- Overview and analysis of accident investigation cases -

Japan Transport Safety Board DIGESTS

JTSB (Japan Transport Safety Board) DIGESTS

Number 45（issued on April, 2024）

Maritime Accident Analysis Report

Preventing major accidents involving small passenger ships

－ Are you aware of the characteristics of the operational areas? －

1. Introduction

On April 23, 2022, a tragic accident occurred when a passenger ship sank off the western coast of the Shiretoko Peninsula in Hokkaido, resulting in the deaths of 18 passengers and 1 crew member and the master, with 6 passengers still missing (as of the release of the accident investigation report).

The passenger shipping business primarily involves transporting people at sea, and while the operation styles vary, passengers typically have limited access to information about the safety of the vessel and sea conditions, forcing them to rely on the operator's judgments.

Therefore, passenger ship operators are strongly required to consistently provide safe transport services to passengers, ensuring "transport safety" based on the principle of prioritizing safety.

Moreover, if even a single accident results in passenger injuries or fatalities, the significant social impact raises questions not only about safety management responsibilities but also about management attitude and governance. Therefore, it is essential for passenger ship operators to maintain strict organizational risk management.

In this context, when using small vessels under 20 gross tons (hereinafter referred to as "small passenger ships”) for tourist transportation in scenic areas facing the open sea, the structural characteristics of the hull, freeboard height, and wind pressure surface area can make them susceptible to the effects of waves and wind during rough weather, posing risks to passenger safety.

The sinking of this passenger ship off the Shiretoko Peninsula occurred under conditions with strong wind and wave warnings in effect. While navigating during the passage of a cold front, the ship experienced hull instability, causing the hatch on the foredeck to open. This allowed seawater to flow into the bow section, leading to flooding in other compartments and ultimately resulting in the loss of buoyancy and sinking of the vessel.

This digest, prompted by the sinking of a passenger ship off the Shiretoko Peninsula, aims to prevent similar accidents by emphasizing the need to understand and address **"the characteristics of operational areas"**—a key factor in the accident. Drawing on past cases and prevention measures for small passenger vessels, it presents universal safe-navigation principles and lessons.

2. The situation and trends of accidents involving small passenger ships

Based on accident investigation reports published from October 2008 (when the JTSB was established) to January 2024, Figure 1 shows the incidence of passenger ship accidents among all vessel types, Figure 2 displays the incidence of accidents involving small passenger ships as a percentage of all passenger ships, and Figure 3 illustrates trends in accident types for small passengers.

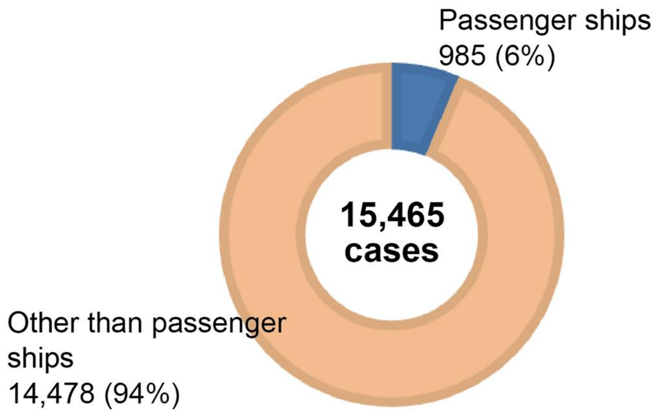


Figure 1 Proportion of accidents involving passenger ships among all vessel types

- Among all vessel types, passenger ship accidents account for about **6%.**
- Over approximately 15 years, a total of **985 accidents** have occurred, averaging about 65 per year.
  Although the nature and severity of these accidents vary, reducing them is crucial for ensuring passenger safety.

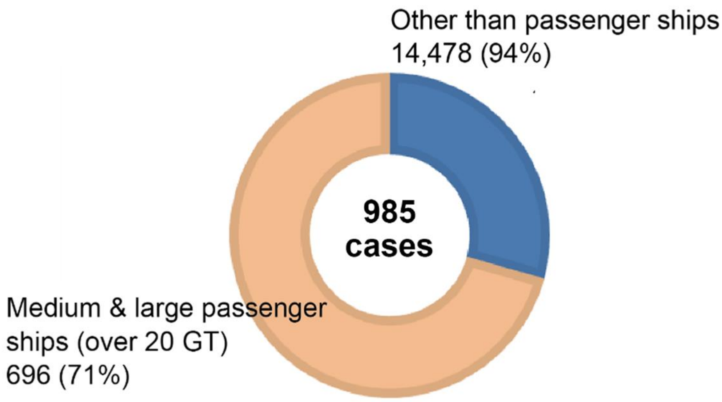


Figure 2 Proportion of accidents involving small passenger vessels among all passenger ships

- Small passenger ships account for about 29% of all passenger ship accidents.
- With a total of **289 accidents** involving small passenger ships, a reduction is desirable.

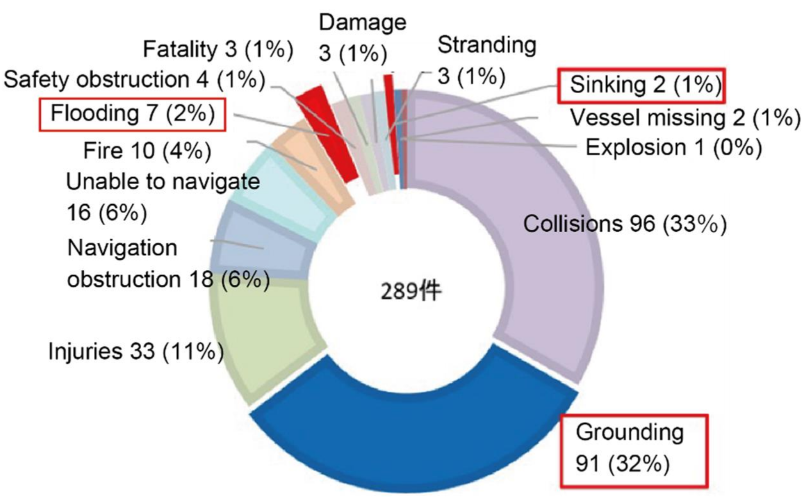


Figure 3 Trends in accident types for small passenger vessels

- Among accident types in small passenger vessels, collisions, in which factors such as vessel type and operating area contribute little, account for about 33%.
- Accidents caused by factors related to **the characteristics of the operational area** (such as weather, sea conditions, and the seabed) include "**grounding**," which accounts for about 32% (nearly equal to collisions) with 91 cases and may cause severe secondary damage (e.g., hull damage). Additionally, there were 7 cases of "**flooding**" and 2 of "**sinking**," both posing high risks to vessels and lives.

Reference （Definitions of accident types ）

・Grounding ： When a vessel mounts an underwater feature (e.g., a coast or reef)

・Stranded ： When a vessel's hull contacts a sandy seabed without causing damage to the vessel or crew/passengers

・Safety obstruction ： When dangerous tilting (e.g., from improper loading) creates an imminent risk of capsizing

・Navigation obstruction ： When events like engine failure increase risk, even without immediate danger

Of the two "sinking" accidents shown in Figure 3, one was the passenger ship sinking off the west of the Shiretoko Peninsula in April 2022 (hereafter, the "Shiretoko passenger ship sinking accident").

Because a small passenger vessel sinking in severe weather poses an extremely high risk to lives, it is essential for operators to continuously implement preventive measures while fully understanding the **operating area's characteristics and associated risks**.

3. The characteristics of the operational areas

Following the Shiretoko passenger ship sinking accident, the Shiretoko Passenger Ship Sinking Accident Countermeasures Study Committee (under the Ministry of Land, Infrastructure, Transport and Tourism) issued "Comprehensive Safety and Security Measures for Passenger Ships" in December 2022, recommending measures tailored to "each company's and operating area's unique conditions." Likewise, the JTSB's report stresses the need for prevention measures based on "operational area characteristics."

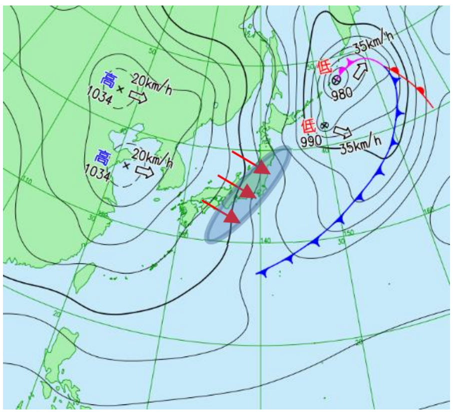
To ensure safe navigation, masters and crew must fully understand and master their vessel's inherent traits and handling quirks, such as hull structure and operability, and gain firsthand knowledge of the features and risks of sea where operators sail their own ships. This principle also is applied to safety managers who is responsible for the safety of overall their business and operation managers who is responsible for overall operational management under the management system.

Below are representative examples of the characteristics of passage area (namely, operational risk factors which influence essentially on the safety of navigation) that small passenger vessel operators should understand to ensure safe operation.

(1) Risks from meteorological and sea conditions

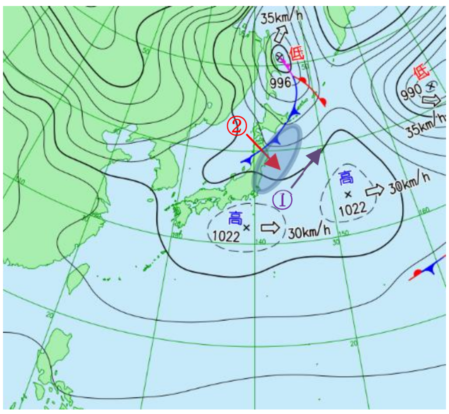
1) Open-ocean areas

i) Meteorological influences such as "monsoons" and "developed low-pressure systems with cold fronts" pose a flooding/sinking risk



（Figure 4: Example of pressure configuration during **winter monsoon gusts**）

Source: Japan Meteorological Agency website



（Figure 5: Example of pressure configuration after **a cold front**）

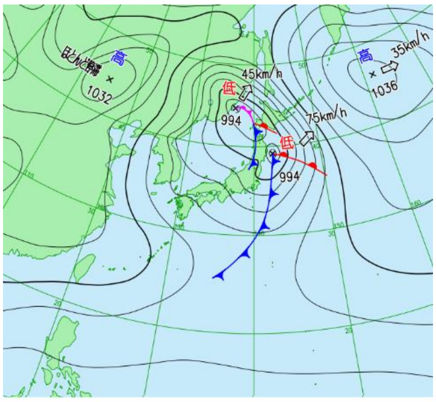
Source: Japan Meteorological Agency website

・In the Sea of Japan coastal area during winter, a high-pressure area in the west and a low-pressure area in the east create closely spaced isobars that produce a steep pressure gradient. **<u>A northwest seasonal wind</u>** <u>(Figure 4, red arrow)</u> blows, and the light blue ellipse shows the general wind path.

・When **a cold front** extending from a developed low passes, the wind direction may change suddenly. For example, Figure 5 shows the wind shifting abruptly from southwest (purple arrow ①) to **<u>northwest</u>** <u>(red arrow ②)</u>, with the light blue ellipse indicating the

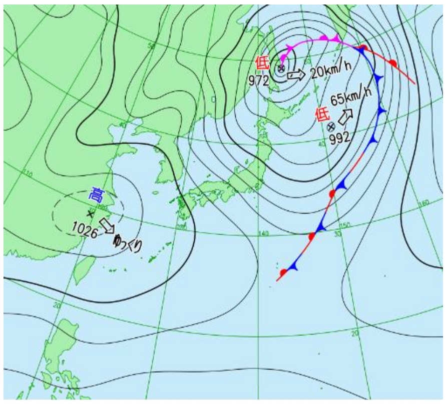
(*Note: The Shiretoko passenger ship sinking accident occurred when a cold front passed, causing a sudden wind to change that exposed the ship to high waves from the northwest or west.)

・In addition, from winter to spring, low-pressure systems move along both the Sea of Japan and Pacific coasts, bringing rain, snow, and strong winds. Operators should also be alert to "**<u>twin-cell low-pressure systems</u>** (Figure 6)," mid-latitude cyclones that rapidly develop from the East Sea of Japan toward the Kuril Islands (with the central pressure dropping by 24 hPa or more within 24 hours, also called "**<u>bomb cyclones</u>**; Figure 7"), and "**<u>regional seasonal winds</u>** (Figure 8)."



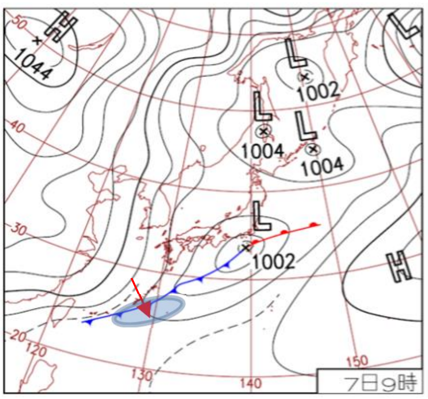
(Figure 6: Example of twin-cell low pressure system patterns)

Source：Japan Meteorological Agency website



(Figure 7: Example of bomb cyclone patterns)

Source：Japan Meteorological Agency website



(Figure 8: Example of atmospheric pressure patterns in Nansei Island region)　Source：Japan Meteorological Agency website

・　Figure 8 illustrates an example of atmospheric pressure pattern during the seasonal wind "Ningwachi Kajimai," which occurs from March to May around Okinawa Island and the Sakishima Islands.

The 'Ningwachi Kajimai' occurs when a rapidly developing low-pressure system with a front moves through the East China Sea after the area between the Okinawa Main Island and the Sakishima Islands has been covered by high pressure, resulting in a sudden shift from a southerly wind to a strong northerly wind (red arrow in the left figure).

When strong maritime winds are expected to generate high waves with the pressure pattern as described above, it is crucial to closely monitor **weather warnings and advisories, including wind speed and wave height information from the Japan Meteorological Agency**. Even after pressure patterns weaken, it is essential to confirm that sea conditions have stabilized and manage operations accordingly.

ii) Effects of ocean wind waves and swells from offshore 【Flooding/Sinking Risk】

Even if the weather and wind conditions in the operating area are calm, “wind waves” generated by typhoons or intense low-pressure systems can travel long distances as “swells.” These swells may develop into “high waves,” affecting navigation.

In general, the formation and changes of wave motion, including wind waves and swells, are as follows.

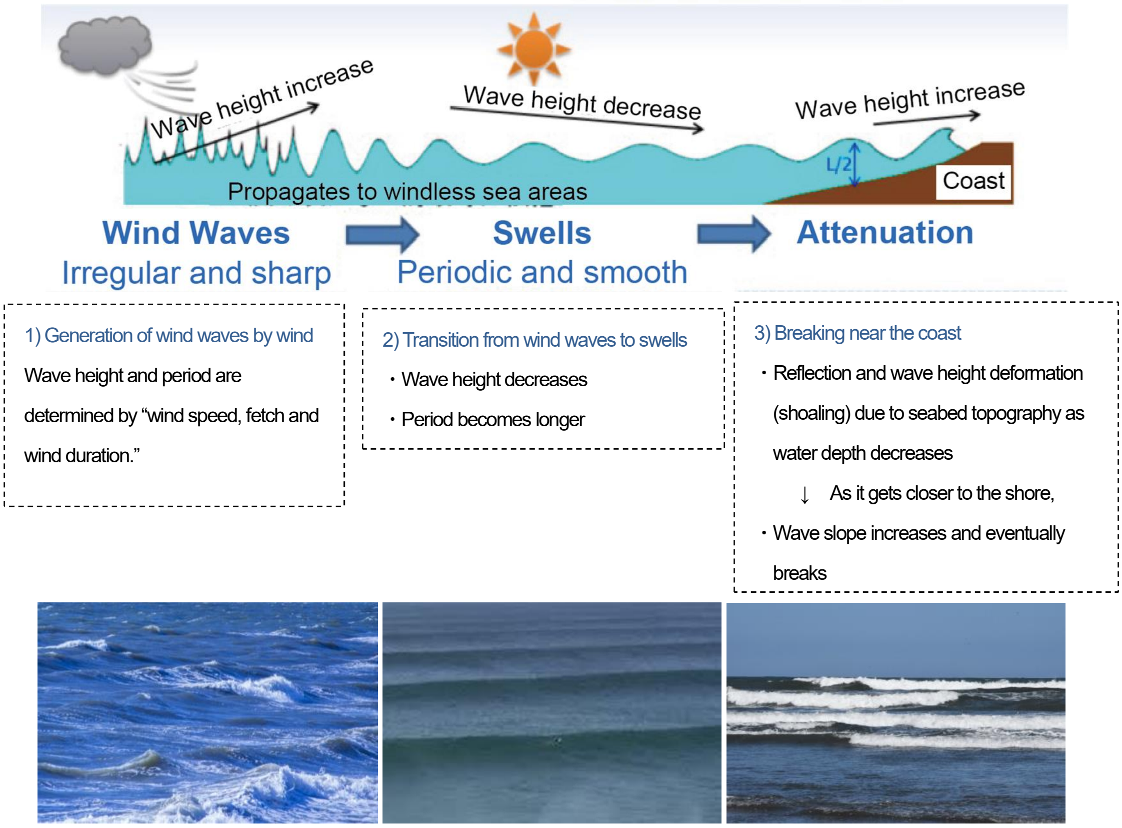


Figure 9 -Source: Japan Meteorological Agency, “Overview of wave forecasts & verification of high wave cases” (modified)

The breaking waves mentioned as number 3) on the right side of Figure 9 are also called "shore waves."

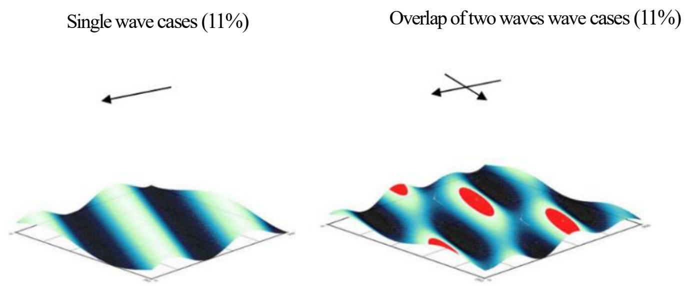


Figure 10-Source: Nadao Kono & Ayako Yamane, (2018), Addition of “information on hazardous rough sea areas for navigation” to Wave forecast maps. Meteorological Bulletin, 85, 1-12.

Offshore, waves from multiple directions can overlap, creating complex sea surface patterns and suddenly generating large waves (red areas in Figure 10).

In particular, sharp, pyramid-shaped "cross waves" can have short or irregular periods with sudden upward force, posing a risk of severe vessel instability and capsizing.

Another concern is "rogue waves," which occur when multiple waves align in period and phase, combining into a single wave several times higher than the significant wave height (see note). Statistically, one in 10 waves reaches 1.27 times the significant wave height, one in 100 waves reaches 1.61 times, and one in 1,000 waves reaches twice the height. Waves twice the significant wave height are estimated to occur about once every two hours.

Note: The significant wave height is the average height of the highest one-third of observed consecutive waves at a certain point.
It closely matches the wave height estimated by experienced observers and is commonly used in weather and wave forecasts by the Japan Meteorological Agency.

BACK TO BASICS!

In the Shiretoko passenger ship sinking accident, the master lacked sufficient understanding, knowledge, and experience regarding the weather and sea conditions of the area, leading to an inadequate ability to assess navigation safety. Lessons from this and similar accidents highlight the following fundamental actions.

【Weather and Sea Condition Assessment】

- Do you understand the weather and sea conditions of the operating area based on accumulated information and experience?
- Can the master and operations manager assess departure feasibility using weather charts and meteorological data?
- Do the master and operations manager accurately understand the wind speed and wave height limits set in the operating standards?
- Are weather observation methods based on natural phenomena and animal behavior used to predict local weather patterns?
- Is the latest weather information from the Japan Meteorological Agency or private providers checked before departure?
- Is the Maritime Safety Agency's "Marine Conditions Display System" used to supplement weather and sea condition information?
- Are real-time weather and sea condition monitoring apps utilized during operations?
- Is communication between the master and operation manager ensured regarding weather conditions and navigation decisions?

【Operational Decision-Making】

- Do you understand your company's operational standards and prioritize safety when making departure decisions?
- Do you ever decide to depart without clearly determining an alternative course when worsening weather and sea conditions are expected?
- Have you established a system to designate and utilize port of refuge in case rough weather makes navigation difficult?
- Is there a cooperative framework with local operators for sharing weather and sea condition information and making operational decisions?
- Is a safety culture in place that respects the master's decisions to suspend operations, turn back, seek shelter, or make an unscheduled stop?

（Column 1） Operational standards

Passenger ship operators are required by the Maritime Transport Act to establish "Safety management regulations" and develop "Operational standards" to implement them effectively.

In the Shiretoko passenger ship sinking accident, the operator had set the following wind speed and wave height limits in the "Operational standards" for deciding whether to operate. If any of these conditions were likely to be met, the vessel was required to suspend departure, turn back, seek shelter, or make an unscheduled stop.

1） **Departure decision (based on port observations): Wind speed: 8 m/s or higher, or wave height: 0.5 m or higher**
2） **Departure decision (based on expected conditions during navigation): Wind speed: 8 m/s or higher, or wave height: 1.0 m or higher**
3） **Operational navigation decision (for stopping, turning back, etc.): Wind speed: 8 m/s or higher, or wave height: 1.0 m or higher**

Despite the likelihood of reaching condition **(2)** during navigation, the vessel was still allowed to depart.

How can wind speed and wave height be accurately assessed on-site before departure?
One useful reference is the "**Beaufort scale of wind force**," described below.

For example, the "Operational standards" in the Shiretoko passenger ship sinking accident set a threshold of **8 m/s wind speed**. Let's see how this is classified in the Beaufort scale. (Note: The scale ranges from 1 to 12, but only a portion is shown in the table below.)

Beaufort Scale	Explanations	Equivalent wind speed		Reference wind speed (meter)
		knot	meter/second	
0	Mirror-like Sea surface	< 1	0~0.2	-
1	Small ripples appear like fish scales, but no foam on the wave crests.	1~3	0.3~1.5	0.1(0.1)
2	Small waves begin to foam, still short but distinct. The wave crests appear smooth and unbroken.	4~6	1.6~3.3	0.2(0.3)
3	Larger small waves. The wave crests start to break, and foam appears glassy, with occasional whitecaps.	7~10	3.4~5.4	0.6(1)
4	Small but longer waves. Whitecaps became quite frequent.	11~16	5.5~7.9	1(1.5)
5	Medium-sized waves, becoming more distinct and longer. Many whitecaps appear, sometimes accompanied by spray.	17~21	8.0~10.7	2(2.5)
6	Larger waves foam, with foamy crests expanding in various places and frequent spray.	22~27	10.8~13.8	3(4)
7	Waves grow larger, and the white foam created by breaking wave crests begins to streak and drift downwind.	28~33	13.9~17.1	4(5.5)
8	Somewhat smaller but longer large waves. The streaks of breaking wave crests start turning into sea spray, and the foam forms distinct streaks that are blown downwind.	34~40	17.2~20.7	5.5(7.5)

Figure 11- Source: Japan Meteorological Agency, Beaufort scale (excerpt)

Figure 11 shows that 8 m/s corresponds to **Beaufort Scale 5** (red box).

Reference wave heights for offshore areas indicate waves reaching approximately 2.0 m**,** with a maximum of around 2.5 m**.**

The sea surface condition at this level generally appears as shown in Figure 12 (photo).

Figure 12- Source: Japan Meteorological Agency, Beaufort wind scale (modified)

Therefore, if "8 m/s wind speed or 1.0 m wave height" is set as the threshold in Operational Standards 2) and 3)**,** once wind speed reaches 8 m/s**,** wave height is also likely to exceed 1.0 m**.**

The Beaufort scale classifies 1.0 m wave height within Scale 3 (around 5 m/s) to Scale 4 (see purple box). The corresponding sea surface conditions generally appear as shown in Figure 13 (photo)**.**

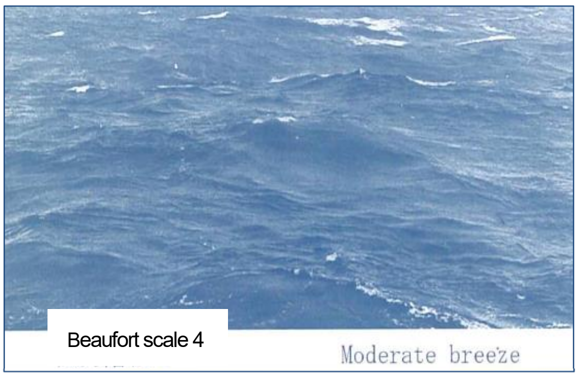


Figure 13- Source: Japan Meteorological Agency, Beaufort wind scale (modified)

Thus, if 0.5 m wave height or around 5.5 m/s wind speed is observed in the port, **offshore waves may already be reaching 1.0 m**. Regardless of the 8 m/s threshold, prioritizing safety and making flexible operational decisions (such as canceling operations) in advance is crucial.

→ Have you established appropriate operational standards for your company while prioritizing passenger safety? Do you consider flexible operations, such as canceling departures even if conditions are below the threshold based on weather and sea forecasts?

2) Coastal Waters

i) Impact of river mouth currents on high waves [risk of flooding/capsizing/sinking]

・ Near large river mouths, complex "river mouth currents" form due to a mix of river flow, nearshore currents, and tidal currents. These currents can cause high waves not only when river water levels rise but even in normal conditions due to interactions with nearshore currents and seabed topography.

・ ”Swells” generated by typhoons or deep low-pressure systems can transform into surf waves ("Iso-nami") in shallow coastal areas. When these waves collide with river mouth currents, they can create high waves, requiring careful attention.

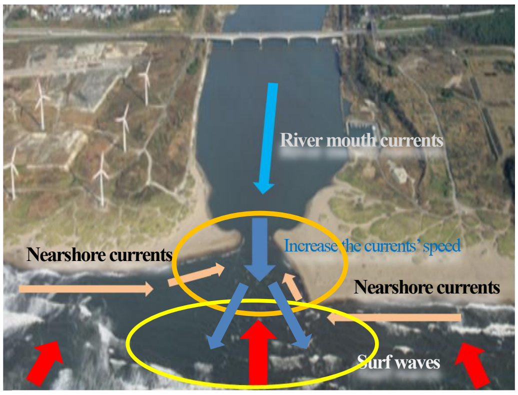


Figure14-The river mouth of Omono River (modified)

・ In Figure 14, the orange circle at the river mouth indicates the area where "**river mouth currents**" occur, while the yellow-circled area extending offshore shows the general region where "**high waves caused by surf waves and river mouth currents**" form.

・ Additionally, even in lakes connected to the open sea via waterways (such as Lake Hamana, Shizuoka), high waves can occur offshore from the waterway exit due to the effects of surf waves and tidal currents.

ii) Impact of surf waves on high waves [risk of flooding/capsizing/sinking]

・Even in areas without the influence of river mouth currents, high waves caused by "**surf waves**" require careful attention.

・ When returning to port while sailing toward the shore, surf waves may act as “following waves,” causing waves to crash into the stern of the vessel.

iii) Impact of High Waves Near Coral Reefs [risk of flooding/capsizing/sinking]

・ In “coral reef” areas such as the Nansei Islands, shallow waters extend from the coastline, transitioning into deeper waters beyond the elevated edge of the reef.

This elevated edge is called a "reef crest," where breaking waves form, creating high waves similar to surf waves.

(Column 2) Steering impact of following waves

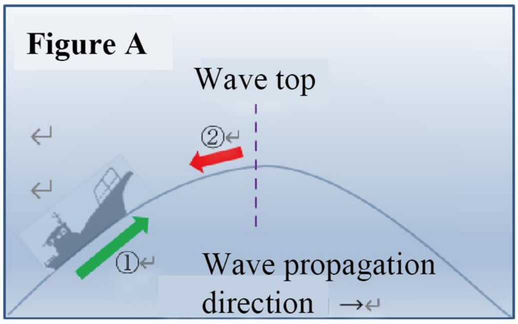
When sea conditions deteriorate rapidly, vessels may encounter surf waves as "following waves" from the stern not only during offshore navigation but also when returning to shore in coastal areas. If this occurs, maintaining a low speed that preserves steering control (scudding) can help reduce vessel movement. However, improper handling may result in capsizing or sinking in an instant.

When waves come from behind, there are two significant risks: "Pooping Down," where waves crash over the stern, possibly damaging the rudder and stern structures, and "Broaching," which happens when waves strike at an angle from behind. Of these, "**Broaching" poses the greatest danger.**

【Broaching】

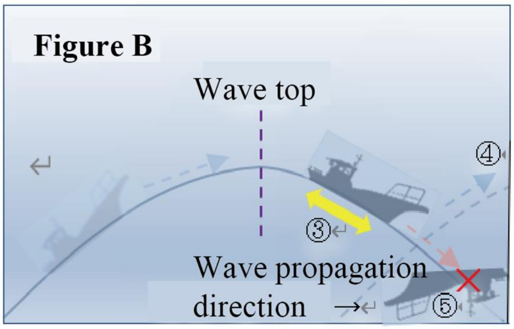
Broaching is a phenomenon that occurs when a vessel encounters "following waves" from the stern, where the wave speed slightly exceeds the ship's speed. As the vessel surfs down the wave slope, its speed nearly matches the wave speed, resulting in a loss of steering control. This leads to sudden yawing and severe heeling, causing the vessel to lose stability and increasing the risk of capsizing. Broaching is more likely to occur in a "diagonal following wave" condition, where waves approach the stern at approximately 20 to 40 degrees.

To avoid this phenomenon, the following maneuvering techniques are necessary:



As shown in Figure A, just before the wave crest, "increase speed ①" while climbing the wave slope, keeping the vessel attached to the wave's surface. "Reduce speed ②" just before reaching the wave top.

* Ensure **frequent speed adjustments** to avoid plunging into the wave trough (descending slope).



As shown in Figure B, if the vessel enters the descending wave slope, adjust speed to "minimum steerageway" and allow the wave to pass ③. Then, increase speed ④ to climb the next wave slope.

* If the vessel remains on the descending slope with speed nearly matching the wave, it may lose steering control, leading to sudden yawing, excessive heeling, and ultimately capsizing ⑤.

A fundamental preventive measure is to thoroughly adjust the course to **avoid receiving diagonal following waves** from the stern.

In contrast to following waves, when encountering rough seas from the bow, methods such as "Heave-To" (a maneuver to maintain the vessel's position in rough seas) or using a "sea anchor" (a parachute-like device deployed to the sea to resist the waves and keep the bow facing them. We can also call parachute anchor) can be used to drift.

Note: "Heave-To" refers to a maneuver in rough seas or during a tsunami, where the ship's bow is angled 2-3 points (about 30 degrees) to the waves. This technique maintains the vessel's posture and minimal rudder speed while riding out the waves.

BACK TO BASICS!

Accidents where small vessels of various types are flooded, capsized, or sunk due to surf waves and other following waves are common. Especially in the operation of small passenger vessels carrying lives, it is essential to avoid careless departure decisions based on overconfidence or complacency, and to always prioritize safety by adhering to the basic principles of safe navigation.

- Do you have a good understanding of the weather and sea conditions, areas, and points where high waves are likely to occur in the operating area?
- Are departure decisions made with safety as the top priority, considering the weather and sea conditions at the planned return time?
- Do you check the watertightness of openings, such as verifying the closure status of access points, during pre-departure inspections?
- Is there any vulnerability in your vessel's hull structure when facing waves coming from the stern?
- Does the master have the knowledge and skills for rough weather navigation, including avoiding broaching phenomena?

(2) Risks related to seabed topography

1) Presence of reefs, rock formations, and tidal effects in coastal navigation areas 【risk of grounding/stranded】

・ In coastal waters with sunken rocks, rock which covers and uncovers, other rocky formations or exposed reefs factors such as dense fog, deviation from designated routes leading to position misjudgment, and wind or tidal currents may increase the risk of grounding or stranded.

・ In shallow waters, spring tides can reduce the under keel clearance (UKC), increasing the risk of stranded.

・ The visual representation of sunken rocks, rock which covers and uncovers, rock awash, which are key components of reef structures, is shown in Figure 15 below.

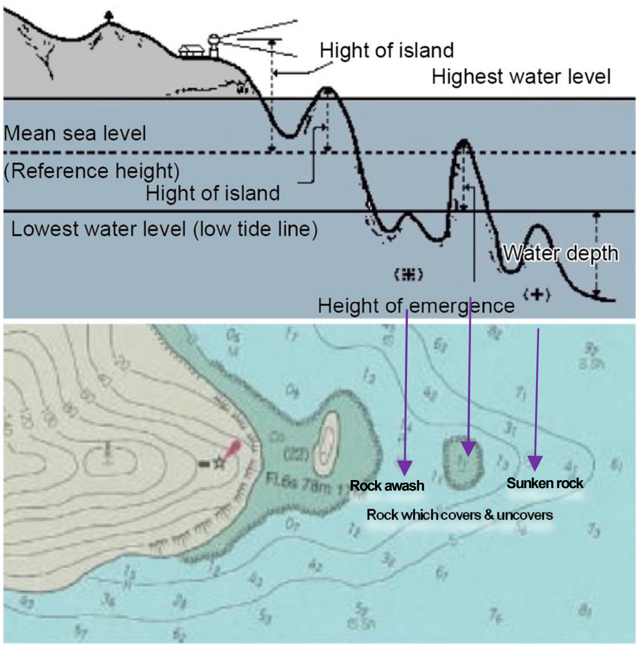


Figure 15-Source: "Depth and elevation reference chart" from Japan Coast Guard website (modified) https://www1.kaiho.mlit.go.jp/KAN1/soudan/kijun.html

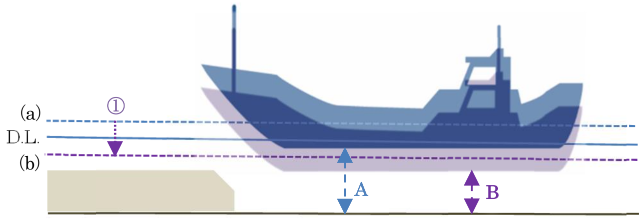
・ "Sunken rock" is a rock located below the chart datum (lowest astronomical tide) and remain submerged at all times.

・ "Rock which covers and uncovers" refers to rocks situated between the lowest and highest water levels, submerging at high tide and exposing their peaks above the surface at low tide.

・ "Rock awash" describes a rock whose peak aligns with the lowest water level at low tide, making it continuously washed by waves.

・ The mechanism of contact in shallow waters due to tidal effects (spring tide) is as follows.

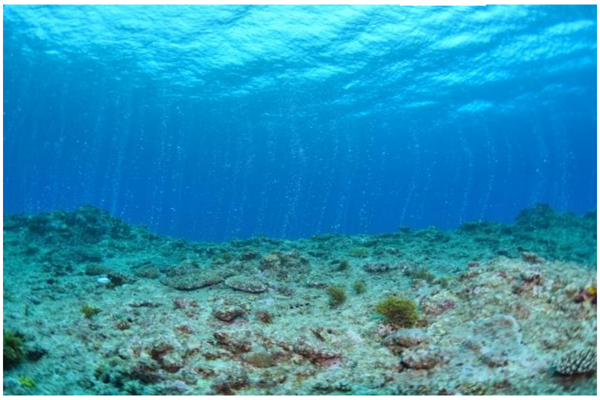
(Figure 16)



1. The draft of the vessel (blue silhouette) shown in Figure 16 is assumed to be the distance from the tidal level (a) above the datum level (D.L.) to the bottom of the hull.

2. The **under-keel clearance** (**UKC**) at that time, from the ship's bottom to the seabed, is represented by the vertical blue arrow A. In this case, the seabed elevation on the left side of the figure can be cleared.

3. However, if the water level drops below the datum level (b) due to the effect of a **spring tide** (purple arrow ①), the UKC of the same vessel (purple silhouette) is reduced to the vertical purple arrow B.



4. In this situation, continuing navigation would lead to contact with or grounding on the seabed elevation on the left side of the figure. Additionally, insufficient tidal planning can result in a low UKC against the D.L., increasing the risk of contact sunken rocks or grounding. Even when navigating at high tide, if the UKC above the peak of an uncovered rock is insufficient, there is a risk of contact or grounding.

BACK TO BASICS!

The year before the Shiretoko passenger ship sinking accident, the same vessel ran aground after deviating from the designated route without recognizing the presence of rocks and reefs. Grounding accidents can cause severe secondary damage beyond hull damage, including risks to human life and marine pollution. Therefore, a structured approach is necessary to ensure that masters and crew thoroughly understand the seabed topography, tidal currents, and tidal effects in the operating area.

- Does the master have a clear understanding of the location of reefs in shallow waters of the operating area?
- Are the positions of reefs registered in the vessel's GPS plotter?
- Are clearing lines for reefs registered in the GPS plotter?

- Are you operating the GPS plotter with an understanding of its positioning accuracy?
- Are you using the nautical electronic reference chart (new pec) with awareness of shoreline display errors?
- Can the master and crew identify reef locations using surrounding landmarks instead of relying solely on navigation aids?
- Can the crew steer and maintain course while considering the unique wind and tidal currents of the operating area?

- Does the designated route have sufficient clearance from the shore, considering shallow waters and wind/tidal effects?
- Are you deviating from the designated route to navigate closer to the shore for sightseeing or to shorten the route?
- Have you obtained tidal and current information for the day before starting operations?

(Column 3) Clearing Line

When navigating near the coastline, it is essential to set a "clearing line" in advance on nautical charts, GPS plotters, or radar screens to prevent grounding on reefs or stranded.

- A clearing line is used to separate dangerous and safe zones by establishing **bearing lines or equidistant lines from prominent landmarks** on nautical charts (or GPS plotter screens). It helps prevent grounding in shallow or narrow waters.
  By setting a clearing line, deviations into dangerous areas can be immediately detected without frequent position checks, allowing the operator to focus on navigation.

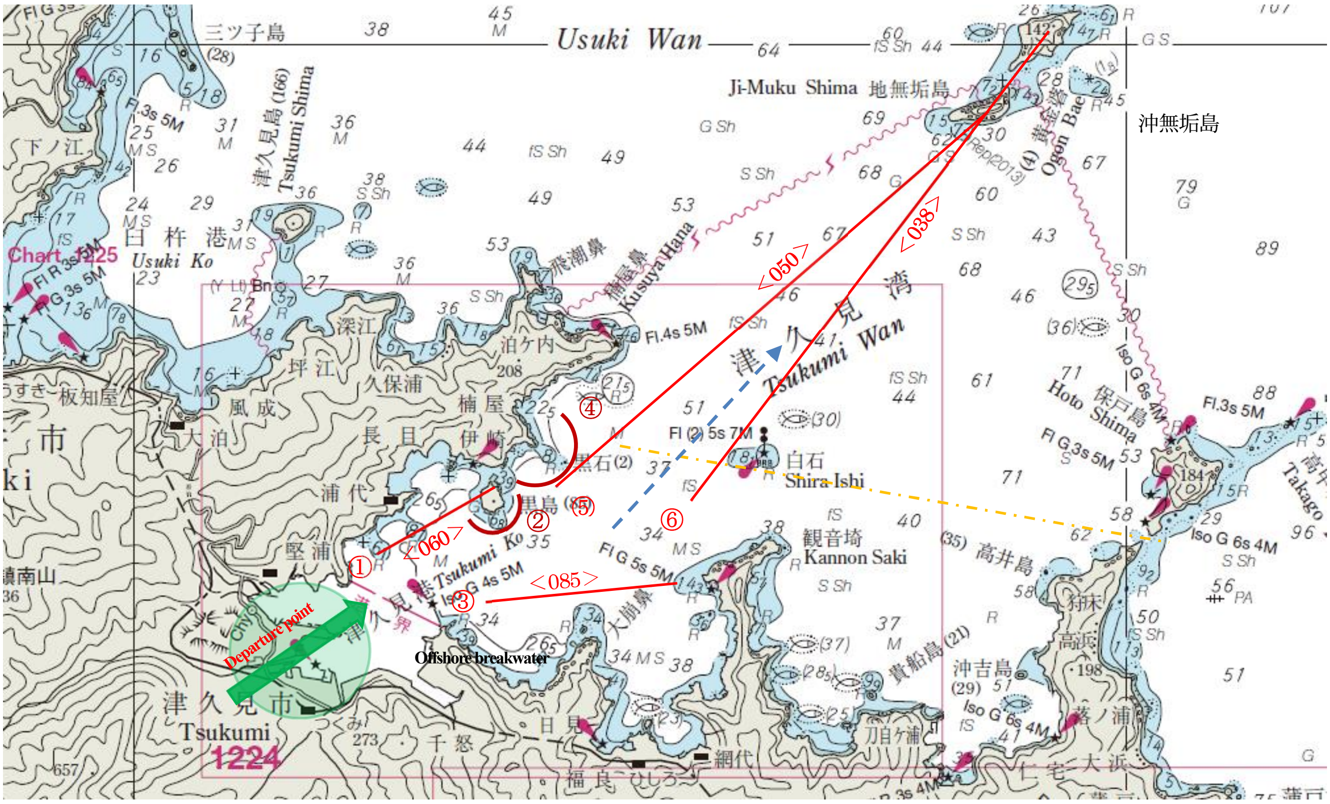


Figure 17- Resource: Japan Coast Guard website (nautical charts W151 modified)
https://www1.kaiho.mlit.go.jp/TUHO/tuho/html/tuho/pdf/2016/hoseizu/2016-39-577-W151.pdf

Figure 17 illustrates an example of a clearing line for a route departing from Tsukumi Port, Oita, toward open waters (blue dashed line).

For a while after departure, maintaining a steady course is challenging due to avoidance maneuvers. Additionally, the narrow coastal waters contain shallow areas with sunken rocks ("+" symbol), the prominent rock above water "Kuroishi", and the "Shiroishi" isolated danger mark. To prevent grounding in an uncertain course state, clearing lines ①–⑥ have been set.

1. Immediately after departure, navigate with caution regarding **clearing line** ① (a true bearing of 060° connecting Kuroshima's peak and the edge of the shallow area with sunken rocks). If Kuroshima's peak exceeds a true bearing of 60°, the vessel enters the danger zone.

2. After passing the harbor breakwater's tip at a true bearing of 180°, avoid entering the inside of **clearing line** ② (a hazard avoidance circle equidistant from Kuroshima's peak to the shallow area). Additionally, pay attention to **clearing line** ③ while navigating.

3. After passing Kuroshima, navigate without entering the inside of **clearing line** ④ (a hazard avoidance circle based on the cape northwest of Kuroishi). Sail between **clearing line** ⑤ (a true bearing of 050° connecting Chimuku Island's peak and the intersection of clearing line ④) and **clearing line** ⑥ (a transit line on a true bearing of 038°, connecting Okinuku Island and Chimuku Island's peaks and extending to the shallow area west of Shiroishi). Once past the yellow line connecting Kusuyahana and Hoto Island, the vessel enters wide area, allowing for steady course alignment as needed.

4. Case studies of the accident

The Shiretoko passenger ship sinking accident was partly due to departing under conditions where wind speeds were expected to reach 8 m/s or wave heights 1.0 m or more, exceeding operational safety standards. Additionally, the grounding accident involving the same vessel a year prior resulted from a failure to recognize the presence of shallow areas. These factors highlight a lack of awareness and measures regarding "the characteristics of the operational area," as detailed in Chapter 3 of this digest.

This chapter reviews grounding, flooding, and sinking accidents where the characteristics of the operational area contributed as causal factors, posing serious risks not only to vessels but also to passengers. By examining past accidents involving small passenger vessels, we aim to reflect on universal lessons learned from both direct and indirect causes, as well as underlying factors, to prevent disasters like the Shiretoko passenger ship sinking accident from recurring.

1. Case of grounding and sinking due to unawareness of reef locations in the operational areas

【Vessel specifications】

Passenger vessel A: 19 GT, registered length 11.95m × beam 4.36m × depth 1.83m

Max capacity: 77 people (including 74 passengers), launched**:** March 1987

【Accident information】

Type: grounding (followed by sinking)

Date & time: November 19, 2020, around 4:36 PM

Location: northwest off Hasajima, Sakaide City, Kagawa Prefecture

Planned route: Takamatsu Port → Seto Ohashi Circuit → Sakaide Port

Weather & sea conditions: cloudy with occasional sunshine, wind: south, 4–5 m/s, wave height: ~0.5m, visibility: good

Tidal current: eastward, ~1.7 knots

Draft: bow ~0.90m, stern ~1.38m

【Accident summary】

The vessel operated in an unfamiliar area without conducting a prior waterway survey or identifying the locations of reefs. During navigation, the master altered the original voyage plan and ran aground on a rock which covers and uncovers in shallow waters, leading to the vessel's sinking.

Accident Investigation Report Web Link：https://www.mlit.go.jp/jtsb/ship/rep-acci/2023/MA2023-1-3_2020tk0012.pdf

【Factual overview】

1. Passenger Vessel A was normally used as a water taxi offshore of Takamatsu Port. It was chartered for an elementary school field trip on November 19, 2020.

2. **The planned voyage** for the school trip was to depart from Takamatsu Port, head north along the western side of the Seto Ohashi Bridge via the waters south of Yoshima, pass eastward through the Shimotsuiseto Bridge north of Hitsuishi Island, then navigate south along the eastern side of the Seto Ohashi Bridge before arriving at Sakaide Port.

3. The vessel, with the master and one deck crew on board, departed Takamatsu Port at around 3:30 PM on November 19, carrying 60 passengers (52 students and 8 accompanying teachers and staff).

4. At around 4:35 PM on the same day, while navigating west of Wasa Island, north of Yoshima, a supervising teacher was explaining Iwakuro Island, visible off the starboard bow, to the students. Based on his/her own judgment, the master decided to **alter the original voyage plan** and pass under the Seto Ohashi Bridge (Iwakuro Island Bridge) to head east of Iwakuro Island.

5. The master was aware that the usual passage towards the east of Iwakuro Island was between the second and third bridge piers. However, having seen fishing boats pass between the third and fourth bridge piers two to three times in the past, he/she decided to take **a direct course** toward the east of Iwakuro Island by passing between the third and fourth piers.

6. To take a direct course east of Iwakuro Island, the master turned starboard and navigated northeast near the fourth bridge pier. However, Passenger Ship A was **pushed by an eastward current of approximately 1.7 knots** and, at around 4:36 PM, ran aground on the rock which covers and uncovers (commonly known as "Osowai"), which had a water surface height of approximately 2.0 meters.

7. After running aground on Osowai, Passenger Ship A took on **water through a hull breach** at the stern portside bottom, causing it to capsize. At around 5:20 PM, a nearby fishing boat began towing the vessel, but it sank at approximately 5:25 PM northeast of Koyoshima.

8. The passengers (four of whom were injured) and crew were wearing life jackets and waited for rescue either in the water or on the vessel. By around 5:20 PM, all were rescued by nearby fishing boats and a patrol vessel.

For reference, **the key events (4–6) in the accident area are marked by numbers** on the map below.

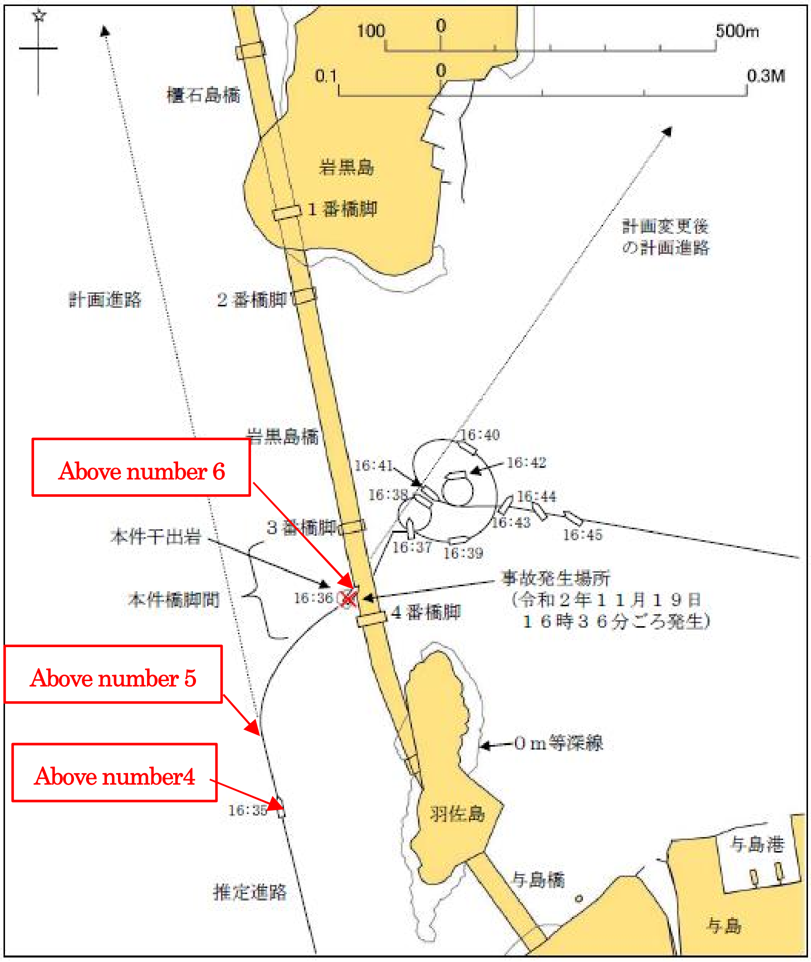


Figure 18- Around the accident area

Additionally, the tidal conditions at the time when passenger ship A ran aground are shown in the following chart.

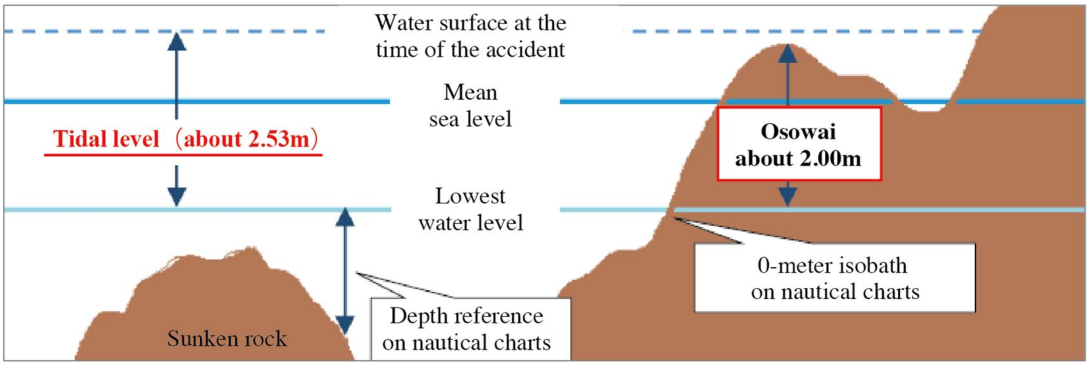


Figure 19-Tidal conditions at the time of the grounding

At the time of the accident, **the tide level was approximately 2.53 meters** above the lowest water level, which serves as the depth reference on nautical charts. Since Osowai protrudes about 2.00 meters above the lowest water level, it was submerged at this tide level. As a result, the depth from the water surface to the top of Osowai was about 0.5 meters.

Given that passenger ship A had a bow draft of approximately 0.90 meters and a stern draft of approximately 1.38 meters at the time of the accident, it is clear that the vessel could not safely pass over Osowai, which was about 0.5 meters below the water surface.

【Probable Cause of the accident】

The causes of the grounding can be classified as follows:

(Direct cause)

- The GPS plotter was not properly used, leading to a failure to notice the presence of Osowai.

(Indirect causes)

- The vessel was **carried toward the shallow area** with Osowai due to the eastward tidal current.
- **A direct course** was taken toward the east of Iwakuro Island, **passing between the third and fourth bridge piers.**
- **The original voyage plan was changed on the spot** without a thorough understanding of the reef locations in the operating area.
- No prior **hydrographic survey** of the operating area was conducted.
- No nautical chart with **clearing lines** was available on board.

(Background factors)

- The master **assumed he/she understood the reef locations** based on only a few past voyages **in the area**.
- The safety manager failed to provide regular in-house training in accordance with **the safety management regulations.**

【Safety Actions】

The accident investigation report outlines the following prevention measures:

- Before departure, conduct a hydrographic survey using nautical charts to identify the location of obstacles and plan a safe voyage plan.
- Be aware that electronic navigation charts (new pec) may not provide detailed information on obstacles like a rock which covers and uncovers or actual shorelines
- Avoid sudden route changes without prior hydrographic surveys
- Use GPS plotters with detailed display settings to verify vessel position accurately
- Keep onboard charts marked with clearing lines as per safety management regulations
- Safety managers must conduct regular safety training based on safety management regulations and relevant laws

【Lesson learned】

This accident occurred when a master, primarily operating a sea taxi near Takamatsu Port, chartered a vessel in an unfamiliar area **without conducting a prior hydrographic survey or setting clearing lines**. Relying on limited past experience, the master **abruptly changed the original voyage plan** and navigated closer to shallow waters to shorten the route, ultimately grounded due to pressure of tidal currents.

While the accident was mainly caused by the master's human error, the underlying factors included the safety manager's failure to provide **training on organizational safety management regulations** and the master's mistaken **assumptions** about his/her knowledge of the reef locations.

Additionally, since the master also served as the operations manager, there was no independent oversight or guidance on the appropriateness of his voyage plan or changes.

The master failed to implement practical procedures suited to the "characteristics of the operating area," and the overall safety management system was not properly enforced within the organization. In this sense, the accident shares fundamental similarities with the Shiretoko passenger ship sinking accident.

The accident occurred in an inland sea, where calm waters, a sea temperature of about 20°C, the presence of nearby fishing vessels, and the passengers remained calm during the evacuation. These factors contributed to a coordinated and swift rescue operation allowing all to be rescued before nightfall. However, if any of these conditions had been different, the consequences could have been much more severe.

↓

Let go of assumptions like "It should be fine" and always return to the basics, prioritizing safe navigation at all times!

2. Case of capsizing and sinking due to unique oceanographic conditions in the operating areas

【Vessel specifications】

Motorboat A: gross tonnage: less than 5 tons, registered length: 5.40m × width: 2.10m × depth: 1.00m, maximum capacity: 6 persons (including 5 passengers), launched: October 1995

【Accident information】

Type of accident**:** capsizing (presumed to have sunk)

Date and time**:** around 5:40 AM on June 26, 2011

Location**:** Offshore, south of Imagireguchi, Lake Hamana, Shizuoka Prefecture

Planned route**:** Marina in Lake Hamana → offshore Enshunada (around 3 km south of Lake Hamana, near an artificial reef) → Marina in Lake Hamana

Weather & sea conditions**:** cloudy, almost no wind, wave height approx. 3.0m

Tidal current: southward flow of approx. 1.0 knot from Imagireguchi into the open sea

Draft: bow draft approx. 0.3m, stern draft approx. 0.5m (freeboard approx. 0.6m)

【Accident summary】

Despite a wave warning for southern Hamamatsu (Enshu South) due to Typhoon No. 5 in the East China Sea, the boat departed. After observing 2m waves at Imagireguchi in Lake Hamana, it continued 3 km offshore to an artificial reef, where three fellow passengers fished. On the return trip, as waves increased, a 3m wave struck the stern south of Imagireguchi, causing the boat to capsize. One fellow passenger drowned.

Accident Investigation Report Web Link：https://www.mlit.go.jp/jtsb/ship/rep-acci/2013/MA2013-2-1_2012tk0044.pdf
(Japanese only)

【Facts and circumstances】

To enhance clarity and understanding, the facts and circumstances of this accident are first presented by outlining the characteristics of the accident area. Then, they are organized using the "Variation Tree Analysis (VTA)" model.

Although this case does not involve a small passenger vessel, it is introduced as a reference due to its relevance—both in using a small boat for passenger transport and in the nature of the accident.

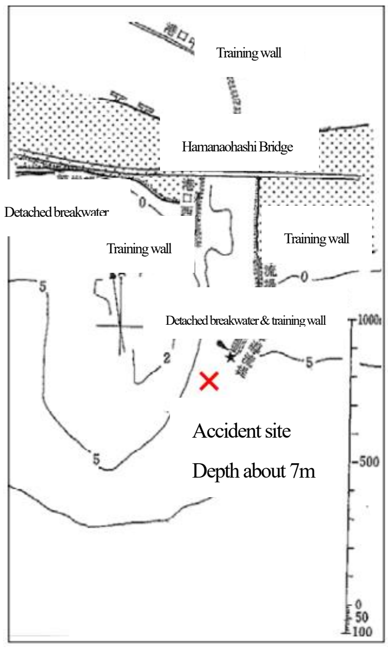


Figure 20-Overview of Imagireguchi

(Characteristics of the accident area)

Imagireguchi in Lake Hamana is a 200m-wide inlet connecting to the Enshu-nada Sea. As the offshore water depth gradually decreases from 10m to 2m near the inlet, incoming waves undergo a transformation. When these regular offshore waves reach the shallow waters, their wavelength shortens while their height increases, often resulting in steep **breaking waves (surf waves)** due to the abrupt change in wave shape.

According to testimony from local fisheries cooperative officials interviewed during the investigation, when **the outgoing tide flows** southward from Imagireguchi, it can **collide with large offshore swells, wind waves, or the Enshu-nada current, generating** extremely high waves—sometimes reaching up to 5 meters. Notably, on the day of the accident, no local fishing boats were operating.

(**Chronology of events**)

June 26
4:30 AM

Around 4:30 AM: **Departed** with three fellow passengers despite a wave advisory (Note 1) ○

Observed **about 2.0m wave heights** near Imagireguchi but continued toward the fishing spot ○

5:00

Around 5 AM: Reached an artificial reef about 3 km south of Imagireguchi, set the engine to neutral, and began fishing

5:20

Between 5:10 and 5:20 AM: Noted increasing wave heights, **decided to stop fishing and return to port**

Increased speed to 15 km/h near the southern tip of the offshore breakwater and proceeded north toward Imagireguchi

While navigating a section where the water depth gradually decreased from 9m to 5m, the boat encountered breaking waves from the **stern** (south side), moving at approximately 25–30 km/h with a height of about 3.0m ○

5:40

Around 5:40 AM, a high wave of about 3.0m struck from the port stern, washing into the boat ○

The vessel capsized (and likely sank soon after) approximately 120m southwest of the offshore breakwater lighthouse in a water depth of about 7m

8:25

The master and two of the three fellow passengers sustained injuries but were rescued; the remaining passenger drowned (Note 2)

master (judgement & actions) Vessel (motion & condition)

Note 1 : Wave Advisory issued by the Shizuoka Meteorological Observatory at 2:42 AM on June 26, 2011, for southern Hamamatsu (Enshu South). It warned of 3.0m wind waves and swells persisting into the early hours of June 27.

Note 2 : The fellow passengers who drowned was on the exposed deck at the time of capsizing and was not wearing a life jacket.

In VTA, bold-framed boxes represent **"variation factors"**, indicating deviations from normal **judgment, actions, or events** related to the accident. In this case, the identified variation factors include: 1)**Judgment:** Departing despite the issuance of a wave advisory, 2)**Action:** Continuing navigation after observing 2m waves near Imagireguchi, 3)**Action:** Navigating while being hit by breaking waves (3.0m) from the stern at 25–30 km/h, 4)**Event:** A high wave striking from the port stern, leading to water ingress.

Additionally, a **"◯ (red circle)"** next to a box represents an **"exclusion node,"** emphasizing that the accident would not have occurred if the factor had been eliminated. Since exclusion nodes are equivalent to direct causes or underlying factors, they typically overlap with variation factor boxes.

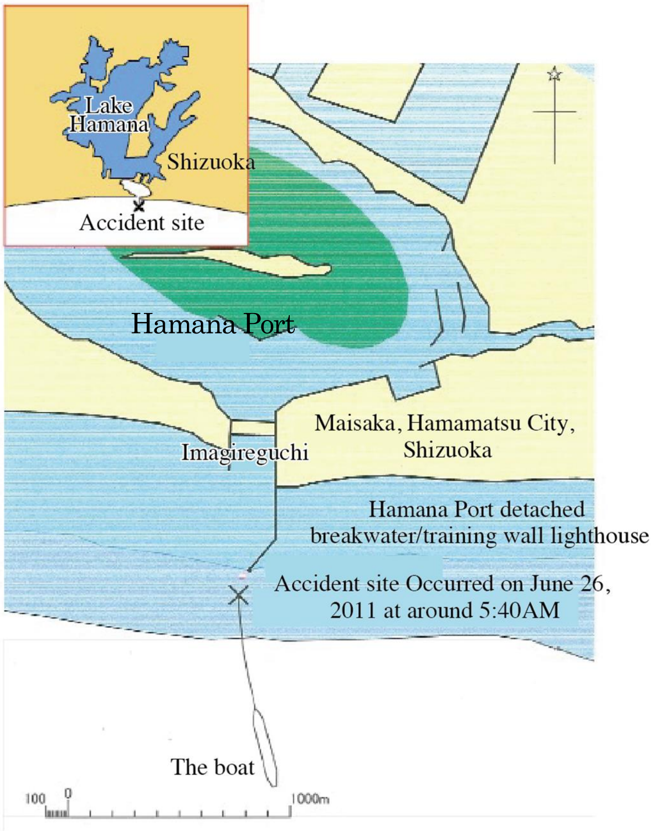


Figure 21 - Estimated navigation route

When classifying the direct causes, indirect causes, and background factors of the capsizing, the following categories apply:

(Direct cause)

- The vessel was **struck by a high wave** from the port stern

(Indirect cause)

- While returning to port after observing an increase in wave height at the fishing site, the vessel navigated north toward Imagireguchi, **receiving breaking waves** with a speed of approximately 25–30 km/h and a height of about 3.0m **in the direction of the stern.**

(Background factors)

- The vessel departed despite the issuance of **a wave warning** predicting continuous swells and wave heights of approximately 3.0m.
- Although **weather conditions** around Lake Hamana were **calm**, swells propagating from the open sea broke near Imagireguchi, where they collided with the ebb tide, **creating high waves**.

【Safety Actions】

The accident investigation report includes a request to the Hamana Lake Comprehensive Environmental Foundation, which is responsible for ensuring navigation safety in Lake Hamana, to inform small vessel operators, including motorboats, of the following key points.

1. Check tidal currents and weather conditions and if high waves are expected south of Imagireguchi, the small vessels should avoid departing from Lake Hamana due to the risk of capsizing.

【Lesson Learned】

This accident occurred despite calm weather conditions near Lake Hamana. However, swells propagated due to the influence of Typhoon No. 5 moving northward in the East China Sea had become breaking waves offshore from Imagireguchi. These breaking waves combined with the ebb tide, resulting in high waves that struck the port stern, ultimately causing the vessel to capsize.

Additionally, once the wave speed exceeded the vessel speed, the risk of broaching increased significantly.

Furthermore, the lack of appropriate navigation decisions based on the characteristics of the navigation area suggests similarities between this accident and the Shiretoko passenger ship sinking accident.

Therefore, operators of small vessels, including small passenger ships, must take the following measures to prevent similar accidents.

1. Operators navigating offshore areas must consider the possibility of waves propagating from distant typhoons or intense low-pressure systems, even in calm weather. They should obtain and analyze meteorological and oceanographic information before departure and prioritize safety by considering trip cancellations when warnings or advisories are issued by the Japan Meteorological Agency.

2. If worsening sea conditions are forecasted, avoid making hasty departure decisions without a clear course change. Depart only after confirming that sea conditions have improved.

3. Operators using harbors with insufficient wave protection must be familiar with areas prone to high waves due to breaking waves, tidal currents, and river outflows. Additionally, they should actively share knowledge with industry peers, local fishing cooperatives, and marinas.

4. Fully understand the structural characteristics and maneuvering performance of your small vessel, establish appropriate operating standards based on the vessel and navigation area, and always prioritize safety. Even if your operations are not subject to the Maritime Transport Act, strive to establish your own safety standards accordingly.

5. Prepare for unexpected rough weather by acquiring knowledge and skills in heavy-weather navigation, such as avoiding "heaving to" and broaching. To achieve this, first develop the ability to read wave directions effectively.

"There is no moment to spare at sea": Once you're on the water, there's no easy turning back. Always stay vigilant of the sea and your vessel's condition, avoid unnecessary risks, and ensure safe navigation!

5. Summary

The Shiretoko passenger ship sinking accident was primarily caused by a malfunction in the bow deck hatch and the failure to properly secure it. Additionally, the vessel departed despite the operational standard indicating a risk of wind speeds reaching 8 m/s or wave heights exceeding 1.0 m.

According to the accident investigation report, the fundamental background of the accident lies in the fact that the passenger ship operator had “no effective operational management in place and lacked a proper safety management system.”

In general, a safety management system functions effectively and enables continuous improvement based on the PDCA cycle when the following resources and systems are properly established and maintained under the leadership of top management.

- **Personnel:** Masters and operational managers who are familiar with the navigation area and possess sufficient ship-handling and decision-making skills
- **Equipment:** Vessels with adequate seaworthiness suited to the navigation area
- **System:** Operational management processes, which is core of safety management systems, and standardized procedures of it

The foundation for establishing an effective safety management system is a thorough understanding of the "**characteristics of the operational area.**"

While safety management systems should be tailored to the scale and nature of the business, small passenger vessel operators, particularly those with limited resources, should first focus on strengthening their operational management processes. This involves **identifying potential risks in their operating waters**, standardizing procedures, and continuously improving them.

By making operational management the core of their safety framework, operators can ensure that daily procedures and navigation decisions are carried out "consistently," "in strict adherence to the basics," and "with vigilance and discipline." Over time, this commitment fosters continuous improvement in safety management system and helps build a strong safety culture.

Message from the head of accident prevention analysis office

As winter transitions into spring once again, we are reminded that the sea never presents the same face regardless of the seasons. It responds with due severity to any careless judgments or actions by operators.

In the passenger vessel industry, where many lives are entrusted to each voyage, precise assessment of sea conditions and prioritizing safety above all else are essential.

As the season of “Ningwachi Kajimai” comes to an end in Okinawa, waters near mainland Japan enter the period of “May Storms” (spring tempests), driven by rapidly developing extratropical cyclones. Understanding the unique characteristics of one's operating waters and identifying necessary measures to ensure passenger safety are crucial. I hope this digest serves as a useful resource for reflection on these vital considerations.

MLIT, Japan Transport Safety Board Secretariat
Attention: Analysis, Recommendation and Opinion Office, General Affairs Division
Yotsuya Tower 15F
1-6-1 Yotsuya, Shinjuku-ku, Tokyo 160-0004, Japan

Phone: 03-5367-5026
URL: https://www.mlit.go.jp/jtsb/index.html
e-mail: hqt-jtsb_bunseki@gxb.mlit.go.jp

We welcome your feedback on the “JTSB Digest” and requests for on-site lectures.