessel are referred to as “No.1”, “No.8”, “No.38” and “No.58”, while the vessels composing the Fleet of No.23 are referred to as “No.23”, “No.2”, “No.15”, “No.18” and “No.52”).

At about 07:15, the master, fishing chief and chief radio operator (hereinafter referred to as “Chief”) stationed themselves in the wheelhouse while the 19 other crew members were stationed at the bow and the stern for departure, and the Vessel departed under the maneuvering by the master.

About three minutes after leaving shore, the Vessel passed under Ikitsuki Bridge connecting Hirado Island, Hirado City and Ikitsuki Island, and proceeded along the west-southwest course directed toward halfway between Uku Island, Sasebo City, Nagasaki Prefecture and Nozaki Island, Ojika Town, Nagasaki Prefecture, at a speed of about 12.3 kn (speed over the ground, the same will apply hereinafter), at an engine revolution of 610 to 620 per minute (rpm), at a blade angle of 21°.

At about 07:20, the chief officer (hereinafter referred to as “C/O”) went on the bridge and took over the steering from the master. When getting out from behind Ikitsuki Island, the Vessel was forced to proceed in following seas with a wave height of about 1 to 3 m coming from north-northeast to northeast in a north to north-northeast wind a little stronger than before. However, C/O continued proceeding, as the Vessel did not roll or pitch largely and the Vessel had not usually avoided navigation while sailing in following sea conditions like that.

After passing under Ikitsuki Bridge and getting out from behind Ikitsuki Island, the Fleet of the Vessel proceeded in the formation where No.1 was positioned 0.5 to 0.6 M on the port beam of the Vessel, No.8 about 1.0 M on the starboard beam of the Vessel, No.38 about 2.0 to 2.2 M dead astern of the Vessel and No.58 about 1.0 to 1.2 M dead astern of No.38.

The fishing chief instructed C/O to reduce the speed, thinking that if the speed was maintained, they would arrive at the fishing ground before the scheduled arrival time of 17:00.

At about 07:30, the second officer (hereinafter referred to as “2/O”) went on the bridge and

^{*1} “net boat” refers to a fishing vessel playing a key role in a roundhaul fishery fleet which employs a single-drum method, such as carrying roundhaul nets on board, locating a school of fish and enclosing them inside the roundhaul net. A net boat is usually boarded by a fishing chief to play the role of commanding the fleet.

^{*2} “light boat” refers to a fishing vessel in a roundhaul fishery fleet, playing the role of collecting the fish located by the fish-finder with underwater lights. Usually two light boats are included in a roundhaul fishery fleet.

^{*3} “fish carrier” refers to a fishing vessel in a roundhaul fishery fleet, playing the role of transporting the fish caught by the fleet from the fishing ground to fish markets. Usually two fish carriers are included in a roundhaul fishery fleet.

took over the steering from C/O. At about 07:50, an ordinary seaman (hereinafter referred to as "OS-A") went on the bridge, and took over the steering from 2/O at about 07:55. 2/O then went down the bridge. In the meantime, the Vessel maintained the west-southwest course, and continued proceeding at a speed of about 12 to 13 kn.

(2) Events leading to capsizing

At about 08:00, the fishing chief and the chief radio operator of No.23 communicated by radio, and when the fishing chief said "a large wave is approaching", the chief radio operator of No.23 responded.

At about 08:02, the fishing chief saw the above mentioned large wave approaching from the starboard quarter of the Vessel (north-northeast to northeast) with a larger height than before, and at the same time, the master took over the steering from OS-A, and the Vessel continued proceeding while the fishing chief stationed himself on the starboard side, C/O in the front of the port side, OS-A at the rear of the port side and the Chief in the radio operating room at the rear of the wheelhouse.

Upon checking with the fishing chief, the master steered to port and altered the course about 1° to 2° to port so that the Vessel should be overtaken by the crest of the first wave (hereinafter referred to as "First Wave") from the starboard quarter.

When the master reduced the speed of the main engine, the Vessel went into a surf-riding attitude, and when the crest of the First Wave approached the stern, the stern was lifted up.

About a minute after the master took the steering, the stern of the Vessel was overtaken by the crest of the First Wave, and was hit by large wave splashes, which caused the Vessel to list to port for a few seconds.

At that moment, the crest of the second wave (hereinafter referred to as "Second Wave") was approaching from the starboard quarter, a little more northerly than the First Wave.

Three to four seconds after being overtaken by the First Wave, the Vessel was hit on the stern by the Second Wave with a wave height higher, and a forefront steeper than the First Wave, and the stern became as if thrusting into the forefront. About 15 seconds after that, as the Vessel listed largely to starboard, the master put the engine to ahead and put the helm hard to starboard, while the fishing chief gave an order of "go ahead" followed by "hard starboard" to confirm the operation .

Listing about 20° to 30° to starboard as if sliding down the slope on the back of the Second Wave, the Vessel started turning to starboard while the top of the starboard bulwark barely touched the surface of the sea.

When the Vessel turned almost 180°, as the angle of starboard list continued increasing while the stability of the Vessel was not restored, the fishing chief gave instructions to sound the emergency bell, and the Chief rushed out of the radio operating room to push the button of the emergency bell on the steering stand. The fishing chief gave the order to abandon the Vessel on the public address system, shouting "get out, get out" (hereinafter referred to as "Abandon Order"), while instructing, at the same time, the Chief, C/O and OS-A remaining in the wheelhouse to get out.

When the Vessel turned a little more than 180°, and the bow was directed toward north-northeast to northeast, the angle of starboard list became about 90°. About a minute after going over the crest of the Second Wave and listing to starboard, the Vessel capsized all at once.

At about 08:05, the master of No.18 reported on the maritime telephone to a person in charge at Company A (hereinafter referred to as "Person-In-Charge A"), and so did the chief

radio operator of No.23 to another person in charge at Company A (hereinafter referred to as “Person-In-Charge B”) that the Vessel had capsized.

(3) Events since capsized until foundering

The propeller was keeping rotating for a while after the Vessel capsized and was entangled with the ropes which had dropped from the Vessel when capsizing and were floating on the sea. While the bow of the Vessel was directed toward north-northeast to northeast at the time of capsizing, the Vessel sank gradually from the bow, turning to starboard under the influence of the wind and waves coming from north-northeast.

At about 08:28, the master of No.18 reported to Person-In-Charge A on the maritime telephone that the Vessel was foundering.

When the consort vessels accompanying the Vessel arrived one after another at the sea area of the accident site, the Vessel was almost in a vertical attitude with the rotation of the propeller stopped, while directing the bow toward south-southwest to southwest, showing the bottom of the stern, rudder and propeller on the sea. The Vessel foundered from the bow at about 08:30, and the chief radio operator of No.23 reported to Person-In-Charge B on the maritime telephone that the Vessel had foundered.

The Vessel capsized at about 08:05, April 14, 2009, and the location was about 243°, 9.1 M from Ikitsuki Ohashi Bridge Light (C1 light) (hereinafter referred to as “Ikitsuki Bridge Center Light”) (approximately 33° 17.0' N, E 129° 16.6' E), and foundered at about 08:30 near the location of the capsized.

2.1.2 Events Leading to the Accident According to the GPS Plotters of No.1 and No.8

(1) The position of No.1 per 30 minutes recorded on the GPS plotter of No.1 and the data on the location where the Vessel capsized which were plotted by the master of No.1 in the vicinity where the Vessel capsized were as follows.

Time / Location	Position
07:00	Inside Tachiura Fishing Port (33°21.39'N,129°26.16'E)
07:30	223° (true bearing, the same will apply unless otherwise noted), 2.9 M from Ikitsuki Bridge Center Light (33°19.07'N,129°23.91'E)
08:00	240°, 8.9 M from Ikitsuki Bridge Center Light (33°16.69'N,129°17.07'E)
08:30	241°, 8.7 M from Ikitsuki Bridge Center Light (33°17.06'N,129°17.20'E)
09:00	237°, 3.8 M from Ikitsuki Bridge Center Light (33°19.15'N,129°22.51'E)
Location of capsized	243°, 9.1 M from Ikitsuki Bridge Center Light (33°16.99'N,129°16.6'E)

(2) The position of No.8 per 20 minutes recorded on the GPS plotter of No.8 and the data on the location where the Vessel capsized, plotted by the master of No.8 in the vicinity where the Vessel capsized were as follows.

Time / Location	Position
07:00	Inside Tachiura Fishing Port (33°21.35'N,129°26.17'E)
07:20	227°, 0.9 M from Ikitsuki Bridge Center Light (33°20.57'N,129°25.48'E)
07:41	247°, 5.2 M from Ikitsuki Bridge Center Light (33°19.18'N, 129°20.52'E)

08:00	247°, 8.9 M from Ikitsuki Bridge Center Light (33°17.67'N,129°16.51'E)
08:20	242°, 9.3 M from Ikitsuki Bridge Center Light (33°16.80'N,129°16.55'E)
08:41	237°, 7.3 M from Ikitsuki Bridge Center Light (33°17.18'N,129°19.01'E)
Location of capsiz3	243°, 9.1 M from Ikitsuki Bridge Center Light (33°17.00'N,129°16.6'E)

2.1.3 Information on the Situation of the Grounding on the Seabed

According to the written reply of the salvage company which salvaged the Vessel (hereinafter referred to as “Company B”), the situation of the Vessel’s grounding on the seabed was as follows.

Location of the grounding: 33°17.19'N, 129°16.47'E
Water depth at the location of the grounding: 85 m
Heading: About 250° (magnetic bearing)
Attitude of the hull: Normal (the bottom of the hull was in contact with the seabed while the upper deck was directed toward the sea surface)

2.1.4 Times Shown on the Ship’s Clocks of the Vessel

When the Vessel was salvaged, it was found that times shown on the ship’s clocks of the Vessel were as follows.

On the port side			On the starboard side	
		Wheelhouse	Radio operating room	08:03
Port side wall in the dining room	12:07	Upper deck		
Navigation officers’ room		Hold Fore accommodation space	Engineers’ room	
Bow side in the master’s room	08:00		Bow side in the Chief’s room	08:20
Starboard side in the chief engineer’s room	08:20		Port side in the fishing chief’s room	08:08
			Starboard side in the fishing chief’s room	08:12
Engine control room	08:18	Hold Engine room		
Cabin (forward)		Hold Aft accommodation space	Cabin (forward)	
Cabin (aft)			Cabin (aft)	
Left side wall in the saloon	08:21			

(See Figure 1: Estimated Navigation Route, Figure 2: Tracks of No.1 and No.8 and Formation of the Fleet of the Vessel, Figure 3: General Arrangement Plan of the Vessel and Figure 4: Schematic Chart Showing the Development of the Capsize)

2.2 Injuries to Persons

According to the statements of the crew of the Vessel and the written reply of Sasebo Coast

Guard Office, injuries sustained by the crew were as follows.

A total of 11 crew members consisting of the master, fishing chief, second engineer (hereinafter referred to as “2/E”), OS-A, six ordinary seamen (hereinafter referred to as “OS-B”, “OS-C”, “OS-D”, “OS-E”, “OS-F” and “OS-G”, respectively) and a wiper died from drowning inside the Vessel, while another ordinary seaman (hereinafter referred to as “OS-H”) went missing. Afterward, OS-H was removed from the family register.

A total of 10 crew members consisting of the chief engineer, Chief, C/O, 2/O and six other ordinary seamen (hereinafter referred to as “OS-I”, “OS-J”, “OS-K”, “OS-L”, “OS-M” and “OS-N”, respectively) were rescued by the consort vessels at about 08:30, and transported immediately to Tachiura Fishing Port. As the rescued crew showed symptoms of emotion^{*4} caused by critical incident stress^{*5}, behavioral disorders and fever, all of them were hospitalized after landing. After they were hospitalized, it was found that one crew member sustained a dislocation of the finger and five crew members sustained an abrasion and a bruise while four others were not injured. While in hospital, all the 10 crew members showed symptoms of sleeplessness and lethargy, and eight of them became feverish, two of whom suffered from pneumonia. However, five of them were discharged from hospital on April 30, 2009, while the five others were discharged on May 1.

2.3 Damage to Vessel

According to the preliminary underwater survey for the salvation of the Vessel and the on-site investigation after the Vessel was salvation, the Vessel sustained the following damage:

Fashion plate ^{*6} , its stiffeners ^{*7} and appendages:	bent upward
Main mast:	folded toward the bow
Broadside walls (outside plating) of No.7 fuel tanks on both sides:	dented
Wall surface of the spare tank in the engine room:	dented on six sides
Four pillars in the aft accommodation space:	bent
Second window from the left at the front of the wheelhouse:	broken
Cathode-ray tubes of the navigation equipment:	ruptured
Main engine, auxiliary engine and electric equipment:	wet damaged

When the Vessel was salvaged afterward, the Vessel was declared a total loss.

2.4 Crew Information

(1) Gender, age and certificate of competence

[1] Master: Male, 44 years old

Fourth grade maritime officer (navigation)

Date of Issue October 6, 1987

Date of Revalidation February 20, 2006

Date of expiry July 11, 2011

[2] Fishing chief: Male, 61 years old

Fourth grade maritime officer (navigation)

^{*4} “emotion” refers to an aspect of feeling or sentiment, arising all of a sudden and brief in duration, accompanied by a relatively strong transient state of feeling or the feeling experienced previously.

^{*5} “critical incident stress” refers to a stress reaction occurring to people who are exposed to problems or threats (critical incidents) which may interfere with their ability to function with their normal behavioral mechanism, or those who have happened to see or heard of the scene of a critical incident.

^{*6} “fashion plate” refers to an outside plating at the bow above the forecastle deck.

^{*7} “stiffener” refers to a reinforcing material to be used for preventing wooden boards from deflecting or buckling.

Date of Issue August 23, 1968
Date of Revalidation September 29, 2004
Date of expiry February 28, 2010

[3] Chief: Male, 44 years old

Fourth grade maritime radio operator

Date of Issue October 21, 1986
Date of Revalidation May 29, 2009

[4] C/O: Male, 28 years old

Fourth grade maritime officer (navigation)

Date of Issue September 3, 2003
Date of Revalidation May 20, 2009
Date of expiry September 2, 2013

(2) Major seagoing experience and health condition

According to the statements of Person-In-Charge A at Company A, Chief and C/O, and to the written reply of Company A, the major seagoing experience and health condition of those crew members were as follows.

[1] Master

The master entered Company A in May 1973, and after boarding net boats as an ordinary seaman, he became a chief officer in 1988. He became the master of the Vessel in August 1992.

His eyesight and hearing ability were normal, and he was in good health condition.

[2] Fishing chief

After entering Company A in April 1966, the fishing chief boarded fish carriers and net boats. He started boarding fish carriers as the master for the first time in 1972. Boarding net boats as the master since 1977, he became a fishing chief in April 1988, and started boarding the Vessel as the fishing chief since March 2002.

His eyesight and hearing ability were normal, and he was in good health condition.

[3] Chief

After entering Company A in April 1983, he started boarding Daiei-maru No.51 (fish carrier) as a mess man for the first time, and became the chief radio operator of the Vessel in March 2002.

His eyesight and hearing ability were normal, and he was in good health condition.

[4] C/O

After entering Company A in April 1998, he started boarding the Vessel as an ordinary seaman for the first time, and became the chief officer of the Vessel in April 2005.

His eyesight and hearing ability were normal, and he was in good health condition.

2.5 Vessel Information

2.5.1 Particulars of Vessel

Fishing vessel registration number: NS1-1045

Base port: Hirado City, Nagasaki Prefecture

Owner: Company A

Gross tonnage: 135 tons

L × B × D: 45.55 m × 7.80 m × 3.20 m

Length waterline: 42.9 m (at a designed load draft of 2.8 m)

Load line* ⁸	Seawater load line, 416 mm downward from the upper end of the deck line
Hull material:	Steel
Fishing area:	East Sea / Yellow Sea Sea-area or North Pacific Ocean Sea-area
Use:	Fishing vessel
Main engine:	Single diesel engine
Output:	640 (engine performance index by the Fishing Vessel Act)
Propulsion:	Single 4-blade controllable pitch propeller
Capacity of persons on board:	28 in total with 26 crew members and 2 others
Date of launch:	April 1991

2.5.2 Performance of the Vessel and Other Information

(1) According to the official sea trial when the Vessel was newly constructed, the performance of the Vessel was as follows.

Test conditions	Length waterline		Displacement		Mean draft	
	43.00 m		369.01 t		2.915 m	
Speed test	Load	Speed	Blade angle		Main engine revolution (rpm)	
	1 / 4	8.86 kn	12.0°		610 rpm	
	1 / 2	11.17 kn	16.2°		610 rpm	
	3 / 4	13.04 kn	19.8°		610 rpm	
	4 / 4	13.82 kn	22.0°		610 rpm	
	11 / 10	13.99 kn	22.8°		610 rpm	
Turning test	Rudder angle		35° to port		35° to starboard	
	Time required for steering / maximum angle of heel		6 seconds / 7°		6 seconds / 7°	
	Maximum advance / maximum transfer		66 m / 58 m		68 m / 59 m	
	Time required for turning 180°		44.2 seconds		42 seconds	
	Time required for turning 360°		83.8 seconds		82.6 seconds	

(2) Loading conditions

According to the drawing and specification of the Vessel and the statements of the crew on board the Vessel, the loading conditions of the Vessel were as follows.

The accident occurred when the Vessel was leaving the port on the first day of the fishing period. The Vessel was fully loaded with fresh water, food and fishing gears in addition to about 50 t of fuel oil against the full load weight of about 67.7 t, while the displacement was about 461 t and the mean draft in that state was about 2.8 m. While the Vessel was under those conditions, the top of the starboard bulwark would sink under water if the Vessel listed about 23° to starboard.

*⁸ "load line", called also as load water line (LWL), refers to a mark showing the minimum freeboard when a vessel is fully loaded, calculated according to the Load Line Regulations (Ordinance No.33 of August 10, 1968 by the Ministry of Transport), prescribed in accordance with Article 3 of the Ship Safety Law (Act No.11 of March 15, 1933).

2.5.3 Situation When the Accident Occurred

According to the on-site investigation and written replies of Sasebo Coast Guard Office and Company B, and to the statements of the crew on board the Vessel, the situation when the accident occurred was as follows.

(1) Closing appliances

Closing appliances of the external openings consisted of four hatches, three doors of the bridge structure and one door of the fore hold, and whether each of the closing appliances was open or closed immediately before the Vessel capsized was as follows.

Closing appliances of the openings	Type	Open / Closed
Entrance door of the fore hold	Watertight	Open
Inner hatch of the fore hold	Non-Watertight	Open
Hatch of the starboard side net storage on the fore upper deck	Non-Watertight	Closed
Aft entrance door on the port side of the wheelhouse	Weathertight	Open (the sash door came off)
Fore entrance door of the dining room	Watertight	Open
Aft entrance door of the fishing preparation section	Watertight	Open
Escape hatch in the aft accommodation space	Watertight	Closed
Entrance hatch of the steering gear room	Watertight	Closed (collapsed)

(2) Rudder angle, condition of the main engine, blade angle and heel angle

	Rudder angle	Condition of the main engine	Blade angle
Actual Vessel	32° to starboard	610 rpm	22° ahead
Equipment in the wheelhouse	25° to starboard	Control lever: positioned at full ahead Value indicated by the load indicator: 8 (equal to 1/4 load)	21° ahead

The right-hand maximum value indicator of the inclinometer in the wheelhouse was stopped at a point beyond the maximum value of 50°, and the left-hand indicator pointed to 32°, while the list indicator pointed to 34° to starboard.

(3) Failure or trouble with the Vessel

There was no failure or trouble with the hull, engine and equipment of the Vessel when the accident occurred.

2.5.4 Compatibility with Stability Criteria

The Vessel was under the scope of the criteria provided for in the Regulations for Ship Stability (Ordinance No.76 of December 28, 1956 by the Ministry of Transport), as shown below, before they were revised on October 29, 2008, and was compatible with the criteria.

- (1) A vessel should possess GM (transverse metacentric height)^{*9} which shall be more than the value determined by the following formula in any of the operating conditions^{*10}.

$$0.04 B + 0.54 \frac{B}{D} - \alpha \text{ (m)}$$

(B is the breadth and D is the depth while α is an invariable determined by the ratio between the freeboard^{*11} and the depth)

- (2) A special criterion is applied to a net boat participating in roundhaul fishery (hereinafter referred to as “Roundhaul Net Boat”), in which the righting arm (GZ)^{*12} of the critical angle of heel^{*13} shall be larger than the heeling arm of couple^{*14} to be generated by the fastening of grommets^{*15}. The value of the heeling couple to be generated by the fastening of grommets is assumed to be 61.03 t·m, which is the product of 14.14 t, twice the capacity of the winding winch, and 4.316 m, the distance from the centerline of the hull to the tip of the winding davit.

When the above regulations were revised on October 29, 2008, the stability criteria were reviewed from the viewpoint of consistency with the criteria in the Intact Stability Code of IMO^{*16} (hereinafter referred to as “IS Code”). As a result, fishing vessels constructed on and after January 1, 2009 fell under the scope of the following criteria; the newly introduced GM criteria; dynamic stability criteria as applied to passenger ships when being hit by a gusty wind while rolling or pitching in waves accompanied by a steady wind; and angle of heel criteria as applied to vessels while in operation.

2.5.5 Characteristics of Roundhaul Net Boats

Roundhaul Net Boats have the following characteristics in comparison with light boats and fish carriers with which to form a fishing fleet.

^{*9} M (transverse metacenter) stands for the point of intersection between two vertical lines, one line through the center of buoyancy of the hull of a ship in equilibrium and the other line through the center of buoyancy of the hull when the ship is inclined to one side. Thus, “GM (transverse metacentric height)” stands for the distance between the center of gravity (G) of the vessel and its transverse metacenter (M).

^{*10} “any of the operating conditions” refers, in the case of the Vessel, to such conditions when the Vessel is in the state of leaving port, arriving at a fishing ground, being ready to leave the fishing ground, leaving the fishing ground and arriving in port.

^{*11} “freeboard” refers to the vertical distance between the upper surface of the freeboard deck (the watertight upper deck) and the load line.

^{*12} “righting arm (GZ)” is expressed by $GM \tan \theta$ when the center of gravity is G and the angle of heel is θ when a vessel generates a righting moment. The product of the displacement and the righting arm (GZ) of the vessel is the value of a righting moment.

^{*13} “critical angle of heel” refers to whichever is smaller, 12° or the angle of heel between the vertical position of a vessel and the position where the gunwale reaches the water surface, as provided for in Section 24 Paragraph 2 of the former version of the Regulations for Ship Stability.

^{*14} “heeling arm of couple” refers to the value obtained when external forces causing a vessel to list like the wind and the movement of persons and cargos inside the vessel are divided by the displacement. The value of heeling arm of couple has been determined in the Regulations for Ship Stability according to the use of a vessel.

^{*15} “fastening of grommets” refers to a method of fishing operation in which a drawstring passing through round-shaped weights (grommets) placed at the bottom of a roundhaul net is fastened to prevent a school of fish escaping from the net when enclosed, and the grommets are later pulled up in a bunch from the broadside.

^{*16} “Intact Stability Code of IMO” refers to the intact stability criteria established by IMO (International Maritime Organization). They are broadly comprised of two criteria, mandatory and non-mandatory (recommendations and guidelines). In the mandatory part, minimum metacentric height (GM), area under GZ curve and dynamic stability criteria are provided for, while in the non-mandatory part, special criteria for certain types of ship like fishing vessels and container ships are provided for, in addition to suggestions for vessel handling in bad weather conditions.

(1) Vessel design

Most of 135-ton type Roundhaul Net Boats including the Vessel are flush deck vessel with forecastle, designed to place the bridge and the engine room amidships in most cases. Light boats have almost similar characteristics, designed to place a raised deck on top of the upper deck in most cases. The type of Fish carriers are flush deck vessel with forecastle and poop, designed to place the bridge on the stern and the forecastle on the bow in most cases.

(2) Fishing nets

There are several types of fishing net to be used for 135-ton type Roundhaul Net Boat according to what fish species they capture, like a bonito/tuna type, mackerel type and horse mackerel/mackerel type net. Their standard net sizes are as shown in the Table 1^{*17}. For the loading of such extensive and heavy nets, the greater part of the stern side of the bridge structure of Roundhaul Net Boats is assigned to the stacking space for the nets. Furthermore, because fishing operation is conducted several times a day once setting sail and because those nets are heavy and need a lot of space when folded, Roundhaul Net Boats are usually unequipped with exclusive lashing devices for the nets, which are instead secured with a crane or derrick boom while on board. Therefore, those nets are liable to shift easily when sea water floods in.

On the other hand, such fishing nets and other heavy materials which are liable to shift are not to be loaded on the upper deck of light boats and fish carriers.

Table1 The standard net size

Net type	Length × Breadth	Dry weight
Bonito / tuna	2,250 m × 375 m	35.0 t
Mackerel	1,650 m × 375 m	21.0 t
Horse mackerel / mackerel	1,320 m × 398 m	21.3 t

(3) Freeboard and upper deck arrangement

For the convenience and improved efficiency of net hauling, it is necessary for Roundhaul Net Boats to lowering the gunwale by decrease the freeboard as much as possible, and to secure as large working space as possible from the starboard bow to the stern on the upper deck. Therefore, the bridge structure is placed along the port broadside while almost the full length of a wooden deck on the starboard side is assigned as working space.

On the other hand, the front section of the upper deck is all over covered with a wooden deck at about 600 mm above the upper deck, and the height from the upper deck to the upper end of the bulwark is about 1.6 m as a result of securing 1.0 m as the height of the bulwark from the surface of the wooden deck.

While the freeboard of light boats and fish carriers is almost the same as that of Roundhaul Net Boats, reserve buoyancy is secured sufficiently for both of them and the bridge structure is arranged symmetrically on the upper deck as light boats are equipped with a raised deck and fish carries are equipped with a forecastle and a poop deck.

(4) Fishing machines

^{*17} Based on “Technical Problems of Roundhaul Fishery and Toward Its Reform – Problems Related to Net Sizes –“ by Yoshihiro Inoue, Professor of Faculty of Fisheries at Kagoshima University (January 2009 issue of Journal of Fishing Boat and System Engineering, compiled by Fishing Boat and System Engineering Association of Japan)

In addition to anchoring, mooring and material handling equipment, such fishing machines are installed on the upper deck and forecastle deck of Roundhaul Net Boats which become necessary for net laying and hauling as well as net adjusting on board. Their weight is as follows.(Table 2)

Table2 The weight of fishing machine

Fishing machine	Weight (kg)	Fishing machine	Weight (kg)
Roundhaul winch	5,750	Derrick and others	1,200
Winding winch	2,240	Mooring winch	1,050
Winding davit	2,650	Anchor winch	290
Power crane	7,310	Fore mast	750
Power block	1,050	Aft mast	1,200
Net hauler	5,900		
Side roller	2,500	Total	31,890

In addition to anchoring, mooring and material handling equipment installed on light boats and fish carriers, an underwater light is installed on the fore raised deck of light boats.

(5) Weather deck

In order to secure as large working space as possible after installing nets and fishing machines on the weather deck, Roundhaul Net Boats are designed in the way that the length and the breadth of the weather deck are extended. On the other hand, the hull structure under the weather deck is designed relatively thin-shaped in order to fix their gross tonnage. Because of these considerations, the angle of heel where the maximum righting arm is generated is small, and the range of stability is small, too.

While playing the role of leading a school of fish by casting an underwater light into the water, light boats do not need so large working space as Roundhaul Net Boats, and fish carriers whose role does not require large working space do not need extended weather deck space.

Also, since the gross tonnage is not limited for light boats and fish carriers, they can change the design of their hull structure under the weather deck in order to extend the weather deck space as they like whenever necessary.

(See Figure 5: Comparison Among Light Boat, Roundhaul Net Boat and Fish Carrier, and Figure 6: Comparison of Midship Section Shapes)

2.5.6 Current Situation of Roundhaul Net Boats

(1) Statistic data

According to the Statistic Tables of Fishing Vessels No.61 issued in 2008 by the Fisheries Agency of Japan, the number of steel-made Roundhaul Net Boats with a gross tonnage of 50 GT or more, registered in Japan as of December 31, 2008, was as follows.

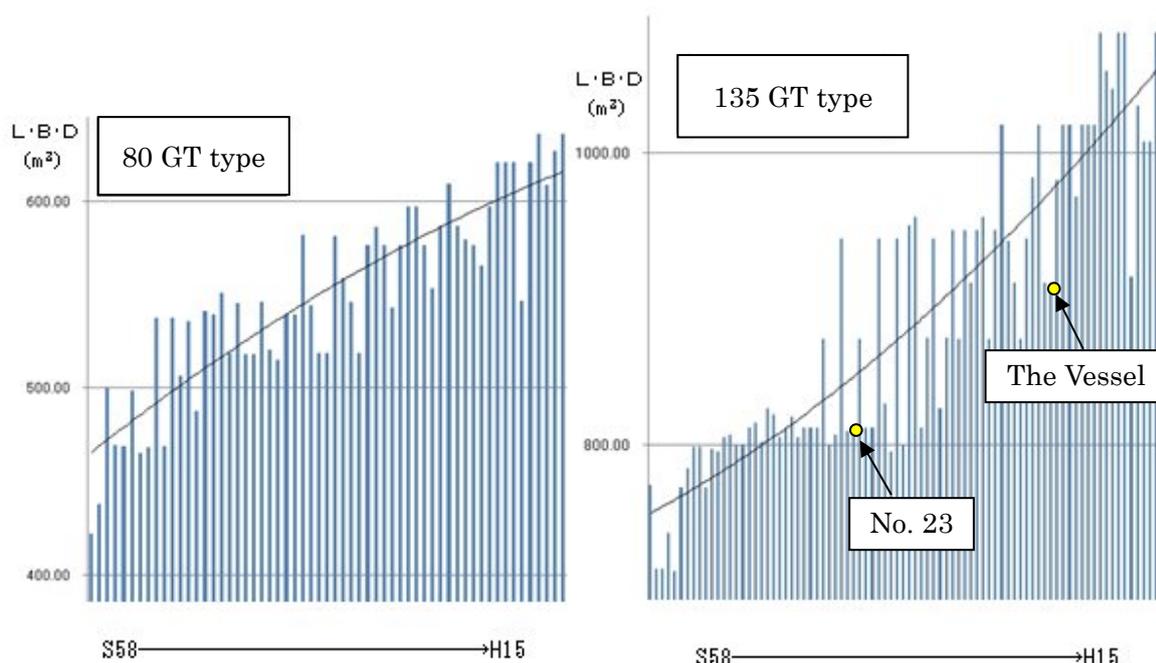
Table3

Gross tonnage(GT)	Number of Vessels	Total gross tonnage(GT)	Average gross tonnage(GT)
50 ~ 99 GT	29	2,320 GT	80 GT
100 ~ 199 GT	32	4,334 GT	About 135.4 GT
200 GT ~	40	14,719 GT	About 368 GT

(2) Situation of fishing vessel construction and development of design change

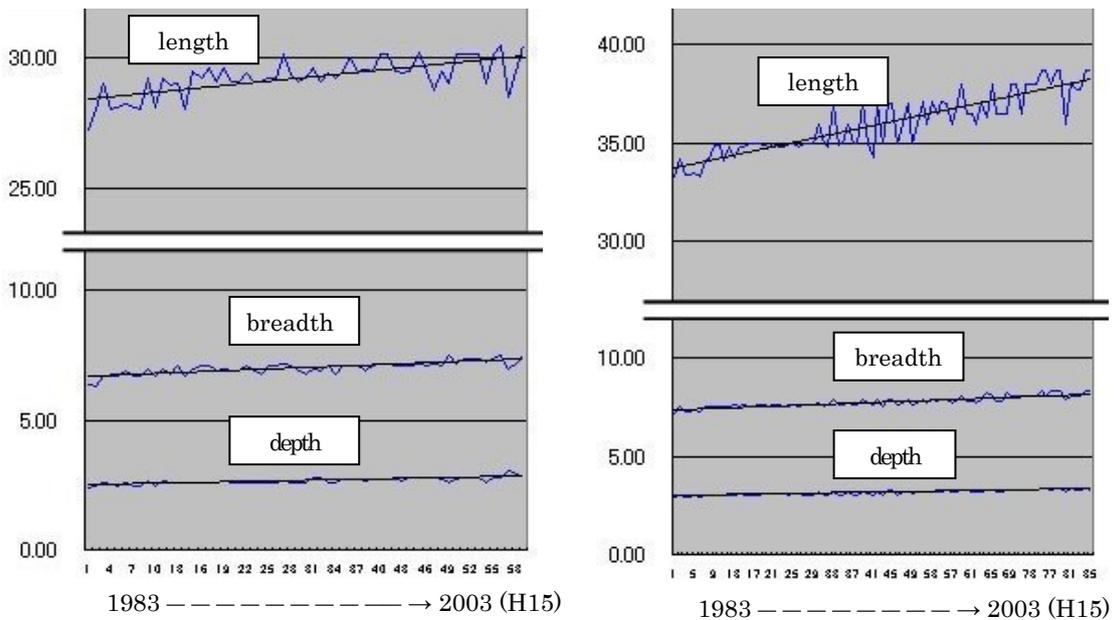
According to certain documents on fishing vessels^{*18}, the number of 80-GT type Roundhaul Net Boats constructed during the 26 years between 1983 and 2008 was 59, and the gross tonnage of each of these vessels was 80 GT, while the number of 135-GT type Roundhaul Net Boats constructed during the same period was 85, and the gross tonnage of each of these vessels was 135 GT (although the number of either type of Roundhaul Net Boats was zero (0)^{*19} for the period between 2004 and 2008).

The values obtained by multiplying the length, breadth and depth (registered measurements) of both 80-GT and 135-GT type Roundhaul Net Boats are shown in the charts below in a chronological order according to the year and month of construction. According the charts, the length and the breadth of the upper deck tend to be larger year by year, while the depth tends to be larger slightly.



^{*18} Based on “Fishing Vessels” compiled by the Fishing Boat Association of Japan, and “Fishing Boat and System Engineering” compiled by the Fishing Boat and System Engineering Association of Japan

^{*19} During the period between 2004 and 2008, five large-scale Roundhaul Net Boats were constructed because of their design with higher safety, and underwent an experimental fishing. Since fiscal 2007, the Fisheries Agency has budgeted a support project for the structural reform of fishing vessels and fishery, and has been supporting a project to verify the feasibility of fishing vessels constructed under the framework of the support project. (As a reference, three out of the five large-scale Roundhaul Net Boats as mentioned above were constructed under the framework of such support project. In addition to these, a fourth large-scale vessel is expected to come under the framework of the verification project in this April.)



2.5.7 Information on Consort Vessels

According to the general arrangement plan of the consort vessels, their particulars were as follows in comparison with those of the Vessel.

Vessel name (Type)	Gross tonnage (GT)	Waterline length (m)	Registered length (m)	Breadth (m)	Depth (m)	Sea trial maximum speed (kn)
The Vessel (net boat)	135	42.9	36.50	7.80	3.20	13.8
No.1 (light boat)	85	38.8	34.95	6.36	3.05	13.7
No.8 (light boat)	85	38.8	34.98	6.40	3.10	Unknown
No.38 (fish carrier)	250	48.2	44.5	8.0	4.0	13.6
No.58 (fish carrier)	343	59.2	53.5	9.0	4.45	15.1
No.28 (net boat)	135	38.5	34.9	7.6	3.05	13.4
No.2 (light boat)	85	38.8	34.95	6.36	3.05	13.7
No.15 (light boat)	85	38.8	34.95	6.36	3.10	14.2
No.18 (fish carrier)	334	53.3	51.0	8.56	4.50	15.3
No.52 (fish carrier)	305	53.3	50.5	8.5	4.4	14.6

(See Figure 3: General Arrangement Plan of the Vessel, Figure 5: Comparison Among Light Boat, Roundhaul Net Boat and Fish Carrier, and Figure 6: Comparison of Midship Section Shapes)

2.6 Information on Operation Management of Vessels

2.6.1 Operation Management

According to the statements of Chief, C/O, and the representative of Company A, and the fishing chief, master and C/O of No. 23, Company A implemented operation management as follows.

Company A owned and operated a group of 10 roundhaul netters including the Vessel, consisting of two fleets. Company A operated the vessels in accordance with the calendar, engaged in fishing operation for a period between the 19th day of each month and the 13th day of the

following month according to the lunar calendar, and suspended fishing operation on days with a spring tide and a full moon.

At the beginning of August every year, the vessels of Company A were put under 15 to 20-day long dock maintenance in the order of the Fleet of the Vessel followed by the Fleet of No.23.

Company A provided assistance for the operation of these fleets, including crew manning, labor management, provision of fishing gears, food, drinking water and fuel oil and vessel engineering work like dock maintenance.

The fishing chiefs of each fleet made decision on all the operational matters including whether or not to depart, avoid navigation or suspend fishing operation. The fishing chiefs stayed inside the bridge to watch and make observations of weather and sea conditions during such times as when leaving and arriving in port, during the period until navigational safety was confirmed after leaving port, while sailing in adverse weather conditions, and during the time of emergency and rescue activities, and at the same time they supervised the ship maneuvering and gave steering and engine orders whenever necessary.

2.6.2 Safety Activities

(1) Safety activities by Company A

According to the statements of the representative and directors of Company A, the masters and fishing chiefs of the consort vessels, Company A carried out the following safety activities.

On a day before entering into each fishing period, Company A held a monthly meeting, which was attended by the masters, fishing chiefs, and chief radio operators of net boats, heads*²⁰ and masters of light boats, masters of fish carriers, the representative and directors of Company A.

At a monthly meeting, the catch of the previous fishing period was reported and confirmation was made among the attendees about prevention of violating fishery-related laws and regulations. Drawing the attention of the attendees to the following safety-related matters, the representative of Company A instructed them to acquaint all the crew thoroughly with these matters. Company A also provided each crew member with both a non-inflatable and an inflatable lifejackets.

- To wear a lifejacket and a helmet while working on the external area, like when leaving and arriving in port, anchoring and fishing.
- To implement avoidance navigation and drifting at an early stage while sailing in adverse weather conditions with a typhoon, and during winter or early spring time.
- To ensure watch-keeping strictly.
- To get acquainted with preceding accident cases and take notice of preventive measures against recurrence of similar accidents.
- To ensure repair and maintenance of every part of a vessel as well as fishing gears, and clear and clean the working deck.

Company A also developed a safety manual and a checklist for internal use on the basis of “Safety Operation Manual for Roundhaul Netters” distributed in 1994 by Pelagic Roundhaul Netters Association of Japan, and distributed each of them to the vessels it owned. Although the manual mentioned about precautions while sailing in adverse weather conditions, such as the need of making preparations on a day-to-day basis and prior arrangements when adverse

*²⁰ “head” refers to a position of a crew member on board a light boat to supervise the fishing operation. Either of two light boats to be included in a fishing fleet is to be boarded by a head.

weather conditions were expected, in addition to general suggestions while sailing in adverse weather conditions and broaching phenomenon, it did not mention about hazards which might lead to broaching and stability reduction while sailing in following and quartering sea conditions, and about detailed and specific vessel maneuvering methods for avoiding them.

(2) Safety activities by fishery cooperatives

According to the documents related to Nagasaki Prefecture Conference for the Prevention of Marine Accidents Involving Roundhaul Netters and to the statement of a director of Tachiura Fishery Cooperative, safety activities carried out by fishery cooperatives and other organizations were as follows.

[1] Nagasaki Prefecture Roundhaul Fishery Cooperative

After the occurrence of two accident cases involving roundhaul netters in 1993, a model of safety operation manuals which roundhaul fishery operators should develop was created to be broadly distributed in January 1994 by Nagasaki Prefecture Roundhaul Fishery Cooperative, jointly with Western Japan Marine Accident Prevention Association.

The model manual consisted of elements such as safety operation management system, safety operation enhancement system, criteria for suspending fishing operation, safety operation measures, actions to be taken when an accident occurred, inspection checklist and education/training part. The manual also included preparations and precautions for sailing in adverse weather conditions.

Jointly with organizations like Seamen Disaster Prevention Association, the Cooperative also provided roundhaul fishery operators with marine accident prevention seminars containing curriculums like marine accident prevention, occupational accident prevention, and drills of jumping into the sea with a lifejacket on and boarding a liferaft, several times a year in several parts of the prefecture.

[2] Pelagic Roundhaul Fishery Cooperative of Japan

As part of the project to study safety measures for fishing vessels which was implemented by the Fisheries Agency, Pelagic Roundhaul Fishery Cooperative of Japan began studying measures to reduce the number of marine accidents like capsizing, collision and man-overboard involving large- and mid-sized roundhaul netters, and to improve their safety since fiscal 2003, and developed "Vessel Handling Guidance to Assist in Safety Operation" in November 2006, and distributed its copies to all of their members for the purpose of acquainting and educating them with the guidance.

[3] Nagasaki Prefecture Federation of Fishery Cooperatives

The safety activities by Nagasaki Prefecture Federation of Fishery Cooperatives were mainly focused on enhancing the wearing of a lifejacket. The Federation sent instruction documents and guidelines to member cooperatives in the prefecture, and made a tour of safety seminars for them.

[4] Fisheries Agency of Japan

A project to study safety measures for the operation of fishing vessels was implemented by Research and Technological Guidance Division at Resources Enhancement Promotion Department of the Fisheries Agency of Japan, National Research Institute of Fisheries Engineering, and Fishing Boat and System Engineering Association of Japan for the period between fiscal 2006 and 2008. They developed "Safety Operation Manual for Fishing Vessels" and "Safety Guide for the Operation of Fishing Vessels" in March 2009 for the purpose of preventing fishing vessels from capsizing while sailing or in fishing operation, and

distributed their copies to parties concerned with the fishing industry in Japan.

2.7 Information on Weather and Sea Conditions

2.7.1 Weather and Sea Conditions, Marine Warnings and Tidal Currents

- (1) Weather conditions, wind directions and wind speeds observed immediately before the accident occurred were as follows according to Hirado Special Regional Meteorological Station, Ojika Aeronautical Meteorological Station and Kamigoto Aeronautical Meteorological Station (Kashiraga Island), which were located 26.8 km east-northeast, 20.2 km southwest and 31.0 km south-southwest of the accident site, respectively.

Table

Time	Hirado	Ojika	Kashiraga
07:00	Shower rain N 6.4 m/s	NNE 10.8 m/s	NNE 11.1 m/s
08:00	Cloudy N 7.7 m/s	NNE 9.7 m/s	NNE 12.5 m/s

- (2) Waves observed immediately before the accident occurred were as follows according to the wave meter installed by Japan Meteorological Agency at Fukue Island, Goto City, Nagasaki Prefecture located 84.1 km southwest of the accident site.

Table

Time	Significant wave* ²¹		Maximum wave	
	Wave period (s)	Wave height (m)	Wave period (s)	Wave height (m)
07:00	5.4	1.87	5.5	2.75
08:00	6.0	1.97	4.8	3.65

- (3) On the day of the accident, a gale warning and fog warning had been issued for the sea west of Nagasaki Prefecture.

2.7.2 Analysis of Weather and Sea Conditions

- (1) According to the coastal wave analysis chart of Japan Meteorological Agency, the estimated wind and wave conditions at the accident site and Point S as indicated in the chart (in the Sea of Genkai, 34°15' N, 130°00' E) at the time of 09:00 on the day of the accident were as follows.

Accident site: Wave height (associated wave height*²²) about 2.5 m

Point S : Wind direction NNE, 28 kn (14.4 m/s)

Wave direction NNE, Wave period 6 seconds, Significant wave height 2.8 m

- (2) According to the analysis of Disaster Prevention Research Institute Kyoto University*²³, the estimated wind and wave conditions in the vicinity of the accident site at about 08:00 on the day

*²¹ "significant wave" refers to a wave with the mean wave height and wave period (significant wave height and significant wave period) of the highest one-third of waves in succession observed at a given point.

*²² "associated wave height" refers to a wave height obtained by combining the wave heights of rough seas and heaving seas.

*²³ "Analysis of Sea Conditions When Marine Accident Involving No.11 Daiei-maru Occurred" by Hajime Mase, Nobuto Mori, Masahiro Yasuda, Surflegend Inc., and Tracey Tom, made public on April 14, 2009 on the homepage of Disaster Prevention Research Institute Kyoto University.

of the accident were as follows.

Wind direction: NNE, Wind speed: 13 to 15 m/s

Wave direction: NNE to NE, Wave period: 4.7 to 5.0 seconds

Wavelength: 34 to 39 m, Wave height: 1.6 to 2.0 m

Wave speed: 7.3 to 7.8 m/s (14.2 to 15.2 kn)

(The phase velocity of the wave was $\frac{g}{2\pi} T \doteq 1.56 T$ (m/s)

(g : gravitational acceleration 9.8 m/s², T: Wave period (second))

2.7.3 Observation by Crew

According to the statements of the crew of the Vessel and the consort vessels, and to the ship's logbook of the consort vessels, observation by the crew was as follows.

(1) Weather and sea conditions in the port at the time of departure

Weather: Drizzle, Wind direction: NNE to N, Wind speed: about 10 m/s

Wave: None, Water temperature: about 16°

(2) Wind, waves and tidal currents after departure until reaching the vicinity of the accident site

Wind direction: NNE, Wind speed: 3 to 15 m/s (with a maximum instantaneous wind speed of about 17 m/s)

Wave direction: NNE to NE (quartering seas from diagonally back right), Wave height: about 2 to 3 m

Tidal currents: NE at a speed of about 0.9 kn

(3) Waves which were directly involved in the capsizing

Two or three waves were directly involved in the capsizing of the Vessel, and their wave heights were larger than the other waves (waves as mentioned in (2) above) observed in the sea area where the accident occurred.

The First Wave: Wave direction NNE to NE, Wave height about 3 to 4 m

The Second Wave: Wave direction N to NNE, Wave height about 4 to 5 m

The third wave: with a wave direction and a wave height similar to those of the waves observed in the sea area where the accident occurred

(4) Wind and waves immediately after the accident occurred

While the crew of the Vessel encountered several large waves after boarding liferafts, the crew on board No.1 encountered several large head waves after altering the course to north to north-northeast in the direction of the Vessel which had capsized to rescue the crew of the Vessel.

2.8 Phenomena Occurring in Following or Quartering Seas and Conditions for Occurrence

Phenomena occurring to a vessel while sailing in following or quartering seas, and conditions for their occurrence are as follows.

(1) Surf-riding and broaching

[1] Phenomena

When a vessel is situated on the steep forefront of a high wave in following or quartering sea conditions, the vessel can be accelerated to ride on the wave. In this situation, the external force of the wave will largely exceed the steering power and the steerability of the vessel will be extremely reduced, which will force the vessel into unstable condition

(surf-riding).

In this situation, the force of the quartering seas may force the vessel to turn sideways to the wave, and endanger it to capsizing as a result of unexpected large heeling in the direction of the wave (broaching).

[2] Conditions for the occurrence

In IMO's Revised Guidance to the Master for Avoiding Dangerous Situations in Adverse Weather and Sea Conditions^{*24} (hereinafter referred to as "Navigation Guidance in Adverse Weather Conditions"), conditions for the occurrence of surf-riding and broaching phenomena are shown in the following formula.

$$135^\circ < \alpha < 225^\circ$$

$$V > (1.8 \sqrt{L}) / \cos (180 - \alpha) \text{ (kn)}$$

α : angle of encounter when a dead astern is a bearing 180° relative

V : vessel's speed (kn)

L : waterline length (m)

(2) Reduction of stability when riding on a wave crest

[1] Phenomenon

When a vessel is riding on a wave crest amidships while the stern is in the wave trough, the breadth of the water plane of the stern becomes small as the water level goes down, and the stability will be reduced, since the cross section of the stern is tapering downward. Although this situation continues only for a moment under normal conditions, the duration of the situation becomes longer as the vessel speed comes closer to the wave speed, which may lead to the capsizing or heavy listing of the vessel.

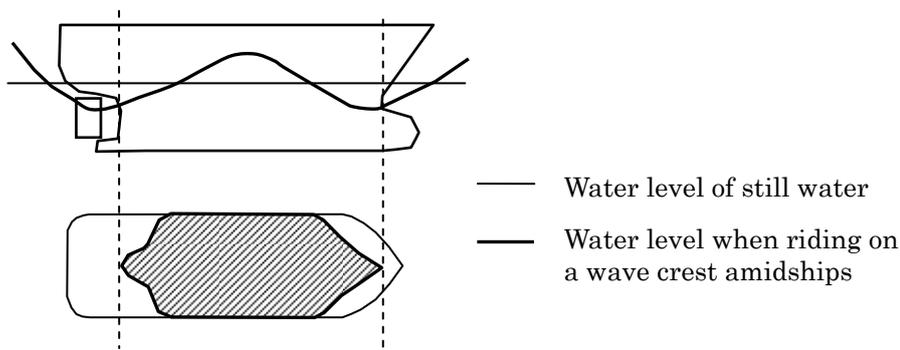
[2] Conditions for the occurrence

In Navigation Guidance in Adverse Weather Conditions, the following formula is shown to indicate conditions where the reduction of stability may occur when riding on a wave crest, in addition to while sailing in following or quartering seas.

$$0.6 L < \lambda < 2.3 L$$

L : waterline length (m)

λ : wavelength (m)



(3) Information on preventive measures against capsize and broaching

According to the research^{*25} conducted by National Research Institute of Fisheries

^{*24} "REVISED GUIDANCE TO THE MASTER FOR AVOIDING DANGEROUS SITUATIONS IN ADVERSE WEATHER AND SEA CONDITIONS" (MSC. 1/Circ. 1228 dated January 11, 2007) by International Maritime Organizations (IMO)

^{*25} Research Presentation at the 29th Fishing Vessel Research Presentation and Panel Discussion (Part 3):

Engineering, information on preventive measures against capsizing and broaching is as follows.

It is hard to prevent 135-ton type Roundhaul Net Boats from capsizing while sailing in beam, head or quartering sea conditions, even if they meet the stability and freeboard requirements provided for in the Regulations for Ship Stability and the Load Line Regulations. However, the danger of capsizing will be minimized if they can meet the stability requirements provided for in the IS Code or the Torremolinos International Convention^{*26}.

They will still be in a dangerous situation which may lead to broaching, if not capsizing, and one of the effective means to avoid broaching phenomenon is to maintain the Froude number^{*27} at 0.3 or less (equivalent in the formula of (1) [2]) in accordance with Navigation Guidance in Adverse Weather Conditions.

Since the design and construction condition of vessels of this class is close to the state of capsize boundary^{*28}, it should be considered that they may capsize once shifting of fishing gears or shortage of freeboard occurs while sailing in adverse weather conditions.

2.9 Information on Water Area Where the Accident Occurred

According to Kyushu coastal sailing directions published by the Japan Coast Guard, information on the water area where the accident occurred was as follows.

Hirado Island is located west of the Kita Matsuura Peninsula, and Ikitsuki Island is located north of Yobusaki at the northwest end of Hirado Island, while both of them are connected by Ikitsuki Bridge. Ikitsuki Port is on the east coast of Ikitsuki Island, and Ikitsuki Fishing Port is in the north of the port area while Tachiura Fishing Port is in the south of it.

The sea area along the west coast of Kyushu is an area where a low pressure tends to develop, and there are cases in which a serious marine accident occurs when a low pressure which was on a small scale the day before developed rapidly in a day.

Crew members on board the consort vessels stated as follows.

In the sea area surrounding Ikitsuki Island, dangerous waves tended to occur under the influence of tidal currents on the west side of the channel between Hirado Island and Ikitsuki Island, in the vicinity of the south end of Hirado Island and on the east side of the channel between Uku Island and Nozaki Island.

2.10 Medical Information

According to the statements and medical certificates of the crew on board the Vessel and the consort vessels, medical information was as follows.

Stability of a 135-Ton Type Round Haul Netter (net boat) by Naoya Umeda, Akihiko Matsuda and Shiro Suzuki at Fishing Vessel and Fisheries Machinery Research Group, Fisheries Technology Division at National Research Institute of Fisheries Engineering, which appeared in "Fishing Vessels No.337" published in October 1998.

^{*26} "Torremolinos Convention" refers to an international agreement reached at a conference held in Torremolinos, Spain, which provided for, as did the Conventions on Safety of Life at Sea (SOLAS), unified technical and safety standards for the construction of fishing vessels of 24 meters in length and over, and for their life saving and navigation equipment. The Convention was superseded by the Torremolinos Protocol adopted in April 1993 to encourage earlier ratification of the Convention. Japan has not ratified the Protocol yet.

^{*27} "Froude number" refers to a dimensionless number defined as the ratio of the inertial to gravity forces in a fluid. Expressed generally as V/\sqrt{gL} in which V is the speed (m/s), L is the waterline length (m) and g is 9.8 m/s², it is an important parameter with respect to the wave making resistance. When the unit of V is kn, the Froude number is expressed as $0.16 V/\sqrt{L}$.

^{*28} "capsize boundary" refers to stability requirements of a vessel sailing in adverse weather conditions, determining whether the vessel will capsize or not. In this case, it indicates a marginal vessel design which meets the IS Code requirements.

The accident occurred when the Vessel was leaving the port on the first day of the fishing period for April to May, after the vacation locally called “Tsukiyoma”, which covers days between the 14th and the 18th over the full moon day of each month of the lunar calendar., and most of the crew drove from inside of the town or from neighboring towns and parked their cars at the berth where the Vessel was moored, and boarded the Vessel at about 05:00 to 06:00 on that day.

The crew did not drink during the fishing period except after the operation or during holidays when they drank the alcoholic drinks brought by themselves on board the Vessel. Company A did not provide the Vessel with alcoholic drinks, either.

Neither the master nor the fishing chief took medicine on a regular basis.

2.11 Search and Rescue Activities, and Damage Reduction Measures

2.11.1 Development of Escape

According to the statements of the crew of the Vessel, the development of the escape from the Vessel was as follows.

(1) Positions of the crew before the accident occurred

The master, the fishing chief, the Chief, C/O and OS-A were engaged in steering and lookout in the wheelhouse.

OS-C and OS-I in charge of preparing meals were moving back and forth between the kitchen and the dining room, and while preparing for meals and washing dishes, they were chatting with crew members picking up their breakfast after finishing their departure work.

The chief engineer and 2/E were chatting with each other in the dining room after moving from the engine room. Seeing the chief engineer sending a text message to his family by his mobile phone, OS-I followed 2/E and moved to the fishing preparation section where mobile phone signals were expected to be strong enough. After sending a text message, the chief engineer went to the kitchen adjacent to the stern side of the dining room to throw trash away.

The three of OS-E, OS-H and OS-N were staying in the fore cabin on the starboard side of the aft accommodation space, taking a rest lying down in their bunks.

The two of OS-G and OS-L were staying in the aft cabin on the starboard side in the aft accommodation space, while OS-G was taking a rest in his bunk with the curtain closed, and OS-L was watching a video lying down in his bunk.

The three of OS-D, OS-F and OS-M were staying in the fore cabin on the port side of the aft accommodation space, taking a rest lying down in their bunks.

The two of 2/O and the wiper were staying in the aft cabin on the starboard side of the aft accommodation space, while 2/O was sitting on the floor near the entrance, talking with the wiper while eating a sandwich.

The two of OS-J and OS-K were staying in the aft cabin on the port side of the aft accommodation space, while OS-J was reading a weekly magazine lying down in his bunk, and OS-L was watching TV lying down in his bunk.

The position of OS-B was not confirmed in either his personal space in the aft cabin on the port side or other places.

(2) Situation during the time from starting the escape until escaping outboard

[1] Escape from the wheelhouse

Since the starboard list of the Vessel increased without restoring the stability, the fishing chief gave instructions to sound the emergency bell, and the Chief rushed out of the radio operating room and pushed the button of the emergency bell on the steering stand.

Soon after that, giving the Abandon Order on the public address system, the fishing chief instructed the Chief, C/O and OS-A remaining in the wheelhouse to get out.

Following OS-A, C/O escaped from the aft entrance on the port side of the wheelhouse to the weather deck (hereinafter referred to as “Embarkation Deck”). The Chief escaped after OS-A with the radar transponder placed near the entrance.

While two inflatable liferafts were installed on the port side of the Embarkation Deck, the Chief stood in front of the fore liferaft (hereinafter referred to as “Liferaft A”), and OS-A stood on the stern side of the aft liferaft (hereinafter referred to as “Liferaft B”), and C/O stood in front of it. The three of them tried to release the inflatable liferafts from their containers to drop them onto the sea. Although the Chief succeeded in releasing the Liferaft A from the container, the Liferaft A did not roll down the rail along which it was supposed to descend because of the large starboard list of the Vessel. While C/O remained unable to release the Liferaft B, the Vessel capsized and the Chief and C/O fell overboard.

[2] Escape from the kitchen and the fishing preparation section

When the chief engineer went to the kitchen to throw garbage away, and OS-I came to the fishing preparation section, the Vessel listed largely to starboard.

Calling out to 2/E to move toward the bow, OS-I walked toward the fore entrance (hereinafter referred to as “Fore Entrance”), and urged the chief engineer to escape when meeting him in the kitchen.

The chief engineer, OS-I and 2/E walked toward the Fore Entrance, followed by OS-B and OS-L who came up the stairs from the aft accommodation space (hereinafter referred to as “Center Stairs”).

The crew who were in the dining room, kitchen or fishing preparation section on the upper deck did not hear the emergency bell and the Abandon Order coming from the aft accommodation space because of the noise in the engine room.

While the chief engineer was looking out and standing by near the Fore Entrance, OS-I followed OS-L and went out of the Fore Entrance to go on the fore deck, and held onto the handrail along the stairs leading to the Embarkation Deck located just on the port side of the entrance (hereinafter referred to as “Port Side Stairs”).

2/E went down to the fore accommodation space, and the chief engineer closed the Fore Entrance door because large waves were flooding in from the broadside on the starboard.

When the chief engineer was about to escape before being hit by the next wave, OS-B came near under the stairs in the dining room leading to the wheelhouse (hereinafter referred to as “Wheelhouse Stairs”).

Escaping to the fore deck, the chief engineer moved toward the starboard side as OS-I and OS-L were near the Port Side Stairs. At that moment, he was carried away by the wave which flooded in, and shortly after that, the Vessel capsized.

[3] Escape from the aft accommodation space

2/O, OS-J, OS-K, OS-L, OS-M and OS-N felt that the Vessel had reduced the speed and turned to starboard, and that the starboard list of the Vessel was becoming larger.

Getting out of their room, OS-L, OS-B, OS-J, 2/O and the chief engineer went along the passageway toward the bow in that order, and started going up the Center Stairs.

Almost at the same time as the emergency bell sounded, the fishing chief gave the Abandon Order on the public address system.

OS-M saw OS-D putting out his head out of the bunk curtain, OS-F, OS-M, OS-N and

OS-K went up the Center Stairs in that order following the chief engineer, and OS-N passed OS-B halfway up the stairs.

OS-L picked up a lifejacket and wore it at the place for lifejackets (hereinafter referred to as “Place for Lifejackets”) located at the top of the Center Stairs. When coming near to the Fore Entrance with OS-I, OS-L saw OS-B coming near to the Wheelhouse Stairs and escaped, and held onto the handrail along the Port Side Stairs with OS-I.

When opening a little the aft entrance door of the fishing preparation section (hereinafter referred to as “Aft Entrance”), OS-J found that the broadside on the starboard had been flooded with sea water about one meter deep, and closed the door immediately. However, because the list of the Vessel became even larger, he opened the door again, and after getting on the aft deck, he jumped into the sea on the starboard side, and swam straight ahead.

Seeing OS-J close the Aft Entrance door of the fishing preparation section, 2/O thought that he would not be able to escape from the Aft Entrance, moved toward the bow and escaped from the Fore Entrance. At that precise moment, the Vessel capsized.

Picking up a lifejacket and wearing it at the Place for Lifejackets, OS-M passed by the kitchen where the starboard list had increased, and passing through the dining room which had listed almost 90° and had been flooded with sea water too deep for his feet to reach the floor, he escaped from the Fore Entrance. Almost at the same time, the Vessel capsized.

Picking up a lifejacket at the Place for Lifejackets, OS-N proceeded while pressing the starboard side wall of the kitchen where the starboard list had increased, and after seeing ahead OS-M going toward the Fore Entrance, he entered the dining room. While proceeding in the dining room flooded with sea water up to the height of his face from the halfway point, OS-N released the lifejacket from his hand as it was caught in the Fore Entrance door when it was closed, and somehow managed to open the door and escape. Almost at the same time, the Vessel capsized.

Seeing OS-F standing at the top of the Center Stairs, OS-K picked up a lifejacket at the Place for Lifejackets, and got on the aft deck from the Aft Entrance. OS-K found that the Vessel had listed nearly 90° to starboard and that the aft deck had been flooded with sea water up to the breadth of one-third of the beam, and when seeing OS-J swimming away from the Vessel, he went up the fishing nets on the aft deck toward the port side, and at the precise moment that he caught a thin wire called “Aba Star” (Float Star) installed on the port broadside, the Vessel capsized.

The situation after the escape as mentioned in (1) and (2) above was confirmed with the master, fishing chief and OS-A who were in the wheelhouse, 2/E and OS-C who were in the kitchen or the fishing preparation section, and OS-B, OS-D, OS-E, OS-F, OS-G, OS-H and the wiper who were in the aft accommodation space.

(3) Development after escaping outboard and falling overboard

[1] Situation of the crew who escaped and the liferafts

The 10 crew members consisting of the chief engineer, the Chief, C/O, 2/O, OS-I, OS-J, OS-K, OS-L, OS-M and OS-N fell overboard into the sea just under or on the right side of the capsized Vessel, and rose to the sea surface on the right. After rising to the sea surface, 2/O wore the non-inflatable lifejacket placed over the shoulder.

The Liferaft A inflated properly and rose to the sea surface near the starboard bow of

the capsized Vessel, while articles like floats, boards and ropes loaded on the Vessel were floating near the right center section of the capsized Vessel. Although the Vessel turned to starboard under the influence of the wind and waves, the Liferaft A and the floating articles like floats moved while maintaining their position to the right of the Vessel.

Immediately before the Vessel foundered, the Liferaft B rose to the sea surface near the starboard quarter of the Vessel, and inflated in a state of capsizing.

[2] Boarding the Liferaft A

The Chief, C/O, the chief engineer, OS-I, OS-J, 2/E, OS-M and OS-N swam to the Liferaft A and boarded it.

(See Figure 7: Development of Escape)

2.11.2 Escape Test

On June 10, 2009, marine accident investigators conducted a fast-walk escape test on board No.23 at anchor, which was designed so that facilities like the wheelhouse, accommodation space, passageway and entrances were arranged almost in the same way as in the Vessel. As a result, the length of time required for each escape case was as follows.

From the wheelhouse to the Embarkation Deck: 5 seconds

From the aft accommodation space (aft) to the fore deck: 19 seconds

From the aft accommodation space (aft) to the aft deck: 14 seconds

From the engine room (amidships) to the fore deck: 14 seconds

From the fore accommodation space (amidships) to the fore deck: 11 seconds

2.11 3 Development of Search and Rescue Activities

(1) Search and rescue activities by the consort vessels

The master, the head and a radio operator of No.1, the master, the head, a radio operator and an ordinary seaman of No.8, the master of No.18, and the master, the fishing chief, the chief radio operator, the chief officer and the second officer of No.23 stated as follows.

The master of No.1 and the ordinary seaman on watch duty of No.8 visually noticed that the Vessel was turning to starboard while listing largely to starboard, and when the masters of both vessels were communicating by radio about the situation of the Vessel, the Vessel capsized about 45° and 0.5 to 0.6 M to the right of No.1, and about 1.0 M to the left of No.8.

While the head of No.1 went on the bridge and took over the steering from the master, while the master of No.8 took over the steering from the ordinary seaman on watch duty and decided to go immediately to the Vessel.

Seeing the abnormal condition of the Vessel with binoculars, the chief officer of No.23 reported it to the master, and went downstairs to report it to the fishing chief. The fishing chief went on the bridge immediately, and after seeing that the Vessel had capsized showing the bottom, he instructed the four other consort vessels of the Fleet of No.23 by radio all at once to go to the rescue of the Vessel, and also instructed the Fleet of the Vessel to tune their radios to the frequency of No.23.

In two to three minutes, No.1 arrived at the vicinity of the Vessel first of all.

Finding it hard to make a port turn by steering sharply because of the stormy sea conditions, No.8 steered 15° to port to proceed at a speed of about 12 kn, and arrived at the vicinity of the accident site a few minutes after the Vessel capsized.

The head of No.1 and the master of No.8 found the crew members of the Vessel who were

about to board the Liferaft A and the other crew members of the Vessel who were afloat holding onto articles like floats and boards on the sea.

No.23 arrived at the accident site following No.1, No.8, No.2, No.18 and No.15, and when being informed by No.1 and No.8 that several crew members of the Vessel were on board the Liferaft A and that other two crew members of the Vessel (OS-K and OS-L) were swimming, the fishing chief instructed No.1 to rescue the two swimming crew members, and No.8 to rescue the crew on board the liferaft.

No.23 stopped on the southwest of the Vessel while sailing around from the port side of the Vessel, No.1 and No.8, and after positioning No.2 between No.23 and the Vessel, No.23 prepared to rescue anyone rising to the sea surface at any time.

Intending to pull up the two swimming crew members from the port side, No.1 directed the bow toward northeast and approached them, while the radio operator of No.1 jumped down on the part overhanging from the broadside and rescued them after pulling them toward him.

While No.1 continued searching at a location close to the Vessel, the Vessel sank almost vertically from the bow raising a lot of bubbles from under the sea, and the Liferaft B rose to the sea surface while the Liferaft A came drifting to No.1.

The master of No.8 put the starboard side along the Liferaft A and pulled up eight crew members of the Vessel, and tried to pull up the Liferaft A next. However, judging that it would take time because of its heaviness, he gave up pulling it up.

On the instructions of the fishing chief of No.23, No.1 and No.8 proceeded to Tachiura Fishing Port to take back with them the crew members of the Vessel who were shivering with cold and emotionally disturbed.

Although the consort vessels continued their searching activities in the sea area surrounding the accident site until May 31, they were unable to find other than the 10 crew members of the Vessel whom they rescued immediately after the accident occurred.

(2) Search and rescue activities by search and rescue organizations and fishing vessels in the neighborhood

According to the Japan Coast Guard and Nagasaki Prefecture, their search and rescue activities were as follows.

At 08:11 and 08:26 on the day of the accident, the master of No.38 notified the Operations Center at the 7th Regional Coast Guard Headquarters (hereinafter referred to as “7th Headquarters”) that an accident had occurred by calling the marine emergency call number of 118. At 08:15, Company A requested Hirado Coast Guard Office for a rescue operation.

The 7th Headquarters immediately dispatched patrol vessels and aircraft, and at 08:40, established the marine accident emergency response headquarters for the foundered fishing vessel Daiei-maru No.11 at the 7th Headquarters, and the local marine accident emergency response headquarters for the foundered fishing vessel Daiei-maru No.11 at Sasebo Coast Guard Office. At 09:13, the 7th Headquarters requested Chief of Sasebo District Headquarters of the Maritime Self Defense Force for a disaster relief operation, and the Maritime Self Defense Force immediately dispatched vessels and aircraft.

Nagasaki Prefecture, on the other hand, established the special serious disaster emergency response headquarters at 09:45 while Hirado City established both the emergency response headquarters and the local headquarters, and dispatched fishery patrol vessels and fishing vessels belonging to Tachiura Fisheries Cooperative. Afterward, the local joint emergency response headquarters for the accident involving Daiei-maru No.11 was established at Tachiura

Fisheries Cooperative by Nagasaki Prefecture, Hirado City, Tachiura Fisheries Cooperative and Company A, and organized the system for search and rescue activities, and for communicating and coordinating with parties concerned.

No crew members of the Vessel were found by the search and rescue activities conducted on the day of the accident with the participation of eight patrol vessels, four aircraft, six special rescue team members and two national strike team members from the Japan Coast Guard, seven surface vessels and three aircraft from the Maritime Self Defense Force, six fishery patrol vessels from the Fisheries Agency, three fishery patrol vessels and a disaster prevention helicopter from Nagasaki Prefecture and 19 fishing vessels including the consort vessels. The Liferafts A and B of the Vessel were collected by a patrol vessel of the Japan Coast Guard.

On April 15, a day after the accident occurred, the search activities continued with the participation of a patrol vessel and an aircraft from the Police Department of Nagasaki Prefecture (hereinafter referred to as “Prefectural Police”) as well as a vessel from Marine Rescue Nagasaki Prefecture.

On April 27, the exclusive search by the Japan Coast Guard was discontinued while the Maritime Self Defense Force was requested to withdraw the disaster relief operation. The breakdown of the total number of the forces participating in the search activities for 14 days from April 14 until April 27 was 79 patrol vessels, 27 aircraft, 12 special rescue team members, 2 helicopter rescue divers and 8 national strike team members from the Japan Coast Guard, 83 vessels and 26 aircraft from the Maritime Self Defense Force, 77 fishery patrol vessels from the Fisheries Agency, 39 fishery patrol vessels from Nagasaki Prefecture, 13 patrol vessels, 9 helicopters and 12 disaster prevention helicopters from the Prefectural Police, 182 consort vessels and about 140 vessels from Marine Rescue Nagasaki Prefecture.

On May 3, the local joint emergency response headquarters for the accident involving Daiei-maru No.11 was dissolved and the exclusive search by Nagasaki Prefecture’s fishery patrol vessels was discontinued, while the search by the four consort vessels was continued.

On May 4, Nagasaki Prefecture changed the special serious disaster emergency response headquarters to the accident response intra-office liaison meeting.

The search activities were conducted for 21 days between April 14, the day when the accident occurred, and May 4, and ended up without finding any crew members of the Vessel.

(3) Search and investigation when the Vessel was salvaged

On September 24, 2009, the Vessel was salvaged and placed on a barge. During the period between September 26 and 30, the Japan Coast Guard searched the Vessel for the missing crew members, and as a result, found the bodies of 11 crew members of the Vessel. According to the Japan Coast Guard, information on where they were found and whether or not they wore a lifejacket when they were found was as follows.

	Location where crew members were found	Lifejacket worn or not
Master	On the starboard console in the bridge	No
Fishing chief	In the radio operating room at the rear of the bridge	No
2/E	Under the stairs in the fore accommodation space	No
OS-A	Under the starboard console in the bridge	No

OS-B	Near the entrance of the aft accommodation space (on the port bow)	No
OS-C	In a bed on the port quarter in the aft accommodation space (on the port bow)	Yes
OS-D	Beside the switchboard in the engine room	No
OS-E	Near the entrance of the aft accommodation space (on the starboard quarter)	Yes
OS-F	In a bed on the port quarter in the aft accommodation space (on the port quarter)	Yes
OS-G	Under the Center Stairs in the aft accommodation space	Yes
Wiper	Under the Center Stairs in the aft accommodation space	Yes

OS-H went missing.

2.11.4 Situation of Life Saving Equipment

(1) EPIRB (Emergency Position Indicating Radio Beacon)

The following was stated in the written reply of the Japan Coast Guard.

The EPIRB, stowed at the rear on the port side under the canopy of the wheelhouse, was designed to rise to the surface automatically from water at a depth of 4 m to transmit signals informing the location of the Vessel. However, no signals carrying such location information were received after the accident occurred, and when the Vessel was salvaged, the EPIRB was found with its antenna caught in a grating^{*29} near the entrance of the fore hold.

The EPIRB sustained a large crack on three sides of the housing, and more than half of the surface area on one of the three sides dropped out in fragments, causing the inner part of the EPIRB to be exposed. The fragments which had dropped out were found near the EPIRB.

On the occasion of the periodical inspection of the Vessel, the EPIRB stowed on the Vessel was provided maintenance on June 26, 2007 at a maintenance service station approved by the Minister of Land, Infrastructure, Transport and Tourism.

(2) Inflatable liferafts

The crew of the Vessel and No.1 stated as follows.

The Liferaft A inflated normally and rose to the sea surface immediately after the Vessel capsized, while the Liferaft B rose to the sea surface immediately before the Vessel foundered, and inflated in a state of capsizing.

On the occasion of the periodical survey of the Vessel, the Liferaft A, manufactured in May 2007 with a capacity of 15 persons on board, was newly stowed on the port bow of the Embarkation Deck together with the automatic release device.

On the other hand, the Liferaft B, manufactured in February 1989 with a capacity of 15 persons on board, was provide maintenance, on August 1, 2007, the periodical survey day for the Vessel, at a maintenance service station approved by the Minister of Land, Infrastructure, Transport and Tourism, together with the automatic release device, and was stowed on the port quarter of the Embarkation Deck.

2.12 Environmental Impact by Spillage of Oil and Its Removal

^{*29} "grating" refers to a framework of metal bars in the form of a grille set into a floorboard, footboard, etc.

The crew of the Vessel, the masters of No.1 and No.8 and the written replies of the Japan Coast Guard and Company B sated as follows.

The Vessel left port with about 50 tons of fuel oil A^{*30}. When the Vessel capsized, several crew members who rose to the sea surface saw fuel oil floating and smelled it while OS-L swallowed a little of it.

When No.8 arrived at the vicinity where the Vessel capsized, fuel oil A and other oil with high viscosity were floating in small amount. Fuel oil A gushed out after the Vessel foundered.

The Japan Coast Guard observed the development of the floating oil closely with their vessels and aircraft nine times in total for the period between April 15 and 18 with two or three times a day.

At the ninth observation conducted at 09:15 on April 15, the Japan Coast Guard confirmed that the area of the floating oil had become the broadest, extending over the length about 3 M from south-southwest to north-northeast, and over the width which was 5 m wide at near the gushing point and 50 m wide at the end, while the color tone^{*31} of the area within 20 m of the gushing point was Color C, the color tone of the area beyond 20 m from the gushing point to the end was Color D or Color E, and the end of the floating oil had dispersed and disappeared under the influence of the wind and waves.

Since that day, the amount of the floating oil was on the decrease although there were some fluctuations each time observed. During the observation conducted between 17:00 and 18:55 on April 18, the Japan Coast Guard confirmed that no oil was gushing out and that there was a floating oil with the color tone of Color E or vaguer in an area of ten percent within a circle of 50 m radius centered on about 100 m south of the location where the Vessel foundered. With that confirmation, they completed their observation.

No.1 and No.8 carried out oil prevention work between April 15 and May 7,.

After the Vessel was salvaged, it was found that the amount of a mixture of oil and water collected from inside the Vessel was about 29.6 kl.

2.13 Laws and Ordinances Related to Roundhaul Netters

(1) Fishery Act

It is prescribed in the Fishery Act that large- and medium-scale roundhaul fishery^{*32} is a designated fishery^{*33}, and shall obtain permission or approval of business commencement of the designated fishery from the Agriculture, Forestry and Fisheries Minister for protecting the reproduction of aquatic animals and plants and for fisheries adjustment. The following are excerpts from Article 59 of the Act in which there is a special provision with respect to

^{*30} “fuel oil A” refers to one of the many oil types classified in Japan according to its taxation system, which shares almost similar ingredients with light oil used as fuel of diesel cars. Although fuel oil A is dark in its appearance while light oil is colorless and transparent, it is hard to distinguish them by the differences in color, smell or viscosity.

^{*31} “color tone” refers to a precise color of oil floating on the sea surface, serving as an indicator for estimating the thickness of an oil film or an oil stratum. Color C means a state in which the surface of an oil film is iridescent with a thickness of 0.0003mm, appearing clearly taking the shape of a bright brown belt on the sea. Color D means a state in which the surface of an oil film is gray with a thickness of 0.00015 mm, appearing slightly brown-colored. Color E means a state in which the surface of an oil film, 0.0001 mm thick, glitters like silver, while the color tones not falling under these categories refer to a state of an oil film with a thickness of 0.00005mm, to be barely seen glittering on the sea only when the condition of light is the best.

^{*32} “large- and medium-scale roundhaul fishery” refers to a designated fishery prescribed in a Cabinet Order as specified in paragraph (i) of Article 52 of the Fishery Act. A roundhaul fishery operated by a powered fishing boat with a gross tonnage of 40 tons (15 tons in the case of a fishery in North Pacific Ocean Sea-area) or more comes under this category.

^{*33} “designated fishery” refers to a fishery to be operated with permission of the Agriculture, Forestry and Fisheries Minister.

permission or approval (permission or approval of the designated fishery when an application has been filed for using another boat like a newly constructed boat to replace the boat already granted permission), and from Article 61 in which there is a provision with respect to permission of change (such as an increase of the gross tonnage of the boat already granted permission).

(Special Provision for Permission.)

Article 59 In the case where an application falls under any of the following items, if the contents of the application are identical with the contents of the previously granted permission or approval of business commencement, permission or approval of business commencement of the said designated fishery shall be granted except for the case where the application falls under any of the respective items of paragraph (1), Article 56.

(i) In the case where a person granted permission for a designated fishery has discontinued the use of the boat granted permission (omitted) and has filed an application for permission or approval of business commencement with respect to another ship

(ii) In the case where a person granted permission of a designated fishery has filed an application for permission or approval of business commencement with respect to another boat, since the boat granted permission was lost or sank, and where the application has been filed within six months from the day of losing or sinking

(iii) In the case where a person who has accepted or borrowed or has been returned a boat from a person granted permission of a designated fishery, or has acquired the right to use the said boat and is going to operate the said designated fishery, has filed an application for permission or approval of business commencement of the said designated fishery with respect to the said boat

(iv) (omitted)

(Permission of Change)

Article 61 When a person (omitted) is going to increase the gross tonnage of the boat (omitted) granted permission or approval of business commencement (omitted), he/she shall be granted permission of the Agriculture, Forestry and Fisheries Minister.

(2) Handling policy with respect to permission of large- and medium-scale roundhaul fishery

On the occasion of the comprehensive permission renewal^{*34}, the Fisheries Agency is to establish or revise “Handling Policy With Respect to Permission of Large- and Medium-Scale Roundhaul Fishery” (the policy currently in force is established on July 30, 2007, and is hereinafter referred to as “Current Policy”) as a policy when putting into practice the applicable provisions in Article 59 and Article 61 of the Fishery Act.

For the purpose of protecting aquatic animals and plants and ensuring fisheries adjustment, the following is provided for in the Current Policy; the upper and lower limits of the gross tonnage of another boat (like a newly constructed boat) to replace the boat already granted permission; the upper and lower limits of the gross tonnage when the size of such a newly constructed boat becomes larger; and the limit of the tonnage to fill the unused tonnage which may arise from the discontinued usage of the boat already granted permission.

^{*34} “comprehensive permission renewal” refers to the action by the Fisheries Agency with respect to 5-year term permission of designated fisheries, where the Agency reviews applicable regulations while making public the total number of the boats granted permission per designated fishery type, and renew those licenses all at once when their permission validity expires. After the Heisei period which started in 1989, the comprehensive permission renewal was implemented on years when the last digit of the Heisei year was 4 or 9. The latest year when it was implemented was Heisei 19 (2007), and the next will be Heisei 24 (2012).

The fishing area specified for the Vessel is East Sea / Yellow Sea Sea-area or North Pacific Ocean Sea-area, and if the Vessel is to be replaced by another boat (like a newly constructed boat), the gross tonnage of such a boat should be within 135 tons, because the limit of the tonnage of the Vessel is specified as 135 tons in Article 3 of the Current Policy.

The following is an excerpt from “Handling Policy With Respect to Permission of Large- and Medium-Scale Roundhaul Fishery” (established on July 30, 2007).

Paragraph 1, Paragraph 2 (omitted)

(Upper Limit of the Gross Tonnage of a Boat)

Paragraph 3 With respect to permission or approval of business commencement as prescribed in Article 59 or Article 61 of the Act, in the case where provisions of Paragraph 4 to Paragraph 8 are applied, the gross tonnage of a boat pursuant to the said permission or approval shall not exceed the gross tonnage for each Sea-area as specified in the table below in relation to the fishing area of the boat.

<i>Sea-area</i>	<i>Boat under new tonnage system</i>	<i>Boat under old tonnage system</i>
<i>North Pacific Ocean Sea-area</i>		
<i>(1) (omitted)</i>	<i>47 tons</i>	<i>39.99 tons</i>
<i>(2) (omitted)</i>	<i>350</i>	<i>499.99</i>
<i>(3) (omitted)</i>	<i>135</i>	<i>99.99</i>
<i>(4) (omitted)</i>	<i>100</i>	<i>79.99</i>
<i>Central Japan Pacific Ocean Sea-area</i>	<i>135</i>	<i>99.99</i>
<i>South Japan Pacific Ocean Sea-area</i>	<i>80</i>	<i>59.99</i>
<i>North Japan Sea Sea-area</i>	<i>135</i>	<i>99.99</i>
<i>Central Japan Sea Sea-area</i>	<i>135</i>	<i>99.99</i>
<i>West Japan Sea Sea-area</i>	<i>135</i>	<i>99.99</i>
<i>West of Kyushu Sea-area</i>	<i>80</i>	<i>99.99</i>
<i>East Sea / Yellow Sea Sea-area</i>	<i>135</i>	<i>99.99</i>
<i>Central Pacific Ocean Sea-area</i>	<i>760</i>	<i>999.99</i>
<i>Indian Ocean Sea-area</i>	<i>350</i>	<i>999.99</i>

Remarks: The Sea-areas shown in the table are the Sea-areas shown in the Appended Table 2. Paragraph 4 to Paragraph 13 (omitted)
Appended Table 1 to Appended Table 4 (omitted)

2.14 Other Relevant Information

After the accident, payment of the fishing boat owners liability insurance under the fishing boat insurance scheme was discussed by organizations like the Fisheries Agency and the Central Society of Fishing Vessel Insurance Association, and according to their conclusion that the foundered Vessel came under the scope of disposal of vessels provided for in Article 43 of the Act on Prevention of Marine Pollution and Maritime Disaster, the insurance was paid for the salvage of the Vessel.

3 ANALYSIS

3.1 Situation of the Accident Occurrence

3.1.1 Course of the Events Leading to the Occurrence of the Accident

According to 2.1, it is probable that the course of the events leading to the occurrence of the accident was as follows.

(1) Course of the events leading to the capsizing

At about 07:15, April 14, 2009, the Vessel, boarded by the master, fishing chief and 20 other crew members, forming a group of 10 vessels consisting of two fleets, departed from Tachiura Fishing Port for the fishing ground in the East China Sea.

About three minutes after leaving shore, the Vessel passed under Ikitsuki Bridge and proceeded toward west-southwest at a speed of about 12 to 13 kn.

At about 08:03, the Vessel altered the course about 1° to 2° to port, proceeded straight ahead, and reduced the speed. After that, the Vessel increased the speed and turned to starboard, and when the bow was directed toward north-northeast to northeast, the Vessel capsized.

(2) Course of the events leading to the foundering

After capsizing, the Vessel sank gradually from the bow, and foundered about 25 minutes later.

3.1.2 Time, Date and Location Where the Vessel Capsized and Foundered

According to 2.1, it is probable that the Vessel capsized at about 08:05, April 14, 2009, at the location about 243°, 9.1 M from Ikitsuki Bridge Center Light (approximately 33°17.0'N, 129°16.6' E), and foundered at about 08:30 near the location of the capsizing.

3.1.3 Situation of the Accident Occurrence

According to 2.1 and 2.5.2 (2), it is probable that the situation when the Vessel capsized (See Figure 4) and foundered was as follows.

(1) Situation of the capsizing

When the crest of the First Wave coming from north-northeast to northeast approached the stern of the Vessel, the stern was lifted up, and when the stern was overtaken by the crest of the First Wave, it was hit by wave splashes, which caused the Vessel to list to port for a few seconds.

A few seconds after being overtaken by the First Wave, the Vessel was hit on the stern by the Second Wave coming from north to north-northeast, and sea water flooded in on the aft deck. About 15 seconds after that, the Vessel listed largely to starboard while being overtaken by the crest of the Second Wave, and accelerated the go-ahead speed and put the helm hard to starboard.

Increasing the angle of starboard list as if sliding down the slope on the back of the Second Wave, the Vessel listed more than 23° to starboard where the top of the starboard bulwark sank under the sea.

When the Vessel turned almost 180°, the angle of starboard list became about 90°, and about a minute after going over the crest of the Second Wave, the Vessel capsized.

(2) Situation of the foundering

When the Vessel capsized, the bow of the Vessel was directed toward north-northeast to

northeast, and the propeller was rotating while entangled with the ropes floating on the sea which had dropped from the Vessel at the time of capsizing. However, as the rotation of the propeller came to a stop, the Vessel sank gradually from the bow, turning to starboard under the influence of the wind and waves coming from north-northeast, and foundered almost in a vertical attitude while directing the bow toward south-southwest to southwest.

3.1.4 Situation of the Injured

According to 2.2, it is analyzed as follows.

It is highly probable that the master, fishing chief, 2/E, OS-A, OS-B, OS-C, OS-D, OS-E, OS-F and OS-G and the wiper died from drowning.

OS-H was removed from the register after he went missing.

The chief engineer, Chief, C/O, 2/O, OS-I, OS-J, OS-K, OS-L, OS-M and OS-N sustained disorders like sleeplessness and lethargy. It is probable that eight out of these 10 crew members became feverish, while two of the eight suffered from pneumonia, and one crew member sustained a dislocation of the finger.

3.1.5 Situation of the Damage

According to 2.1.1 (3), 2.1.3 and 2.3, it is analyzed as follows.

It is highly probable that the four pillars in the aft accommodation space located between No.7 fuel tanks on both sides under the upper deck were bent, because the fuel tanks were dented under the influence of the water pressure during the time from when the Vessel foundered and when grounded on the seabed, while the wall surface of the spare tank in the engine room was dented, cathode-ray tubes of the navigation equipment were ruptured, and the main and auxiliary engines as well as the electric equipment sustained wet damage.

It is highly probable that the fashion plate at the bow, its stiffeners and appendages were bent, and the main mast was folded under self-weight when the Vessel grounded on the seabed.

3.2 Causal Factors of the Accident

3.2.1 Situation of the Crew

According to 2.4 (1), the master, fishing chief and C/O held a legal and valid seaman's competency certificate, and the Chief held a legal and valid radio operator certificate.

According to 2.4 (2), it is probable that the master, fishing chief, Chief and C/O had proper eyesight and hearing ability, and they were in good health condition.

3.2.2 Situation of the Vessel

- (1) According to 2.5.3 (1), it is probable that the entrance door of the fore hold, inner hatch of the fore hold, Fore Entrance door, Aft Entrance door and aft entrance door on the port side of the wheelhouse were left open immediately before the Vessel capsized.
- (2) According to 2.5.3 (2), it is probable that the rudder angle was 32° to starboard, the revolution of the main engine was 610 rpm, and the blade angle was 22° ahead immediately before the Vessel capsized.
- (3) According to 2.5.3 (3), it is probable that there was no failure or trouble with the hull, engine and the equipment of the Vessel when the accident occurred.
- (4) According to 2.5.4, it is certain that the Vessel was compatible with the criteria provided for in the Regulations for Ship Stability before they were revised in October 2008.

3.2.3 Analysis of Roundhaul Net Boats

- (1) According to 2.5.5, it is considered that Roundhaul Net Boats are inferior to light boats and fish carriers in stability while sailing in adverse weather conditions, because they are loaded with nets which are heavy and liable to shift, a large amount of sea water is liable to be trapped due to their structural and arrangement characteristics, and they have a high center of gravity.
- (2) According to 2.5.6 (2), it is probable that 135-ton type Roundhaul Net Boats including the Vessel have a smaller angle of heel where the maximum righting arm is generated and a smaller range of stability than light boats and fish carriers, because they tend to get thin-shaped as their registered length and registered breadth become larger while their gross tonnage is fixed.

3.2.4 Weather and Sea Conditions

According to 2.7, it is probable that the weather and sea conditions were as follows.

(1) Weather and sea conditions

[1] At the time of departure (at about 07:15)

Weather: Drizzle, Wind direction: N to NNE, Wind speed: about 10 m/s

Wave: None, Visibility: 1M or more, Water temperature: about 16°

[2] Sea area where the accident occurred (at about 08:05)

Weather: cloudy, Wind direction: NNE, Wind speed: about 13 to 15 m/s

Tidal currents: NE at a speed of about 0.9 kn

(2) Waves in the sea area where the accident occurred

[1] Waves in the sea area where the accident occurred before and after the occurrence

Wave direction: NNE to NE, Wave height: about 2 to 3 m

Wave period: 4.7 to 5.0 seconds, Wavelength: 34 to 39 m

Wave speed: 7.3 to 7.8 m/s (14.2 to 15.2 kn)

[2] Wave direction and wave height directly involved in the capsizing

The First Wave: Wave direction NNE to NE, Wave height about 3 to 4 m

The Second Wave: Wave direction N to NNE, Wave height about 4 to 5 m

The third wave: similar to those of [1] above

(3) On the day of the accident, a gale warning and fog warning had been issued for the sea west of Nagasaki Prefecture.

3.2.5 Situation of Steering

According to 2.1, 2.5.3 (2), 2.6.1 and 3.2.2 (2), it is analyzed as follows.

It is probable that when the accident occurred, the master was steering the Vessel under the supervision of the fishing chief while, in the wheelhouse, the fishing chief was stationed on the starboard side, the master in front of the steering stand, C/O in the front of the port side, OS-A at the rear of the port side and the Chief in the radio operating room.

It is probable that the master steered a little to port when seeing the First Wave on the starboard quarter, and reduced the speed before the Vessel was overtaken by the First Wave, and as the fishing chief gave an order of go ahead and hard starboard when the Vessel listed to starboard after being overtaken by the crest of the Second Wave, the master steered to an blade angle of 22° ahead and put the helm hard to starboard (about 35° to starboard).

3.2.6 Capsize of the Vessel

(1) Relevance to the course, speed and waves when the accident occurred

According to 2.1.1, 2.1.2, 2.5.2, 2.5.7, 2.7.2 (2), 2.8, 3.1.1, 3.2.2 (2), 3.2.4 (1) [2], and 3.2.4 (2), it is analyzed as follows.

[1] Course and speed of No.1 and No.8

According to the findings that the distance traveled by No.1 between the position at 07:30 and the position at 08:00 was about 6.2 M, it is probable that the speed and the course of No.1 was about 12.4 kn and about 248°, respectively.

According to the findings that the distance traveled by No.8 between the position at 07:41 and the position at 08:00 was about 3.7 M, it is probable that the speed and the course of No.8 was about 11.7 kn and about 246°, respectively.

[2] Course and speed of the Vessel

According to the findings that the Vessel altered the course about 1° to 2° to port before capsizing, it is probable that although the Vessel took almost the same course as No.1 and No.8, the course of the Vessel before capsizing was about 244° to 247°.

According to the findings that the Vessel was proceeding about 0.5 to 0.6 M ahead of No.1 and about 45° to the right of No.1 immediately after the Vessel capsized, and the distance of travel between 07:30 and 08:00 was about 6.6 M, which was about 0.4 M longer than No.1, it is probable that the average speed of the Vessel was about 13.2 kn.

At the sea trial, the Vessel recorded the speed of 13.82 kn at an engine revolution of 610 rpm, at an blade angle of 22°.

Accordingly, it is probable that the speed of the Vessel before capsizing was about 13.2 kn.

[3] Angle of encounter and encounter period

According to the course and wave directions of the Vessel, it is considered probable that the angle of encounter was about 135.5° to 161°, while the encounter period was within the range of about 13.4 to 40.9 seconds, as obtainable by the following formula.

$$T_E = \frac{3T_w^2}{3T_w + V \cos \alpha} \quad (\text{s})$$

T_E : Encounter period (s), T_w : Wave period (s), V : Vessel speed (kn)

[4] Course, speed, angle of encounter and encounter period of the consort vessels

The speed, course, angle of encounter and encounter period of No.1, No.8, No.38, No.58 and No.23 accompanying the Vessel were as follows.

	Speed (kn)	Course	Angle of encounter	Encounter period (s)	Speed length ratio ^{*35} V/\sqrt{L}
No.1	12.4	248°	136.5° to 158.5°	12.5 to 25.9	1.99
No.8	11.7	246°	134.5° to 156.5°	11.0 to 19.7	1.88
No.38	10.5	246° to 248°	134.5° to 158.5°	9.8 to 15.3	1.51

^{*35} “speed length ratio” refers to a value to be used for the comparison of the speed of vessels with different lengths and for resistance and horsepower calculations. Speed length ratio is denoted by V/\sqrt{L} , where V is the vessel speed (kn) and L is the waterline length in this case.

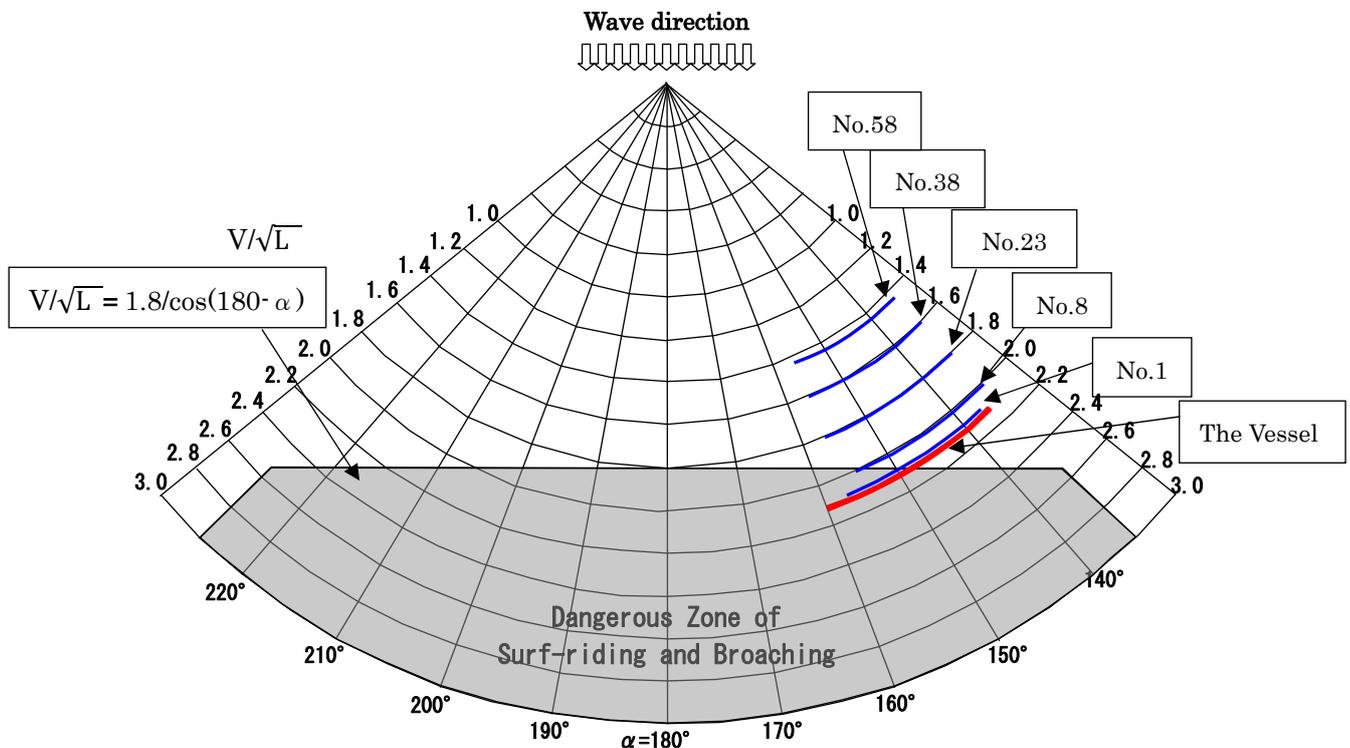
No.58	10.5	246° to 248°	134.5° to 158.5°	9.8 to 15.3	1.36
No.23	10.5	246° to 248°	134.5° to 158.5°	9.8 to 15.3	1.69

Remarks: The speed, course, angle of encounter, encounter period and speed length ratio as shown in the table were approximate values.

The data of No.2 and No.15 which are light boats in the Fleet of No.23 are omitted because they are of almost the same type with No.1 and No.8 in the Fleet of the Vessel, while the data of No.18 and No.53 which are fish carriers in the Fleet of No.23 are also omitted because they are of almost the same type with No.58 in the Fleet of the Vessel.

(2) Analysis of surf-riding and broaching phenomena

According to 2.8 (1) and (1) above, it is probable that when the accident occurred, the angle of encounter of the Vessel was within the range of conditions inducing the occurrence of surf-riding and broaching phenomena, and the Vessel was put in a dangerous situation which might lead to surf-riding and broaching because such conditions were satisfied when the angle of encounter became about 154° to 161°.



However, according to the findings that the Vessel turned to port after steering to port before capsizing, and turned to starboard after steering to starboard after being hit by the Second Wave and, it is probable that the Vessel was steerable at that time and neither surf-riding nor broaching occurred.

With respect to the consort vessels, it is probable that while No.1 was situated in the dangerous zone when the angle of encounter became about 155° to 158° as shown in the figure above, the other consort vessels were situated outside the dangerous zone.

(3) Reduction of stability when riding on a wave crest

According to 2.8 (2), 3.2.4 (2) and 3.2.6 (1), it is somewhat likely that the stability of the Vessel was reduced because the Vessel was in the range where the stability reduction might

occur, as the vicinity where the Vessel capsized was in quartering and following sea conditions when the Vessel capsized with a wavelength of about 34 to 39 m, while $0.6 L = 25.7$ m and $2.3 L = 98.7$ m, leading to $0.6 L < \lambda < 2.3 L$.

It is probable that the consort vessels were all in the range where the stability reduction might occur as shown in the table below. However, according to the findings that the Vessel had a speed closer to the wave speed and an encounter period longer than the consort vessels, it is probable that the Vessel rode on the wave crest for a longer period, and was put in a more dangerous situation leading to a heavy list or capsize.

	0.6 L (m)	Wavelength λ (m)	2.3 L (m)
No.1	23.3	34 to 39	89.2
No.8	23.3		89.2
No.38	28.9		110.9
No.58	35.5		136.2
No.23	23.1		88.6

According to the findings that wavelength conditions are broad and are liable to fall within the range of conditions inducing the reduction of stability as mentioned above, it is probable that adopting such measures as decreasing the angle of encounter by reducing the speed largely and shortening the time riding on a wave crest is important to minimize the danger of listing heavily or capsizing while sailing in following or quartering sea conditions.

(4) Behavior of the Vessel leading to the occurrence of capsizing

According to 3.1.3, 3.2.4, 3.2.5 and (1) and (3) above, it is analyzed as follows.

[1] Listing to port when being hit by the First Wave

It is probable that the Vessel listed to port because heeling couple from the starboard quarter was generated when the Vessel was overtaken by the crest of the First Wave from the starboard quarter.

[2] Encounter with the crest of the Second Wave

According to the findings that the Vessel listed largely to starboard about 15 seconds after encountering the Second Wave three to four seconds after being hit by the First Wave, and that the Vessel put the helm hard to starboard and started turning to starboard on the slope of the back of the Second Wave, it is probable that the Vessel rode on the crest of the Second Wave for about 15 seconds.

[3] Listing to starboard when being hit by the Second Wave

According to the findings that when being overtaken by the crest of the Second Wave, the stern of the Vessel became as if thrusting into the forefront of the wave, it is probable that when the Vessel restored the stability from the port list in a state where sea water flooded in on the aft deck and the stability of the Vessel was reduced while riding on the crest of the Second Wave in following sea conditions, the Vessel listed to starboard because the sea water which had flooded in shifted to starboard all at once but also the nets loaded on the aft deck shifted to starboard too.

It is probable that on that occasion, initial inward heeling couple^{*36} was generated

^{*36} “initial inward heel” refers to a state of heeling, occurring to a displacement-type vessel in most cases at the initial stage of steering, toward the direction of the steering because the counteractive rudder force acts centripetally at a point below the center of gravity. While beginning to turn, the vessel heels to the opposite side

while turning to starboard and the list of the Vessel increased, because the Vessel put the helm starboard and accelerated the go-ahead speed by altering the blade angle to 22°.

[4] Factors leading to the capsizing

According to the findings that the Vessel was proceeding while directing the starboard side toward the down slope of the waves, and that the Vessel was unable to restore the stability because the top of the starboard bulwark sank under the sea at a starboard list of about 23°, in addition to the situation which led to the reduction of stability as mentioned in [2] above, it is probable that the Vessel capsized because the Vessel turned almost 180° without restoring the stability while increasing the starboard list, which as a result forced the Vessel to be hit by the wind and waves from the port bow.

3.2.7 Foundering of the Vessel

According to 2.1, 2.5.3 (1) and 3.2.2 (1), it is probable that the situation when the Vessel foundered was as follows.

As the aft entrance door on the port side of the wheelhouse, the Fore and Aft Entrance doors and the entrance door of the fore hold were left open, the Vessel capsized while sea water continued flooding from the Fore and Aft Entrance doors and the entrance door of the fore hold.

As the Vessel listed to the bow, the sea water which flooded the aft accommodation space and the wheelhouse before the Vessel capsized shifted gradually to the fore accommodation space and the fore hold after the Vessel capsized. This increased the list of the Vessel to the bow.

While the Aft Entrance door became exposed, the list to the bow became even larger and the Vessel sank deeper as sea water flooded in again, the Vessel foundered almost in a vertical attitude.

3.2.8 Operation Management of Vessels

(1) Departure

According to 2.1.1 (1), 2.6.1, 2.7.1, 2.7.3 (1), 3.2.4 (1) [1] and (3), it is probable that the Vessel had usually left port in weather and sea conditions similar to those observed on the day when the accident occurred.

(2) Avoidance navigation

According to 2.1.1 (1), 2.6.1, 2.7.1, 2.7.2, 2.7.3 (2), 3.2.4 (1) [2], (2) [1] and (3), it is probable that the Vessel had usually continued proceeding in weather and sea conditions similar to those observed on the day when the accident occurred.

(3) Knowledge of vessel maneuvering

According to 2.1.1 (2), 2.7.1 and 3.2.4 to 3.2.6, the situation of vessel maneuvering knowledge was as follows.

According to the findings that neither the master nor the fishing chief implemented secure vessel maneuvering like reducing the speed largely when they saw a larger wave than before approaching, being unable to foresee urgent circumstance which might lead to capsizing, it is somewhat likely that while riding on the wave crest in quartering and following sea conditions, the Vessel was in a dangerous situation which might lead to capsizing.

It is probable that when the Vessel listed to starboard while being overtaken by the crest of the Second Wave, the Vessel accelerated the go-ahead speed by altering the blade angle to 22° and put the helm to starboard, with the intention of not only restoring the stability from the starboard list by making use of the centrifugal force generated by the starboard turn, but also

of the steering because the centrifugal rudder force acts on the center of gravity.

discharging the trapped water from the scuppers on the Vessel's sides. However, it is somewhat likely that the initial inward heel increased the starboard list, which then forced the Vessel to turn almost 180° and to be hit by the wind and waves from the port side.

Accordingly, it is somewhat likely that neither the master nor the fishing chief of the Vessel had a full knowledge of not only hazards which might lead to broaching and stability reduction while sailing in quartering and following sea conditions, but also necessary vessel maneuvering methods for avoiding them.

(4) Fatigue, sleep, disease and medication

According to 2.1.1, 2.4 (2), 2.10 and 3.2.1, they were as follows.

It is probable that the crew did not suffer from accumulated fatigue or lack of sleep, as the day when the accident occurred was the departure date for the fishing, and was a day after the holiday. It is also probable that neither the master nor the fishing chief took alcoholic drinks, as it was early in the morning soon after departure preparations were completed, and they had been continuously engaged in steering and watch duty in the wheelhouse after the Vessel left port.

According to the findings that neither the master nor the fishing chief took remedies on a regular basis, it is probable that medication was not involved in the maneuvering of the Vessel when the accident occurred.

(5) Safety management and operation management by Company A

According to 2.6.1, the fishing chief took care of safety management and operation management for the Vessel and the four other vessels comprising the Fleet of the Vessel during the time from when leaving port until when arriving in port; he stayed inside the bridge to watch and make observations of weather and sea conditions during such times as when leaving and arriving in port, during the period from when leaving port until when navigational safety was confirmed, while sailing in adverse weather conditions, and during the time of emergency and rescue activities; and at the same time he supervised the ship maneuvering and gave steering and engine orders as necessary. Therefore, it is probable that safety management or operation management by Company A was not involved in the occurrence of the accident.

However, it is probable that at a monthly meeting held before the opening of each fishing period and in the safety manual distributed by Company A to its vessels, Company A did not provide education or mention in detail about not only hazards which may lead to broaching and stability reduction while sailing in following and quartering sea conditions, but also vessel maneuvering knowledge for avoiding them. Therefore, it is somewhat likely that neither the master nor the fishing chief had a full knowledge of these.

3.2.9 Occurrence of the Accident

According to 2.1, 2.5.2, 2.5.3 (2), (3), 2.5.4 to 2.5.7, 2.7, 2.8, 3.1.1 (1), 3.1.3 and 3.2.2 to 3.2.6, it is analyzed as follows.

- (1) It is probable that while proceeding in following seas off the west of Hirado Island with waves coming from the starboard quarter, the Vessel was hit by the First Wave and listed to port, and a few seconds later, the stability was reduced while riding on the crest of the Second Wave; when the Vessel restored the stability from the port list, the sea water which had flooded in when the Vessel was hit by the Second Wave shifted to the starboard side of the upper deck and was trapped there while the nets loaded on the upper deck also shifted to starboard, and the Vessel listed largely to starboard; the Vessel attempted turn her upright by accelerating the speed and

continuing turning to starboard; and when the list of the Vessel increased to the extent that the top of the starboard bulwark sank under the sea, the Vessel capsized without restoring the stability.

- (2) It is somewhat likely that the insecure implementation of vessel maneuvering by the master and the fishing chief like reducing the speed largely before encountering the First Wave was involved in the stability reduction which occurred when the Vessel rode on the crest of the Second Wave.
- (3) It is somewhat likely that the fact that when neither the master nor the fishing chief was able to foresee urgent circumstances which might lead to capsizing, or the fact that neither of them had a full knowledge of not only hazards which might lead to broaching and stability reduction while sailing in quartering and following sea conditions, but also necessary vessel maneuvering methods for avoiding them was involved in their insecure implementation of vessel maneuvering like reducing the speed largely.
- (4) It is somewhat likely that the fact that the Vessel possessed the following factors which would impair stability was involved in the inability of the Vessel to restore the stability after listing largely.
 - [1] The Vessel had a high center of gravity because a larger number of heavy materials were loaded on the weather deck than a light boat and a fish carrier.
 - [2] The Vessel had a low freeboard for the convenience of net laying and hauling.
 - [3] Sea water was liable to be trapped on the starboard side of the Vessel once it was trapped, as the bridge structure was arranged on the port side while the working space was secured on the starboard side for the convenience of net laying and hauling.
 - [4] The cross section of the Vessel under the waterline was thin-shaped.
- (5) It is probable that the Vessel acquired factors which would impair stability such as those mentioned in (4) above, because the Vessel intended to secure as large working space as possible after installing heavy nets and fishing machines on the weather deck in order to improve workability and efficiency of roundhaul fishery, within the limit of the maximum gross tonnage of 135 tons as specified in the Fishery Act pertaining to large- and medium-scale roundhaul fishery.

3.3 Rescue Activities and Damage Reduction Measures

According to 2.1 and 2.11, it is analyzed as follows.

- (1) It is somewhat likely that although the fishing chief gave the Abandon Order when the Vessel turned almost 180° after being hit by the Second Wave and listed to starboard, he was unable to make a judgment that the Vessel would capsize when or before the Vessel listed to starboard.
- (2) According to the findings that the escape test showed it was possible for an adult to escape within 19 seconds at a fast walk from any place inside the Vessel to the external area while the Vessel was not rolling or pitching, and that some crew members escaped from the aft accommodation space on foot without putting their hands on the wall after the Abandon Order was given, it is probable that there were 19 seconds or more after the Abandon Order was given until the Vessel capsized.
- (3) It is probable that the fact that most of the crew who died were staying in the aft accommodation space when the Abandon Order was given, and had difficulty in going up the Center Stairs because of the already large list, and the fact that they did not use the escape door located at the rear of the saloon were involved in their inability to escape from the aft accommodation space.
- (4) It is probable that the crew members who were staying in the dining room, kitchen or fishing

preparation section on the upper deck were unable to hear the emergency bell and the Abandon Order because of the noise in the engine room.

- (5) According to the findings that the five crew members, among the 11 crew members who died, who wore a lifejacket were found in the aft accommodation space, it is somewhat likely that they went down, or dropped, to the aft accommodation space after going up to the Place for Lifejackets and wearing a lifejacket.
- (6) All the crew members who escaped to the external area before the Vessel capsized survived except OS-A, whichever escape route they took. On the other hand, it is probable that all the crew members who were unable to escape to the external area before the Vessel capsized died inside the Vessel except OS-H who went missing, because it was hard for them to move inside the Vessel as the Vessel was flooded, overturned and all the lights went out after capsizing.
- (7) Although only three crew members wore a lifejacket among the 10 crew members who escaped, it is probable that all the 10 crew members who escaped were able to survive, because the Liferaft A rose to the sea surface near them, and the escort vessels arrived at the accident site in a short period of time.
- (8) It is probable that because the group of 10 fishing vessels consisting of two fleets was proceeding in formation, the consort vessels were able to find the capsizing Vessel at an early stage and go to the rescue of the Vessel.
- (9) It is probable that because having been released from the container before the Vessel capsized, CO₂ gas in the bottle to inflate the Liferaft A was discharged at the same time the Vessel capsized, and the Liferaft A inflated normally and rose to the sea surface.

According to the findings that the Liferaft B rose to the sea surface immediately before the Vessel foundered, it is probable that the rising to the sea surface was delayed because the capsizing Vessel had fallen on it.

- (10) It is probable that the EPIRB neither rose to the sea surface nor transmitted signals, because while having been released automatically when the Vessel was foundering, it sank together with the capsized Vessel which had fallen on it, its antenna was caught in the grating near the entrance fore hold, and its housing and inner structure were destroyed by the water pressure.

If a vessel should founder without changing the attitude at the time of capsizing, an EPIRB on board the vessel is expected not to rise to the sea surface, as in the case of the accident. Therefore, the issue of where and how to install an EPIRB on a vessel should be reviewed.

3.4 Environmental Impact by Spillage of Oil and Its Removal

According to 2.12, it is analyzed as follows.

It is probable that immediately after the Vessel capsized, the amount of fuel oil A and other oil with high viscosity which spilled from the Vessel was to the extent that several crew members who fell overboard noticed.

It is probable that fuel oil A spilled from the air vent pipe after the Vessel foundered, and about 23 ℓ of fuel oil A, the largest amount during the observation period as mentioned below, was floating on the sea surface at 09:15, April 15, according to the color tone and the area where it had spread. However, it was not possible to determine the total amount of the spilled oil.

The floating oil had extended over the length about 3 M from the gushing point, and over the thin trapezoid-shaped width which was 5 m wide at near the gushing point and 50 m wide at the end. The amount of the floating oil in the area within 20 m of the gushing point was 0.03 ℓ because the color tone was Color C, the oil film was 0.0003 mm thick, and the area was 101.6 m². The

amount of the floating oil in the area beyond 20 m from the gushing point to the end was 22.9 ℓ because the color tone was Color E or vaguer, the oil film was 0.00015 mm thick and the area was 152,683 m². Accordingly, the total amount of the floating oil was 23 ℓ.

4 CONCLUSION

4.1 Summary of the Analysis

(1) Course of the Events Leading to the Occurrence of the Accident

It is considered probable that while proceeding toward west-southwest at a speed of about 12 to 13 kn after departing from Tachiura Fishing Port at about 07:15, April 14, 2009, the Vessel capsized at about 08:05 and foundered about 25 minutes later at the location about 243°, 9.1 M from Ikitsuki Bridge Center Light after the Vessel reduced the speed, altered the course about 1° to 2° to port and proceeded straight ahead, and turned to starboard increasing the speed.

It is highly probable that 11 crew members including the master and the fishing chief died from drowning, and one crew member went missing.

(2) Situation of the capsize and foundering

It is probable that the Vessel listed to port when the stern of the Vessel was overtaken by the crest of the First Wave coming from north-northeast to northeast; a few seconds later, the stern was overtaken by the Second Wave coming from north to north-northeast, when the Vessel became as if thrusting into the forefront of the wave, and sea water flooded in on the aft deck; about 15 seconds after that, the Vessel listed largely to starboard while being overtaken by the crest of the Second Wave; the Vessel accelerated the go-ahead speed and put the helm hard to starboard; the Vessel turned to starboard listing further to starboard as if sliding down the slope on the back of the Second Wave; the Vessel capsized when the top of the starboard bulwark sank under the sea and turned almost 180°; afterward, the Vessel sank gradually from the bow while turning to starboard under the influence of the wind and waves coming from north-northeast, and foundered almost in a vertical attitude while the bow was heading toward south-southwest to southwest.

(3) Causal factors of the occurrence of the accident

[1] It is probable that while proceeding in following seas with waves coming from the starboard quarter, the Vessel was hit by the First Wave and listed to port, and a few seconds later, the stability was reduced while riding on the crest of the Second Wave; when the Vessel restored the stability from the port list, the sea water which had flooded in when the Vessel was hit by the Second Wave shifted to the starboard side of the upper deck and was trapped there while the nets loaded on the upper deck also shifted, and the Vessel listed largely to starboard; the Vessel attempted to turn her upright by accelerating the speed and continuing turning to starboard; and when the list of the Vessel increased to the extent that the top of the starboard bulwark sank under the sea, the Vessel capsized without restoring the stability.

[2] It is somewhat likely that the insecure implementation of vessel maneuvering by the master and the fishing chief like reducing the speed largely before encountering the First Wave was involved in the stability reduction which occurred when the Vessel rode on the crest of the Second Wave.

[3] It is somewhat likely that the fact that neither the master nor the fishing chief was able to foresee urgent circumstances which might lead to capsizing when they saw a larger wave than before approaching, or the fact that neither of them had a full knowledge of not only hazards which might lead to broaching or stability reduction while sailing in quartering and following sea conditions, but also necessary vessel maneuvering methods for avoiding them was

involved in their insecure implementation of vessel maneuvering like reducing the speed largely.

[4] It is somewhat likely that the fact that the Vessel possessed factors which would impair stability, such as a low freeboard and a high center of gravity because of a large number of heavy materials loaded on the weather deck, was involved in the inability of the Vessel to restore the stability after listing largely.

[5] It is probable that the Vessel acquired factors which would impair stability such as those mentioned in [4] above, because the Vessel intended to secure as large working space as possible after installing heavy nets and fishing machines on the weather deck in order to improve workability and efficiency of roundhaul fishery within the limit of the maximum gross tonnage of 135 tons as specified in the Fishery Act pertaining to large- and medium-scale roundhaul fishery.

(4) Analysis of the casualties

While all the crew members who escaped to the external area before the Vessel capsized survived except one crew member, whichever escape route they took, it is probable that all the crew members who were unable to escape to the external area before the Vessel capsized died inside the Vessel except one crew member who went missing, because it was hard for them to move inside the Vessel as the Vessel was flooded and overturned after capsizing.

(5) Analysis of the oil spill

It was not possible to determine the total amount of the spilled oil, although it is probable that about 23 ℓ of fuel oil A, the largest amount after the Vessel foundered, was floating on the sea surface at 09:15, April 15, according to the observations conducted after the Vessel foundered until April 18 to check the floating conditions of fuel oil A which spilled from the air vent pipe of the Vessel.

4.2 Probable Causes

It is probable that the accident occurred as follows: the Vessel was proceeding in following seas off the west of Hirado Island with waves coming from the starboard quarter; the Vessel's stability was reduced while riding on the wave crest after being hit by the First Wave and the Second Wave successively; as a result, the sea water which had flooded in when the Vessel was hit by the Second Wave shifted to the starboard side of the upper deck and was trapped there; the nets loaded on the upper deck also shifted to starboard, and the Vessel listed largely to starboard; the Vessel attempted to turn her upright by continuing turning to starboard; and when the list of the Vessel increased to the extent that the top of the starboard bulwark sank under the sea, the Vessel capsized without restoring the stability.

It is somewhat likely that the stability reduction which occurred when the Vessel rode on the crest of the Second Wave was affected by the insecure implementation of vessel maneuvering by the master and the fishing chief like reducing the speed largely.

It is somewhat likely that the insecure implementation of vessel maneuvering by the master and the fishing chief like reducing the speed largely was affected by the fact that they were unable to foresee urgent circumstances which might lead to capsizing when they saw a larger wave than before approaching, or they did not have a full knowledge of hazards and methods for avoiding them while sailing in quartering and following sea conditions.

It is somewhat likely that the inability of the Vessel to restore the stability after listing largely was affected by the fact that the Vessel possessed a low freeboard, high center of gravity and

thin-shaped design.

It is probable that the reason why the Vessel possessed a low freeboard, high center of gravity and thin-shaped design was that the Vessel intended to secure as large working space as possible after installing heavy nets and fishing machines on the weather deck within the limit of the gross tonnage.

5 REMARKS

5.1 Safety Measures for the Existing Roundhaul Net Boats

(1) It is desirable that Nagasaki Prefecture should support the project of planning regional activities for “Marine Accident Prevention” implemented by Nagasaki Prefecture Roundhaul Fishery Cooperative in cooperation with Japan Coast Guard and the Fishery Agency, and also provide the roundhaul fishery operators in the prefecture necessary information and guidance on the result gained at “Nagasaki Prefecture Conference for the Prevention of Marine Accidents Involving Roundhaul Netters” held in February 2010 and on measures to be taken like a periodical review of the result.

It is desirable that the prefecture should concentrate their guidance on teaching not only hazards which may lead to broaching and surf-riding phenomena and vessel maneuvering methods for avoiding them, but also hazards which may lead to stability reduction and vessel maneuvering methods for avoiding them while sailing in following and quartering sea conditions, by utilizing “Safety Operation Manual for Fishing Vessels (March 2009)” and “Guide to Safety Operation of Fishing Vessels (March 2009)” which were made by National Research Institute of Fisheries Engineering and adopted in the proposal made at the above mentioned conference.

(2) With respect to the result gained at Nagasaki Prefecture Conference for the Prevention of Marine Accidents Involving Roundhaul Netters and measures to be taken like a periodical review of the result, it is desirable that the Fisheries Agency should acquaint the roundhaul fishery operators and the crew of roundhaul netters throughout Japan with preventive measures against recurrence of similar accidents while taking notice of (1) above, in collaboration with fishermen’s associations concerned.

5.2 Safety Measures for Newly Constructed or Converted Roundhaul Net Boats

It is somewhat likely that the fact that the Vessel possessed factors common to 135-ton type Roundhaul Net Boats which would impair stability, such as a high center of gravity because of a larger number of heavy materials loaded on the weather deck than a light boat and a fish carrier, in addition to a thin-shaped cross section under the waterline at the bow and the stern, was involved in the occurrence of the accident. It is probable that the reason why the Vessel acquired such factors was that the Vessel intended to secure as large working space as possible after installing heavy nets and fishing machines on the weather deck in order to improve workability and efficiency of roundhaul fishery, within the limit of the maximum gross tonnage of 135 tons as specified in the Fishery Act pertaining to large- and medium-scale roundhaul fishery.

When new construction or conversion of a Roundhaul Net Boat is planned or implemented, the Fisheries Agency and roundhaul fishery operators should ensure that the vessel should be designed

without impairing stability for the sake of loading as many nets as possible or securing as large working space as possible on the upper deck within the limit of the gross tonnage.

For this reason, it is desirable that the Fisheries Agency should consider taking necessary measures when it is found necessary to increase the gross tonnage of a Roundhaul Net Boat which a fishing operator intends to newly construct or convert for the improvement of safety.

It is also desirable that the Fisheries Agency should instruct the roundhaul fishery operators from this viewpoint, and listen to the opinions of specialists and parties concerned in order to study what the desirable future roundhaul fishery should be in terms of workability, efficiency and higher safety.

6 ACTIONS TAKEN

Nagasaki Prefecture established “Nagasaki Prefecture Conference for the Prevention of Marine Accidents Involving Roundhaul Netters“ in collaboration with experts with relevant knowledge and experience, administrative agencies concerned and roundhaul fishery associations in September 2009, at which they discussed measures for preventing marine accidents involving roundhaul netters, including those for preventing capsized accidents in particular and a review of “Safety Operation Manual for Roundhaul Netters” (made in January 1994 by Western Japan Marine Accident Prevention Association and Nagasaki Prefecture Roundhaul Fishery Cooperative). On February 4, 2010, the prefecture made and published a report which contained a proposal for taking preventive measures against recurrence and adopting a scheme to continue utilizing the safety operation manual.

After making the report, it was decided that the prefecture should provide guidance so that each of the roundhaul fishery operators in the prefecture should develop their own safety operation manual as well as safety operation check list and put them into practice on the basis of “Model Safety Operation Manual” and “Model Safety Operation Check List”, which was developed adding new supplementary items to the “Safety Operation Manual for Roundhaul Netters” distributed by Nagasaki Prefecture Roundhaul Fishery Cooperative and Pelagic Roundhaul Fishery Cooperative of Japan to each of their members operating roundhaul fishery.

It was also decided that a conference with the function of promoting coordination among parties concerned should be newly established in order to check regularly the progress of the development and utilization of these manuals and share information on marine accident prevention.

Figure 1: Estimated Navigation Route

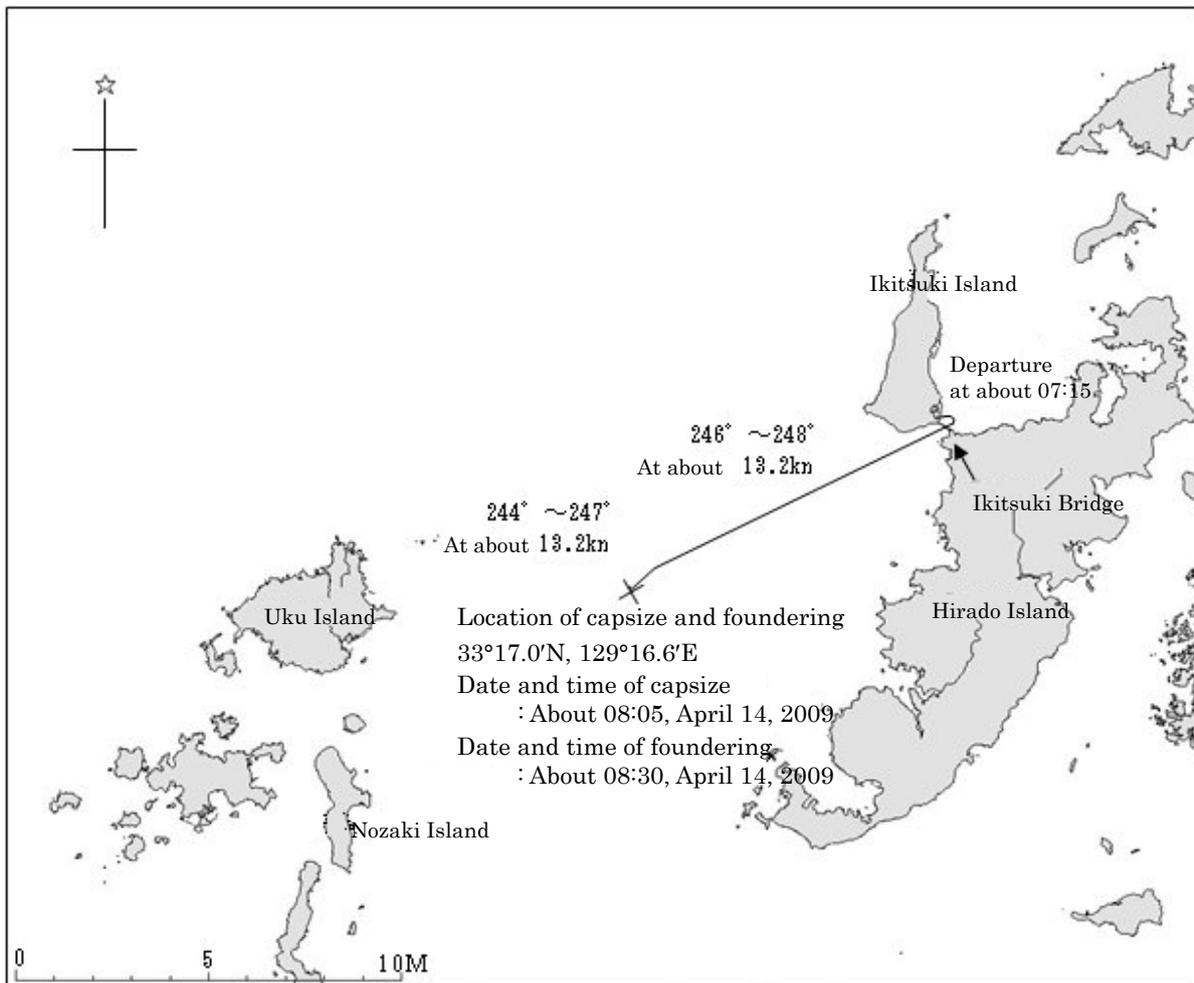
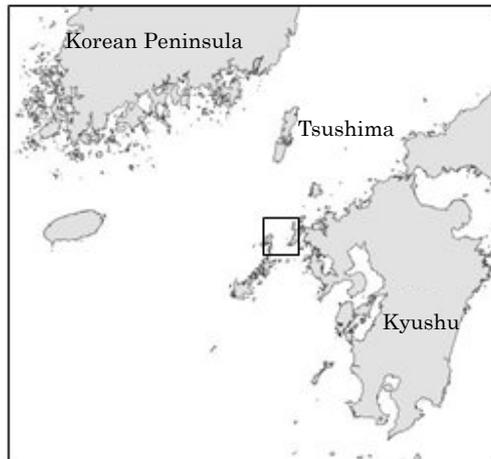


Figure 2: Tracks of No.1 and No.8 and Formation of the Fleet of the Vessel

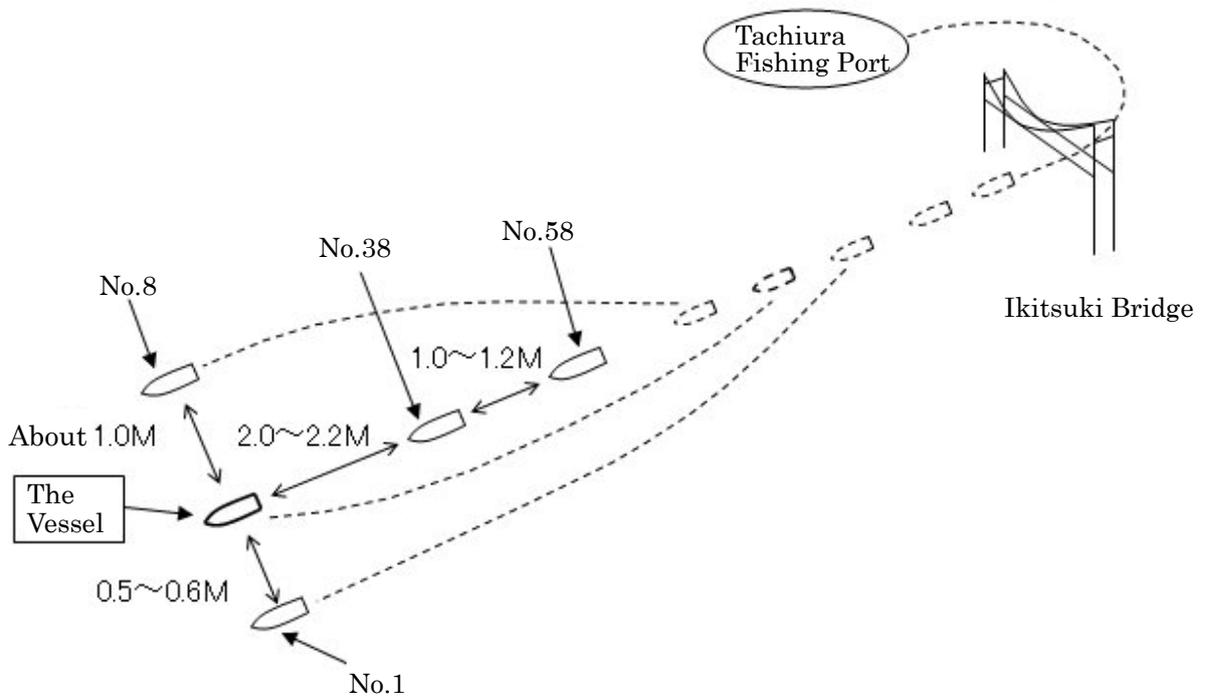
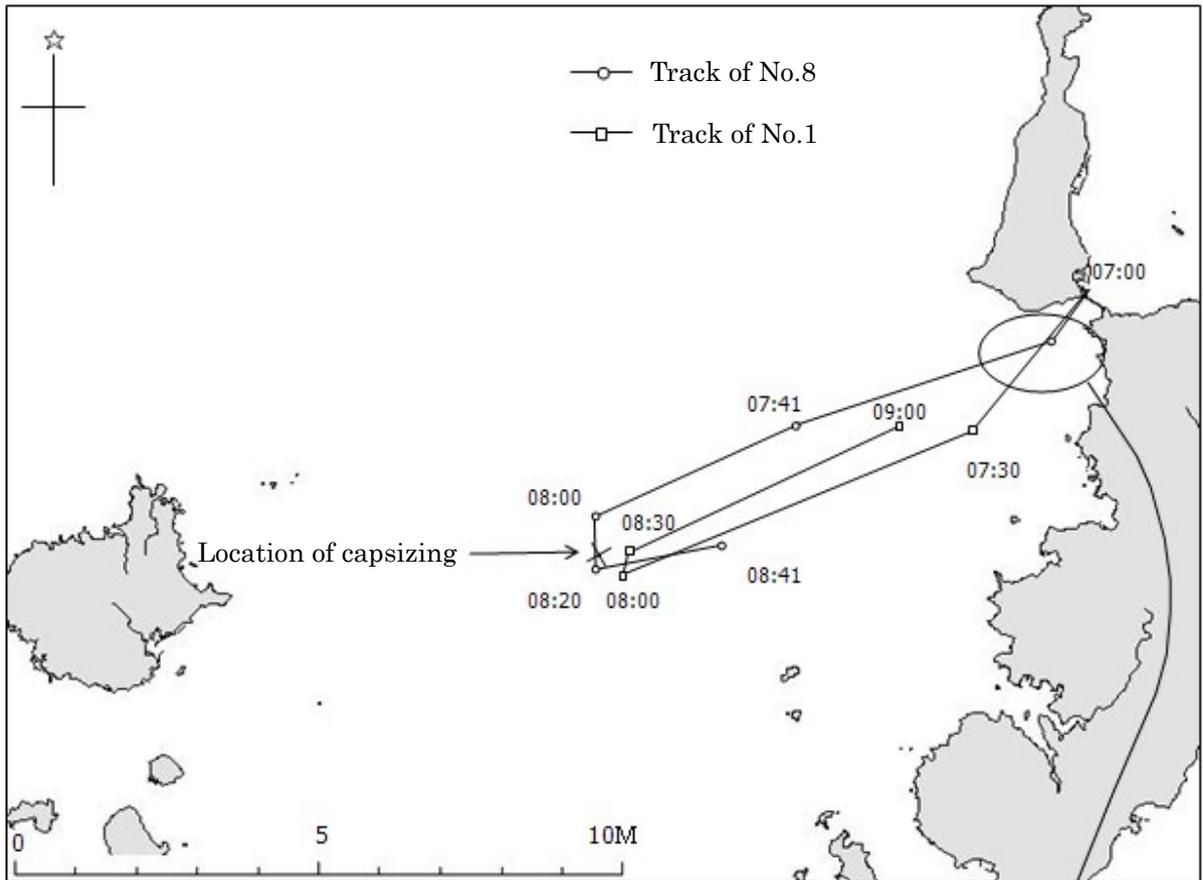


Figure 3: General Arrangement Plan of the Vessel

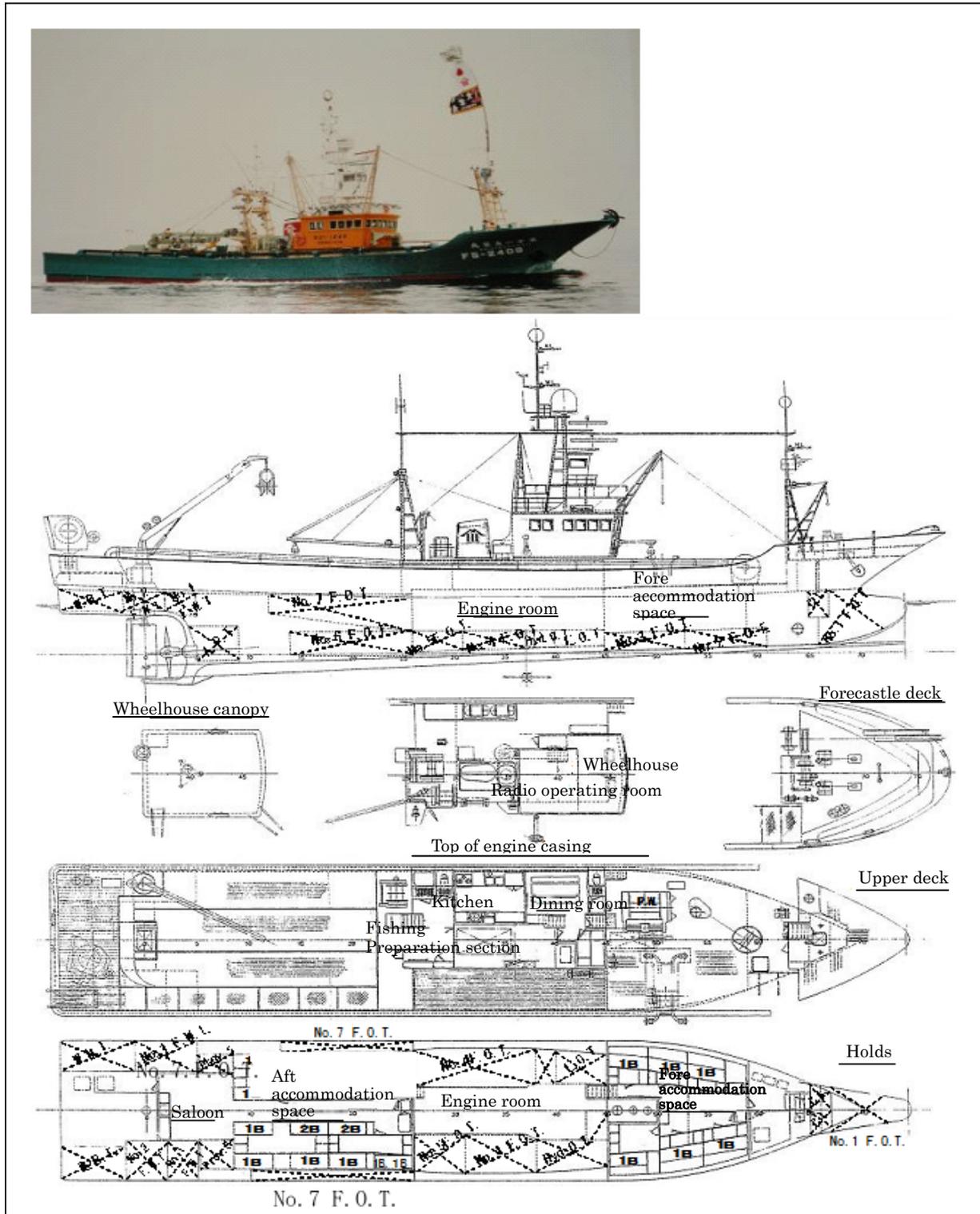


Figure 4: Schematic Chart Showing the Development of Capsizing

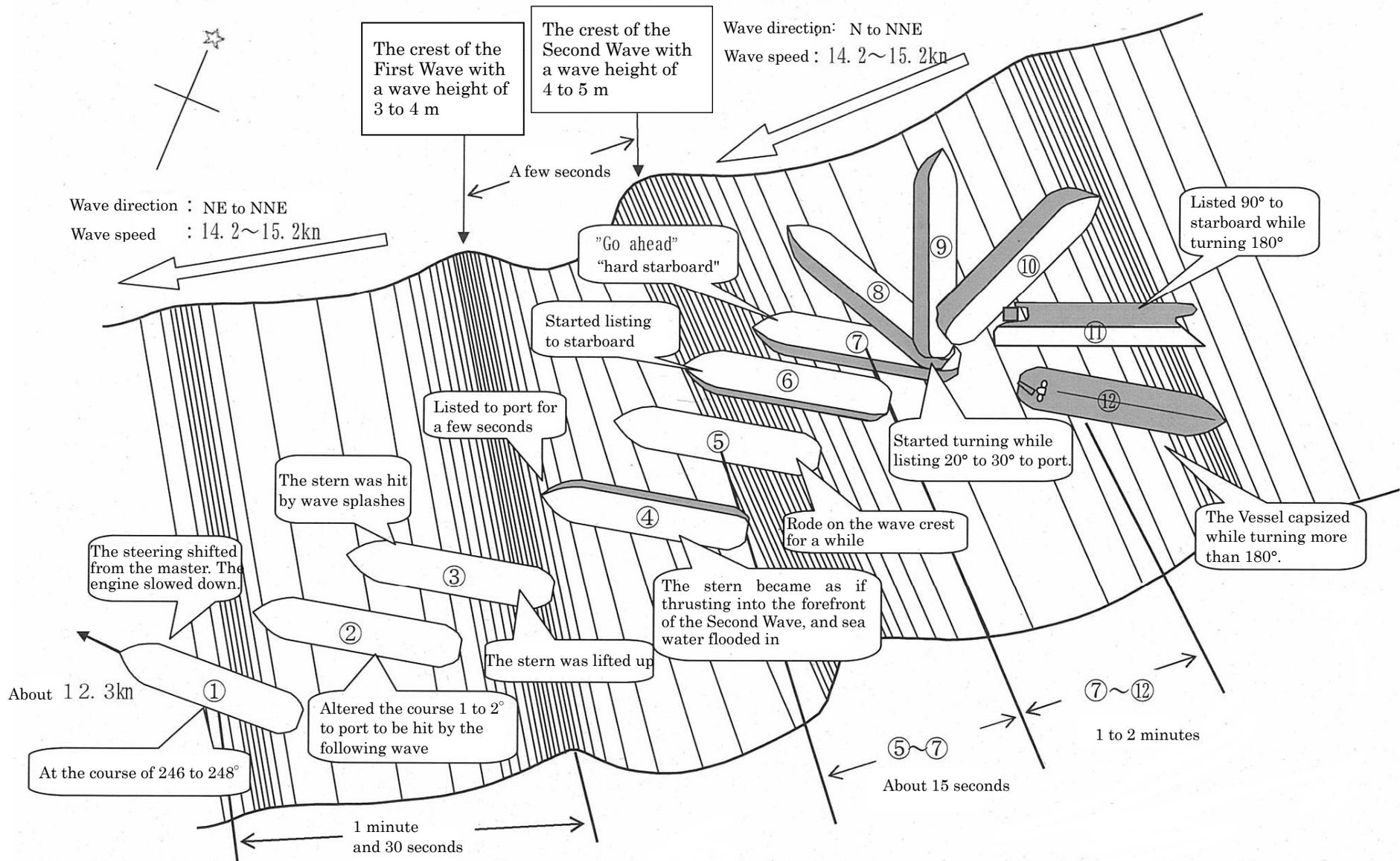


Figure 5: Comparison Among Light Boat, Roundhaul Net Boat and Fish Carrier

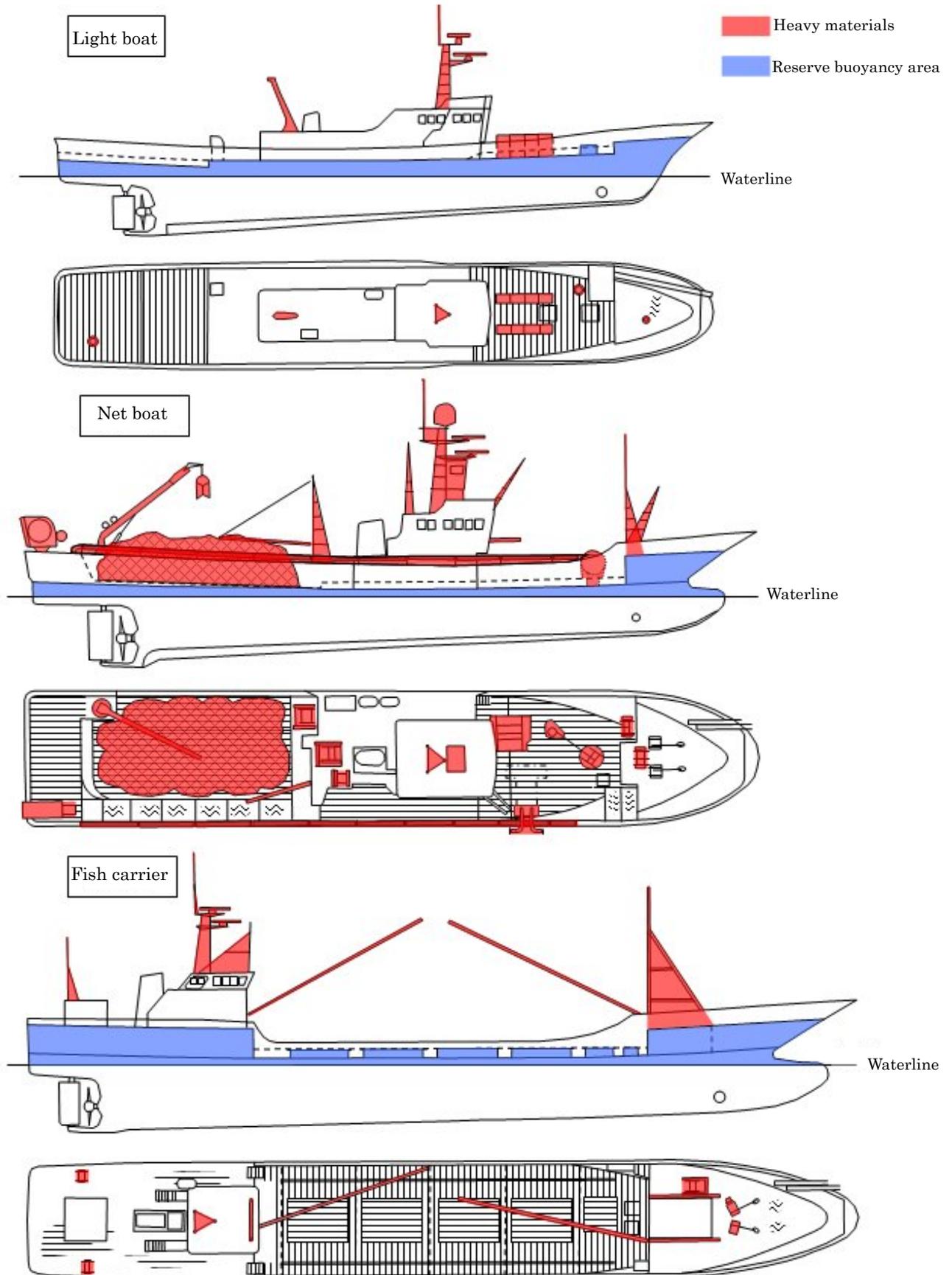


Figure 6: Comparison of Midship Section Shapes

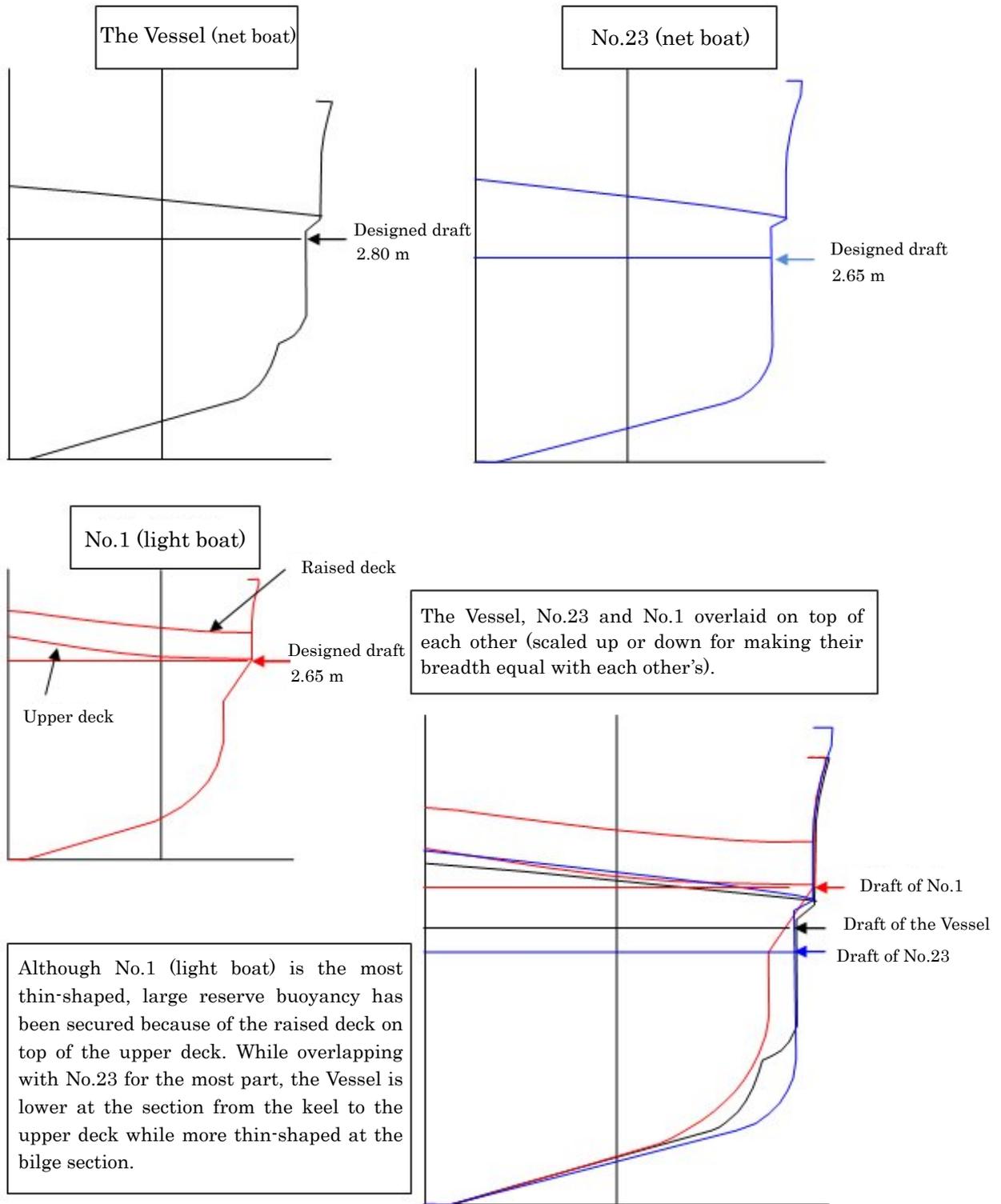
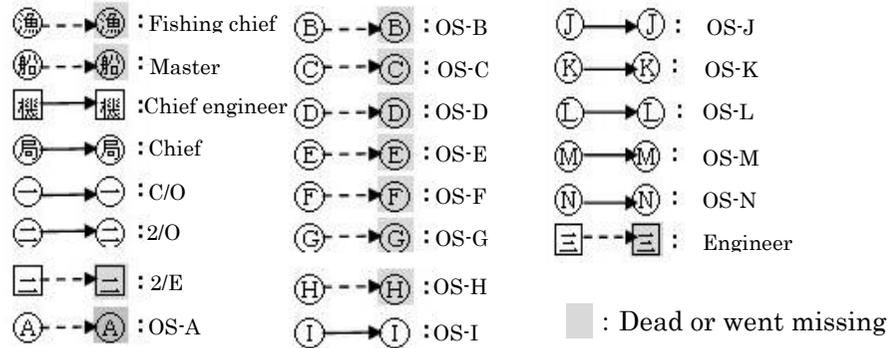


Figure 7: Development of Escape



Wheelhouse /
Embarkation Deck

