

MA2012-12

**MARINE ACCIDENT
INVESTIGATION REPORT**

December 21, 2012



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: Chemical Tanker SEIYO
Vessel number: 137203
Gross tonnage: 499 tons

Accident type: Foundering
Date and time: Around 09:22 (Local time, UTC+9 hours), January 9, 2011,
Location: South-west off Sado Island, Sado City, Niigata Prefecture,
Around 216° true bearing, 16.0 km from Sawazakihana lighthouse
located at Sado City,
(approximately 37°42.5'N, 138°05.6'E)

November 15, 2012

Adopted by the Japan Transport Safety Board

Chairman	Norihiro Goto
Member	Tetsuo Yokoyama
Member	Kuniaki Shoji
Member	Toshiyuki Ishikawa
Member	Mina Nemoto

SYNOPSIS

<Summary of the Accident>

When the chemical tanker SEIYO, manned with a master and four crew members and loaded with approximately 1,000 tons of vinyl acetate monomer, which had left an anchorage off the Oita Airport, Oita Prefecture and had passed off Rokkosaki, Suzu City (Noto Peninsula), Ishikawa Prefecture, was heading east-northeast toward Akadomari Port (Sado Island), Sado City, Niigata Prefecture on January 9, 2011, she capsized and foundered at around 09:22.

The chief engineer died and the master went missing.

<Probable Causes>

It is probable that this accident occurred in the following manner.

When the Vessel SEIYO was sailing off Saruyama misaki, Wajima City, Ishikawa Prefecture toward Akadomari Port in following waves from port quarter, the water inflow prevention function of the air vent pipe heads of the air vent pipes of the port ballast tanks failed to function and it allowed sea water, that had flooded upon the port side of the upper deck and the expansion trunks and to continuously remain onboard, to flow into the port side ballast tanks. The flowed-in sea

water in the ballast tanks increased the list of the vessel to port and caused the air vent pipe heads of the air vent pipes to be repeatedly submerged. The sea water that flowed continuously into the port ballast tanks from the air vent pipes increased the port list to consequently capsize and founder the vessel.

It is probable that the reason why the water inflow prevention function of the air vent pipe heads failed to work was that the ballast tanks had been flooded during the voyage of November 2010, but no flood preventive measures for the air vent pipes had been taken since then.

1 PROCESS AND PROGRESS OF THE INVESTIGATION

1.1 Summary of the Accident

When the chemical tanker SEIYO, manned with a master and four crew members and loaded with approximately 1,000 tons of vinyl acetate monomer, which had left an anchorage off the Oita Airport, Oita Prefecture and had passed off Rokkosaki, Suzu City (Noto Peninsula), Ishikawa Prefecture, was heading east-northeast toward Akadomari Port (Sado Island), Sado City, Niigata Prefecture on January 9, 2011, she capsized and foundered at around 09:22.

The chief engineer died and the master went missing.

1.2 Outline of the Accident Investigation

1.2.1 Setup of the Investigation

The Japan Transport Safety Board (JTSB) appointed an investigator - in-charge and one other marine accident investigator to investigate this accident on January 9, 2011.

1.2.2 Collection of Evidence

January 12 to 15, 19, February 21 and 24, March 17, June 15, 24 and 27, July 11 and 12, November 1, December 16 and 27, 2011 and March 19, and June 2, 2012: Interviews

February 14 and August 15, 2011: on-site investigations

July 13, 19 and 25, August 2 and 16, October 26, December 9 and 27, 2011 and January 11, March 5 and August 20, 2012: collection of replies submitted to the questionnaires

February 19, 2012: on-site investigations and Interviews

1.2.3 Test and Research by Other Institutes

With respect to this accident, the JTSB entrusted to the Maritime Research Institute (NMRI) the analytical investigations into the foundering of the chemical tanker.

1.2.4 Interim Report and Opinion

On June 29, 2012, based on the facts found up to that date, the JTSB submitted an interim report to the Minister of Land, Infrastructure, Transport and Tourism in accordance with the Article 25, Clause 3 of the Act for Establishment of the Japan Transport Safety Board, and also stated its opinion and made it available to the public in accordance with the Article 28 of the same act.

1.2.5 Comments from Parties Relevant to the Cause

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

2 FACTUAL INFORMATION

2.1 Events Leading to the Accident

According to the statements of the chief officer (hereinafter referred to as “the Officer”), the boatswain (hereinafter referred to as “the Boatswain”), the second engineer (hereinafter referred to as “the Engineer”) of SEIYO (hereinafter referred to as “the Vessel”), the person in charge of the shipowner, SY Promotion Co. (hereinafter referred to as “the Company A”), and according to the reply to the questionnaire by Japan Coast Guard (hereinafter referred to as “JCG”), the events leading to the accident were as follows:

(1) Development of Events Leading to the Vessel’s Capsize after Departure

On January 6, 2011, the Vessel, manned with a master of the Vessel (hereinafter referred to as “the Master”) and four crew members, fully deballasted and loaded approximately 1,000 tons of vinyl acetate monomer*1 at Oita Port, Oita City, Oita Prefecture. Then at around 18:30, departed, heading to Niigata Higashi Port, Niigata City, Niigata Prefecture via Akadomari Port, Sado City, Niigata Prefecture as scheduled, where the Vessel had often stayed so as to adjust the time to enter Niigata Higashi Port. However, due to the bad weather, the Vessel anchored at off the Oita Airport, Oita Prefecture.

On January 7, 2011, at around 08:00, the Vessel, after leaving the anchorage, headed to the destination. On January 8, at around 23:30, passed approximately 3 nm (M) off north-west of Saruyama misaki, Wajima City, Ishikawa Prefecture, and at around 23:50, the Master handed over the watch duty to the Boatswain.

On January 9, 2011, at around 01:00, the Engineer had his engine watch from 01:00 to 06:00.

When the Vessel, after passing off Rokkosaki at around 02:20, was sailing in following waves from the stern with the wave height of about 2.5 to 3.0 m and the west wind speed of about 20 m/s, the course of about 081° (true bearing, same shall apply hereinafter) on autopilot, with the engine revolution at about 290 RPM at the speed of about 11.0 kn, waves washed over the deck and the Vessel repeatedly rolled to port in the range from about 2° to 7°.

At around 03:45, when the Officer took over the watch duty from the Boatswain, he felt that the rolling motion was bigger than usual and he was afraid that it might disturb the sleep of the crew members, and then he reduced the engine revolution to about 280 RPM.

At around 04:00, the Vessel was sailing with the course of about 078° at the speed of about 9.8 kn, in following waves from port quarter at an angle of about 40 ° with the wave height of about 2.5m and the west wind speed of about 12 m/s, and was rolling in the range from about 5° to starboard to about 20° to port.

*1 Vinyl acetate monomer is colorless, transparent, sweet-scented fragrant odor liquid and after transforming it into vinyl acetate polymer by a chemical reaction, it is used as adhesive agent for plywood, coating material for weekly magazine, and material of fiber etc. According to Ship Safety Act, it is classified as flammable liquid and according to Act on Prevention of Marine Pollution and Maritime Disaster, it is specified as a hazardous material (a harmful substance-containing liquid) in view of marine environment conservation and classified as Y Material. Besides, the harmful substance-containing liquids are classified as X Material (grave risk), Y Material (risk) and Z Material (slight risk) depending on the magnitude of impact on ocean resources and human health.

The Officer lighted up the cargo tanks and found that the expansion trunks*² provided on both No.3 and No.4 port cargo tanks were washed by the waves from port quarter, and also found that the air vent pipe heads*³ of the air vent pipes*⁴ of No.2 to No.4 ballast tanks*⁵ on the port side were flooded with sea water.

The Officer felt that the Vessel would not roll to starboard and increased the port heel and that the rolling was getting bigger.

The Master, since the Vessel rolled increasingly and heeled to port by about 30°, went up to the bridge, decided to head the Vessel against waves to reduce the waves washing over the upper deck and deballast, judging from his experience wherein sea water had flowed in the ballast tanks on her voyage performed on the same route in November, 2010.

The Master ordered the Officer to deballast, while in order to head the Vessel's bow against waves, he ordered to reduce the engine revolution to about 250 RPM and attempted to turn to port at speed of about 9.0 kn, but failed to head her bow against waves.

The Officer, in order to deballast, wearing a raincoat, proceeded to the vicinity of the entrance hatch to the pump room which was installed on the port side fore poop deck via the entrance to the starboard side poop deck and found that the hatch to the pump room was submerged in the sea water and gave up deballast.

The Officer, on his way back to the wheelhouse, tightened door handle clips of the entrance to the starboard side poop deck at four positions from outside and returned to the wheelhouse from the exposed area of the navigation bridge deck on the starboard side by passing the tweendeck ladder installed outside of the wheelhouse.

The Engineer, since the rolling of the Vessel gradually got bigger and he had had the experience with other ship wherein sea water flowed in the fuel oil service tank*⁶ under stormy weather, went up to the bridge and contributed to the Master that when the Vessel further heeled, fuel oil service tank would be flooded with sea water to cause the engine to stop which would lead to the critical situation.

The Engineer, after having reported to the chief engineer (hereinafter referred to as "the Chief Engineer") of what had happened until that time, returned to the engine room when the Vessel heeled to a great extent and he went up to the bridge again to contribute the same to the Master.

The Engineer, when the significant heel of the Vessel took place for the second time, inspected the engine room and confirmed through the sight glass*⁷ of overflow pipe*⁸ of fuel oil service tank that sea water was running through it and the sea water coming out of the mist

*² An "Expansion Trunk" is a section installed on the cargo tank to prevent such a risk as pressure rising to a high level due to temperature rise.

*³ A "Air Vent Pipe Head" is an automatic closing device installed on an air vent pipe to prevent water inflow such as wave inflow.

*⁴ An "Air Vent Pipe" is a pipe installed to prevent the pressure in the tank from getting in positive or negative condition.

*⁵ A "Ballast Tank" is a tank to load ballast water (sea water or fresh water) to maintain stability of a ship.

*⁶ "Fuel Oil Service Tank" is a small capacity tank to feed fuel oil from fuel oil tank to main engine little by little.

*⁷ A "Sight Glass" is a glass or acrylic transparent plate to be fitted in order to observe the conditions inside machineries, equipment, pipes etc. through it.

*⁸ A "Overflow Pipe" is a pipe to guide overflowed liquid when the liquid entering beyond the capacity of tank.

pipe^{*9} of the sludge treatment unit for the lubricating oil of main engine remained in the engine room.

The Chief Engineer prepared for draining water out of the engine room and the Engineer opened the drain cock of fuel oil service tank. Since two units of 20 liter pail can^{*10} were filled with sea water, the Engineer thought that sea water entered the fuel oil service tank through the air vent pipe installed on the poop deck and that there was no fuel oil left in the fuel oil service tank.

The Engineer, after having reported to the Chief Engineer that sea water came out of the fuel oil service tank and the engine would stop, immediately went up to the bridge and reported the same to the Master.

The Master ordered the crew members to put on the life jackets.

The Engineer, when proceeding to his room located at the port side poop deck, saw sea water inundating through the gap at the port side entrance to the poop deck and remaining in the lavatory and bath, and noticed that a ventilation fan fitted in the lavatory dropped on the floor due to the heel of the Vessel, and then put on a sweater over a short-sleeve shirt.

The main engine monitoring console provided in the wheelhouse of the Vessel gave an alarm for abnormal exhaust gas temperature of the main engine.

At around 06:10, the Master informed JCG of the situation of the Vessel being listed by about 25° and others, and requested them for rescue, while he contacted the engineering personnel of the Company A to inform that the main engine would stop and the Vessel was listing, and that they had reported to JCG and all the crew members would abandon the Vessel, and requested the Company A to set up an accident rescue quarters.

The Chief Engineer went up to the bridge and reported to the Master that the engine might stop at any time as the amount of sea water which entered into the fuel oil service tank was abnormally large. As a consequence, the main engine stopped.

At around 06:30, the Master reported to JCG that the main engine had stopped.

The diesel engine generator stopped and the light on board went off.

The crew members, while the Vessel was listing to port by more than about 30°, putting on the life jackets, gathered around the inflatable life raft (hereinafter referred to as “the Life Raft”) fitted to the boat deck on the starboard side

The Master, while waiting for the rescue by JCG, informed JCG from time to time by using two way radiotelephone^{*11} of the situation wherein the Vessel was placed.

The Master ordered the Engineer to plunge into the sea first when the rescue team arrives and also advised the crew members to share drinking water in case they are thrown into the sea and they get thirsty due to the sea water.

The crew members, checking each other whether they put on the life jackets or not, were unable to drop the Life Raft because the Vessel was listing to port, and they did nothing but pull the safety pin out of the cradle.

^{*9} A “Mist Pipe” is a pipe connected with a container to store deliquoring sludge. The mist pipe for the sludge treatment system of the Ship was connected with the air vent pipe installed on the poop deck.

^{*10} A “Pale Can” is a kind of oil drum having a grip.

^{*11} A “Two Way Radiotelephone” is a compact portable radio unit which will be brought on a life raft and all other things to communicate between a rescue boat and a ship in distress.

At around 07:05, since the Vessel listed to port by more than about 50° and the port side end of the boat deck came to be submerged under sea surface, the Master reported the situation to JCG and then all the crew members shifted to the starboard exposed area of navigation bridge deck to wait for the rescue at the highest possible place.

It was not long before the Vessel listed to port by about 90° and sank about 7 to 8 m underwater, and then rose to the surface with her bottom turned upward.

(2) Events Leading from Capsize to Rescue and Foundering of the Vessel

The crew members plunged into the sea upon foundering of the Vessel.

The Officer, the Boatswain and the Engineer came to the surface in the vicinity of her stern and caught hold of the Life Raft which rose to the surface with the tent turned upside-down, and after a while recognized the Chief Engineer who came to the surface in the direction of her bow.

The Officer and the Boatswain spoke to the Chief Engineer with no reply and he was carried away toward her bow.

The Officer, the Boatswain and the Engineer attempted to turn over the Life Raft but failed to climb up on it due to high waves, and gave up turning it over in order to conserve their physical strength.

The Officer, the Boatswain and the Engineer, whenever the Life Raft was pulled close to the drifting Vessel by the painter which was bounded up with the Vessel, were trying to carry the Life Raft away from the Vessel by swimming. When the Life Raft was pulled right on the Vessel, she pushed the Life Raft up and the Officer and the Boatswain were forced to separate from the Life Raft.

The Officer noticed a mast of other ship in the distance and realized that the patrol boat of JCG came to rescue them.

At around 07:40, the patrol boat of JCG found the capsized Vessel and survivors drifting around the Vessel, and by around 08:35, rescued four persons, the Officer, the Boatswain, the Chief Engineer and the Engineer who had been drifting around the Life Raft. Four of them were transferred to the Niigata Airport by a helicopter of JCG and then transported to a hospital.

The Vessel was positioned almost vertical to the sea surface with her bow turned upward and foundered at around 09:22.

JCG continued to search the missing Master until January 11, 2011 but failed to find him and gave up full-time search.

The date and time of occurrence of the accident was at around 09:22 on January 9, 2011, and the location was around 216°, 16.0 km from Sawazakihana lighthouse located at Sado City,
(Refer to Figure 1 Map, Photo 1 the Vessel)

2.2 Injuries to Persons

According to the statements of the Officer, the Boatswain and the Engineer and the reply to the questionnaire by the Company A and the hospital, the injuries to persons were as follows:

The Master went missing and he was certified dead by JCG later on.

The Chief Engineer was confirmed dead at the hospital where he was transported, and the cause of the death was drowning.

The Officer, the Boatswain and the Engineer were hospitalized for 3 days and had treatment for hypothermia there.

2.3 Damage to Vessels and Environmental Effect

According to the reply to the questionnaire by the Company A, the investigation into the situation of the foundered Vessel was conducted by a salvage company between June 8 and June 11, 2011 and the investigation results were as follows:

The Vessel was sitting on the sea bottom with a depth of about 1,130m at 37°42.3'N, 138°04.9'E, in nearly correct position, heading her bow toward about 273 ° and the trace, indicating that the Vessel had slid on the sea bottom about a few hundred meters after hitting the bottom, was observed.

At the sea area where this accident occurred, there was neither smell of vinyl acetate monomer nor floating oil found.

According to the reply to the questionnaire by JCG, floating oil was found in the vicinity of the site of the occurrence of this accident between January 19 and March 22, 2011.

2.4 Crew Information

(1) Gender, Age, and Certificate of Competence

The Master: Male, 47 years old

Fifth Grade Maritime Officer (navigation)

Date of Issue: August 29, 1990

Date of Revalidation: August 12, 2010

Date of Expiry: August 28, 2015

The Officer: Male, 29 years old

Fourth Grade Maritime Officer (navigation) (carrier limitations)

Date of Issue: March 28, 2002

Date of Revalidation: January 19, 2007

Date of Expiry: March 27, 2012

Fourth Grade Maritime Officer (engineering) internal combustion engine

Date of Issue: March 28, 2002

Date of Revalidation: January 19, 2007

Date of Expiry: March 27, 2012

The Boatswain: Male, 49 years old

Fourth Grade Maritime Officer (navigation)

Date of Issue: June 3, 1991

Date of Revalidation: June 22, 2006

Date of Expiry: June 21, 2011

The Chief Engineer: Male, 46 years old

Third Grade Maritime Officer (engineering)

Date of Issue: May 30, 1985

Date of Revalidation: November 30, 2009

Date of Expiry: May 29, 2015

The Engineer: Male, 60 years old

Third Grade Maritime Officer (engineering), internal combustion engine

Date of Issue: April 25, 1975

Date of Revalidation: July 7, 2010

Date of Expiry: April 3, 2016

(2) Sea-going Experience

1) The Master

According to the statement of the engineering personnel of the Company A and the reply to the questionnaire by the Company A, his experience was as follows:

a) Experience in service aboard

The Master had navigation experience of chemical tanker for about 20 years. He served as a master since commissioning of the Vessel in service and had wide experience of sailing off Noto Peninsula in winter season.

b) Condition of health

No illness was reported.

2) The Officer

According to the statement of the Officer and the reply to the questionnaire by the Company A, his experience was as follows:

a) Experience in service aboard

He had navigation experience on chemical tanker for about 6 years. He first boarded the Vessel to serve as a second officer while working as a back-up member for the first officer and the chief engineer, then served as a first officer since December, 2010. He had wide experience of sailing off Noto Peninsula in winter season.

b) Condition of health

He was in good health.

3) The Boatswain

According to the statement of the Boatswain and the reply to the questionnaire by the Company A, his experience was as follows:

a) Experience in service aboard

He had navigation experience on chemical tanker for about 5 years. He first boarded the Vessel on December 20, 2010 and served as a boatswain since then. He had wide experience of sailing off Noto Peninsula in winter season.

b) Condition of health

He was in good health.

4) The Chief Engineer

According to the statement of the engineering personnel of the Company A and the reply to the questionnaire by the Company A, his experience was as follows:

a) Experience in service aboard

He had navigation experience on chemical tanker for about 20 years. He served as a chief engineer since commissioning of the Vessel in service and had wide experience of sailing off Noto Peninsula in winter season.

b) Condition of health

No illness was reported.

5) The Engineer

According to the statement of the Engineer and the reply to the questionnaire by the Company A, his experience was as follows:

a) Experience in service aboard

He had navigation experience on chemical tanker for about 30 years. He served as a second engineer since 2005 and had wide experience of sailing off Noto Peninsula in winter season.

b) Condition of health

He was in good health.

2.5 Vessel Information

2.5.1 Particulars of Vessel

Vessel number	137203
Port of registry	Tokyo, Japan
Owner	the Company A
Charterer	Rokuseiwa Shipping Co. Ltd., Japan
Gross tonnage	499 tons
L x B x D	64.80 m x 10.00 m x 4.50 m
Hull material	Steel
Engine	Diesel engine x 1
Output	1,176 kW
Propulsion	4-blade fixed pitch propeller x 1
Month of launch	December 2003
Classification society	Nippon Kaiji Kyokai (hereinafter referred to as “Class NK”)
Ship building yard	Hakata Shipbuilding Co., Ltd., Japan (hereinafter referred to as “the Company B”)

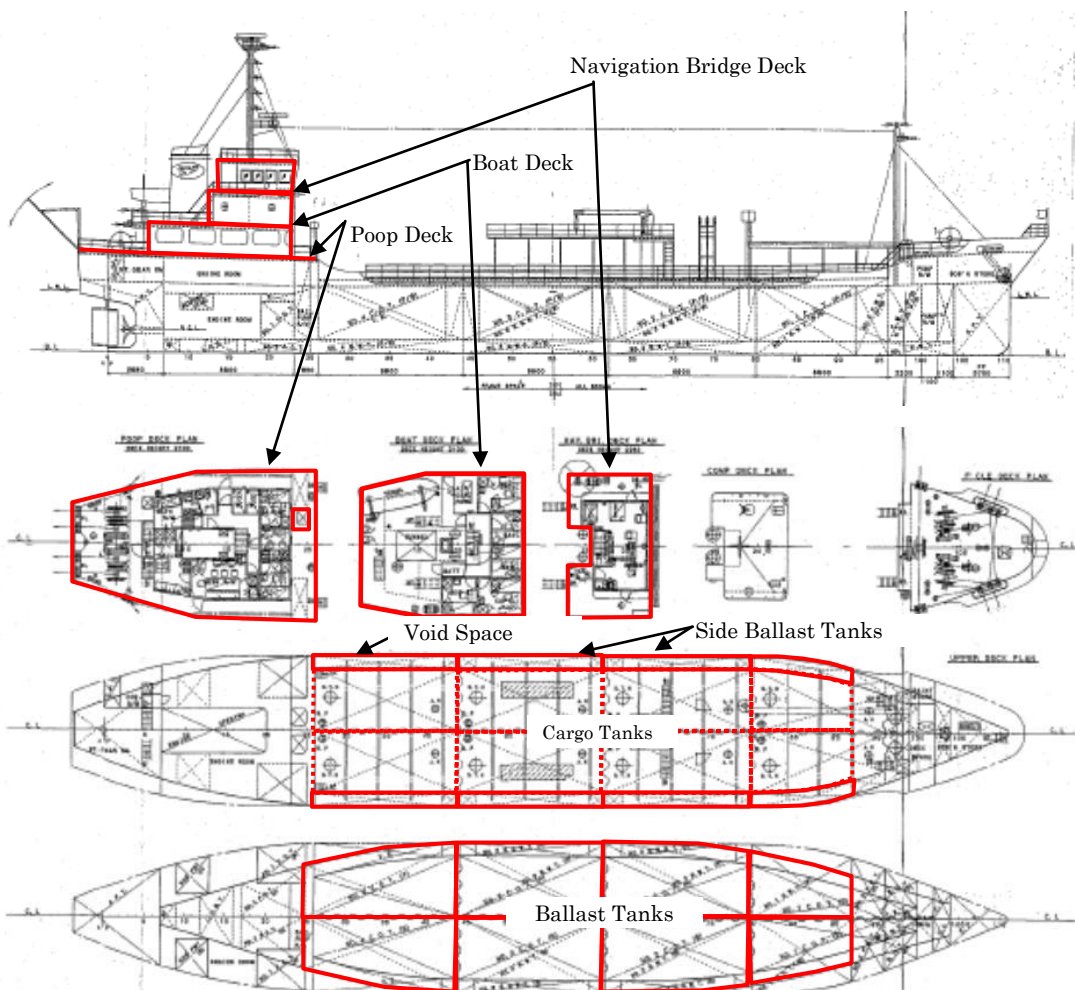


Figure 2-1 General Arrangement of the Vessel

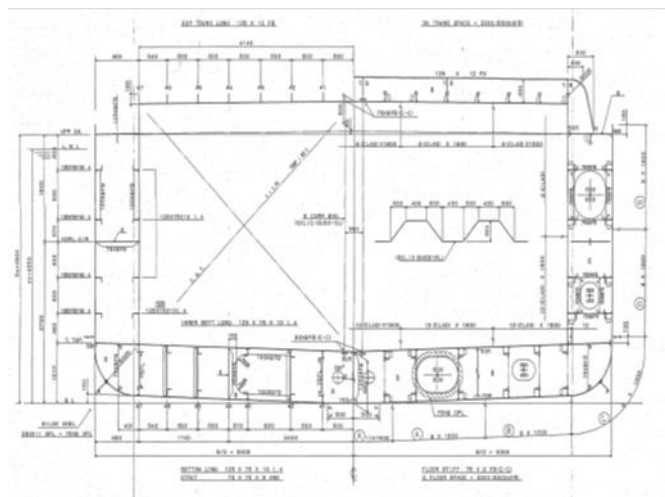


Figure 2-2 Midship Section of the Vessel

2.5.2 Other Relevant Vessel Information

(1) Hull Structure

According to the reply to the questionnaire by the Company A, hull structure of the Vessel was as follows:

The Vessel was the aftbridge type chemical tanker having double hull structure whereby the side and the bottom of the cargo tanks are surrounded with ballast tanks and void spaces.

The Vessel was provided with four cargo tanks from No.1 to No.4 cargo tanks which were separated into two sides by the longitudinal bulkhead built in the center of the hull structure to provide eight cargo tanks in total. They are referred to as port side No.1 to No.4 cargo tanks and starboard side No.1 to No.4 cargo tanks by counting from bow end and each cargo tank is equipped with cargo pump for loading and unloading of the cargo.

With the Vessel, the double side hull and double bottom section contacting the ship side and bottom of the starboard side No.1 cargo tank is referred to as “the starboard side No.1 ballast tank,” the double side hull sections contacting the ship side of the starboard side No.2 and 3 cargo tanks are referred to as “the starboard side No.2 and 3 side ballast tanks” respectively, the double bottom sections contacting the bottom part of the same cargo tanks are referred to as “the starboard side No.2 and 3 ballast tanks” respectively, the double bottom section contacting the bottom part of the starboard side No.4 cargo tank is referred to as “the starboard side No.4 ballast tank,” and the ballast tanks and side ballast tanks on the port side shall be referred to in the same manner. The double side hull section contacting the ship side of the starboard side No.4 cargo tank is void space*¹² and the same is true of the port side.

Each cargo tank is provided with an expansion trunk on top of it, and the upper surface of cargo tank is higher than the upper deck by about 0.50m at the ship side and by about 0.55 in the center of the hull.

*¹² “Void Space” is an unused space among other vacant spaces installed in the Ship.

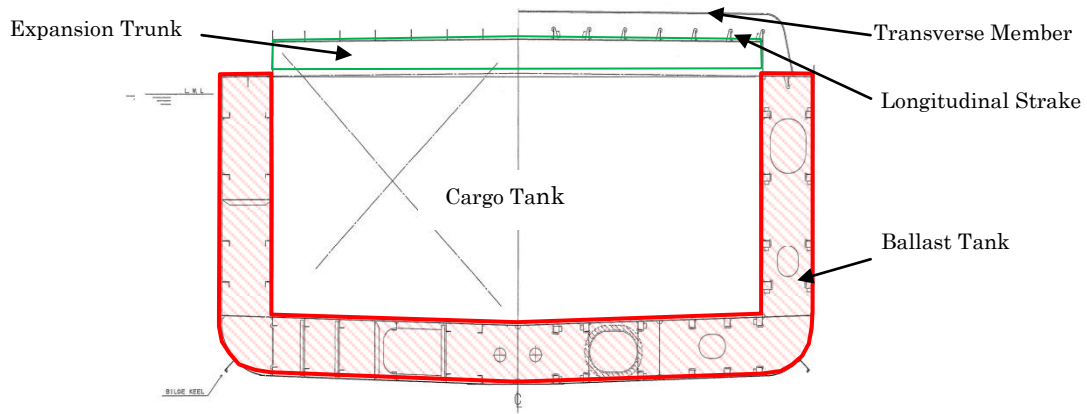


Figure 2-3 Arrangement of Expansion Trunks, Cargo Tanks and Ballast Tanks

(2) Strength Member on the Cargo Tank

According to the reply to the questionnaire by the Company A, strength member of the cargo tank is as follows:

As longitudinal strakes^{*13}, one on-deck girder with 160mm height longitudinally penetrated on each ship side on the cargo tanks, and one on-deck girder with 125mm height is at the center of the hull, six on-deck girders of same height are on each side from the center of the hull at 600mm interval, total 13 on-deck girders longitudinally penetrated.

As on-deck transverse members^{*14}, three on-deck girders with 400mm height transversely penetrated on No.1 cargo tank at 2,200mm interval and four on-deck girders of same height transversely penetrated on No.2 to 4 tanks.

(3) Situation of Door of the Poop Deck

According to the statements of the Officer, the Boatswain and the Engineer, and the reply to the questionnaire by the Company A, the situation of the poop deck of the Vessel was follows:

The poop has three layer structures with navigation bridge deck, boat deck and poop deck. Crew cabins and other related facilities (hereinafter referred to as “Accommodation Space “) were arranged on the boat deck and the poop deck.

On the navigation bridge deck, there was a wheelhouse which had entrances to the exposed area on both sides of the room. When all crew members abandoned the Vessel, the door on the starboard side was open.

On the boat deck, Accommodation Space was furnished with a door to the exposed area at its port side aft which had kept open with a support bar while all the crew members were preparing to abandon the Vessel. In addition, the Life Raft was installed on the exposed area on the starboard side.

On the poop deck, doors were provided at both sides of Accommodation Space and at its aft, and all of them had kept closed while the Vessel was sailing and all crew members were abandoning the Vessel.

(4) Navigational Instruments

According to the statement of the Officer, the Vessel was equipped with VHF, two radars, AIS^{*15}, GPS^{*16}, Navigation Telex receiver, two way radiotelephone and radar transponder^{*17}. However, AIS Power was turned off.

^{*13} A “Longitudinal Strake” is a strength member which was installed in the direction from stem to stern of a ship.

^{*14} A “Transverse Member” is a strength member which was installed in the direction from side to side of a ship.

(5) Maneuverability of the Vessel

According to the reply to the questionnaire by the Company A, the results of the official sea trial conducted when the Vessel was newly built were as follows:

Test Condition	Displacement	Fore Draft	Midship Draft	Aft Draft
	1,878.24t	3.889m	4.240m	4.589m
Speed trial	Load Factor	Speed (kn)	Engine Speed (rpm)	Main Engine power(kW)
	1/2	10.666	270	565.7
	3/4	11.781	310	837.6
	8.5/10	12.092	322	956.4
	4/4	12.468	340	1101.6
Turning trial	Rudder Angle	Port 35°		Starboard 35°
	Max. Heel Angle	2.5°		3.0°
	Max. Advance* ¹⁸ / Max. Transfer* ¹⁹	211m/242m		198m/210m
Inertia trial	Time/distance needed to stop engine at speed of 13.8kn and to reduce speed to 2kn			
	17minutes 14seconds/2,614m			

(6) Loaded cargo and other things

According to the statements of the Officer, the Boatswain, the Engineer and the engineering personnel of the Company A, the Vessel loaded fresh water at Niigata Higashi Port on her previous voyage, and cargo and fuel oil at Oita Port prior to her departure respectively. The loaded quantity was as follows:

The Vessel consumed about 170 liters of fuel oil in an hour and about eight tons on her voyage from Oita Port to Niigata-Higashi Port, and also consumed about one ton of fresh water in a day.

	Tank Name	Tank Capacity	Loaded Quantity
Fresh Water Related Tanks			
	No.1 Fresh Water Tank	11.59m ³	100%
	Starboard No.2 Fresh Water Tank	11.78m ³	100%

*¹⁵ "AIS" is an abbreviation of "Automatic Identification System" and it is a device used by vessels to transmit and exchange call sign, type, name, position, course, speed, destination, navigational status and other safety-related information with other vessels and land-based navigational aid facilities, etc.

*¹⁶ "GPS" is an abbreviation of "Global Positioning System" and it is a system capable of calculating vessel's exact own location by receiving radio signal from more than one satellite and calculating the distance from each satellite to itself. The measure of the position is achieved by using signals transmitted from about 30 satellites orbiting around the earth. When 3 satellites are available, latitude and longitude can be measured, and when 4 satellites are available, height in addition to latitude and longitude can be measured with a margin of error between a few centimeters and dozens of meters respectively.

*¹⁷ A "Radar Transponder" is a device capable of informing of the position of victims in distress by reacting to the emission of radars from patrol boats and aircrafts engaging in search operation and by automatically transmitting responding signal.

*¹⁸ "Max. Advance" is a maximum longitudinal advance distance between the position of gravity center of a vessel at the time when she begins rudder turning and the position of the same on her current course in the trajectory (turning circle) drawn by her gravity center when she is turning.

*¹⁹ "Max. Transfer" is a maximum transverse transfer distance of the gravity center from the current course in the turning circle.

	Port No.2 Fresh Water Tank	11.78m ³	100%
	Starboard No.3 Fresh Water Tank	3.11m ³	0%
	Port No.3 Fresh Water Tank	3.11m ³	0%
	Starboard Cleaning Water Tank	13.335m ³	100%
	Port Cleaning Water Tank	13.335m ³	100%
	Aft-Peak Water Tank	26.94m ³	100%
Ballast Water Related Tanks			
	Forepeak Water Tank	24.24m ³	100%
	Starboard No.1 Ballast Tank	40.06m ³	0%
	Port No.1 Ballast Tank	40.06m ³	0%
	Starboard No.2 Ballast Tank	45.31m ³	0%
	Port No.2 Ballast Tank	45.31m ³	0%
	Starboard No.2 Side Ballast Tank	22.92m ³	0%
	Port No.2 Side Ballast Tank	22.92m ³	0%
	Starboard No.3 Ballast Tank	46.93m ³	0%
	Port No.3 Ballast Tank	46.93m ³	0%
	Starboard No.3 Side Ballast Tank	22.81m ³	0%
	Port No.3 Side Ballast Tank	22.81m ³	0%
	Starboard No.4 Ballast Tank	38.28m ³	0%
	Port No.4 Ballast Tank	38.28m ³	0%
	Starboard Void Space	27.73m ³	0%
	Port Void Space	27.73m ³	0%
Fuel Oil Related Tanks			
	Starboard No.1 Fuel Oil Tank	20.47m ³	80%
	Port No.1 Fuel Oil Tank	20.47m ³	80%
	Starboard No.2 Fuel Oil Tank	9.36m ³	80%
	Port No.2 Fuel Oil Tank	9.12m ³	80%
Cargo Related Tanks			
	Starboard No.1 Cargo Tank	117.929m ³	60%
	Port No.1 Cargo Tank	117.918m ³	60%
	Starboard No.2 Cargo Tank	165.791m ³	95%
	Port No.2 Cargo Tank	166.597m ³	95%
	Starboard No.3 Cargo Tank	166.925m ³	95%
	Port No.3 Cargo Tank	167.731m ³	95%
	Starboard No.4 Cargo Tank	160.061m ³	80%
	Port No.4 Cargo Tank	160.867m ³	80%
Others			
	Lub.Oil Tank	4.71m ³	80%
	Foam Fire-extinguishing Tank	2.54m ³	100%
	Bilge Tank	1.03m ³	29%
	Starboard Flush Tank	8.08m ³	0%
	Port Flush Tank	8.08m ³	0%

*	Fuel Oil Service Tank	900ℓ	
*	Cleansing Oil Tank	250ℓ	
*	Lub. Oil Storage Tank	900ℓ	

Note: *mark indicates floor type tank

(7) Air Vent Pipe

1) Pipe Fitting Position, Heel Angle at Submergence and Structure of Air Vent Pipe

According to the reply to the questionnaire by the Company A, air piping arrangement was as follows:

- a) For each ballast tank of the Vessel, two air vent pipes are installed on the upper deck, one at fore side and the other at aft side respectively. On top of the air vent pipe, an air vent pipe head is fitted and it has a mechanism to prevent sea water from flowing into the ballast tank by a rising up disc float.
- b) For the fuel oil tanks and fuel oil service tank, one air vent pipe is installed on each tank on the poop deck respectively and the same air vent pipe head on the air vent pipe of the ballast tank is fitted on each air vent pipe of these tanks.
- c) The positions of air vent pipe from bow to stern and the heel angles at submergence*²⁰ for the port side air vent pipe under the draft condition when the Vessel departed from Oita Port were as follows:

Frame Number	Tank Fitted with Air Vent Pipe on Port Side of the Vessel	Heel Angle at Submergence
On Upper Deck		
95.5	Port No.2 Fresh Water Tank	32.78°
91.5	Port No.1 Ballast Tank Fore	26.90°
84.5	Port No.1 Ballast Tank Aft	21.37°
84.5	Port No.2 Ballast Tank Fore	21.37°
77.5	Port No.2 Side Ballast Tank Fore	20.40°
66.5	Port No.2 Side Ballast Tank Aft	18.86°
62.0	Port No.2 Ballast Tank Aft	18.21°
62.0	Port No.3 Ballast Tank Fore	18.21°
59.5	Port No.3 Side Ballast Tank Fore	17.86°
49.5	Port No.3 Side Ballast Tank Aft	16.40°
44.0	Port No.3 Ballast Tank Aft	15.60°
44.0	Port No.4 Ballast Tank Fore	15.60°
30.5	Port No.4 Ballast Tank Aft	13.59°
On Poop Deck		
23.0	Port No.1 Fuel Oil Tank	52.19°
23.0	Port No.2 Fuel Oil Tank	55.41°
22.5	Port Void Space on Fuel Oil Tank	26.96°
20.5	Fuel Oil Service Tank	26.73°
18.5	Lub. Oil Purifier	26.48°
17.5	Cleansing Oil Tank	26.36°

*²⁰ In this report, "Heel Angle at Submergence" is an angle at which air vent pipe is submerged in the sea water when a vessel is heeled.

13.5	Port No.3 Fresh Water Tank	25.89°
12.5	Lub. Oil Tank	25.77°
8.0	Bilge Tank	28.19°
5.0	Aft-Peak Water Tank	29.03°
1.0	Foam Fire-extinguishing Tank	34.50°

d) The heights of the air vent pipes installed on the upper deck are 760 mm corresponding to the height from the deck to the flange, and the heights of those installed on the poop deck are 450 mm corresponding to the height from the deck to the flange, and an air vent pipe head was fitted on top of each air vent pipe. The inner diameters of air vent pipe heads of the air vent pipes installed on the ballast tanks at fore side were 100 mm and those of the others at aft side were 80 mm.

(Photo 2-1 Air Vent Pipe and Air Vent Pipe Head for reference)

e) With the Vessel, in case of the air vent pipe with the diameter bigger than 50 mm, disc float type air vent pipe head made in P. R. of China was fitted, and in case of the air vent pipe with the diameter smaller than 50 mm, disc float type air vent pipe head made in Japan was fitted.

2) Understanding of Air Vent Pipe Head

According to the statement of the person-in-charge of the company who delivered the air vent pipe head to the Company B, their understanding was as follows:

- The air vent pipe head made in P. R. of China is the product which was approved by Class NK.
- They were not aware of whether or not sea water comes in through the air vent pipe head made in Japan.

3) Test for Air Vent Pipe Head in Accordance with Rules

According to the statement of the person-in-charge of Class NK and the reply to the questionnaire by Class NK, the test results were as follows:

a) As for the air vent pipe head made in P. R. of China, according to the results of water tight tests which were repeatedly carried out prior to giving the approval, amount of water inflow was as follows:

(a) Air vent pipe head with inner diameter of 100 mm

Test Condition	When descending in correct position	When descending with an opening turned upward at heel angle 40°	When descending with an opening turned downward at heel angle 40°
In case air vent pipe head submerged and immediately raised	10 ml	70 ml	80 ml
In case air vent pipe head submerged and raised 4 minutes later	90 ml	90 ml	92 ml
In case air vent pipe head submerged and raised 8 minutes later	110 ml	140 ml	135 ml
In case air vent pipe head submerged and raised 12 minutes later	156 ml	160 ml	130 ml

(b) Air vent pipe head with inner diameter of 80 mm

Test Condition	When	When descending	When descending

	descending in correct position	with an opening turned upward at heel angle 40°	with an opening turned downward at heel angle 40°
In case air vent pipe head submerged and immediately raised	5 ml	65 ml	92 ml
In case air vent pipe head submerged and raised 4 minutes later	44 ml	95 ml	116 ml
In case air vent pipe head submerged and raised 8 minutes later	70 ml	85 ml	165 ml
In case air vent pipe head submerged and raised 12 minutes later	122 ml	140 ml	145 ml

- b) When the Vessel was built, water tightness against weather was required for the air vent pipe head but tightness against water pressure was not required.
- c) When the Vessel underwent a periodic inspection in February 2009, the inspection for air vent pipe was carried out and there was no problem found.

4) Maintenance of Air Vent Pipe Head

According to the statements of the Officer, the Boatswain, the engineering personnel of the Company A and the person in charge of a ship repair company, and the reply to the questionnaire by the Company A, the maintenance of air vent pipe head was as follows:

- a) When the Vessel docked at the ship repair company in February 2009, air vent pipes were removed at 24 points and the repair works were executed. However, this ship repair company filed an application for court-led rehabilitation proceedings and went bankrupt which made the information on the maintenance and inspection unavailable.
- b) When the Vessel poured sea water into ballast tank, they used to confirm that the ballast tank was filled with water by observing that the sea water came out of air vent pipe head.
- c) An overhaul of the air vent pipe head of the air vent pipes was not performed by the crew members on board and the pipe head was not furnished with a waterproof cover.

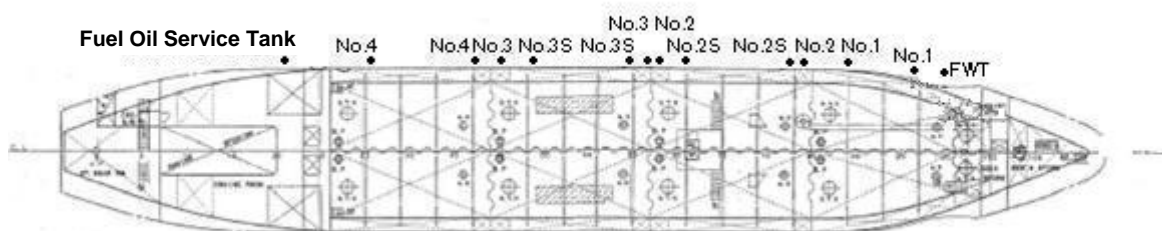
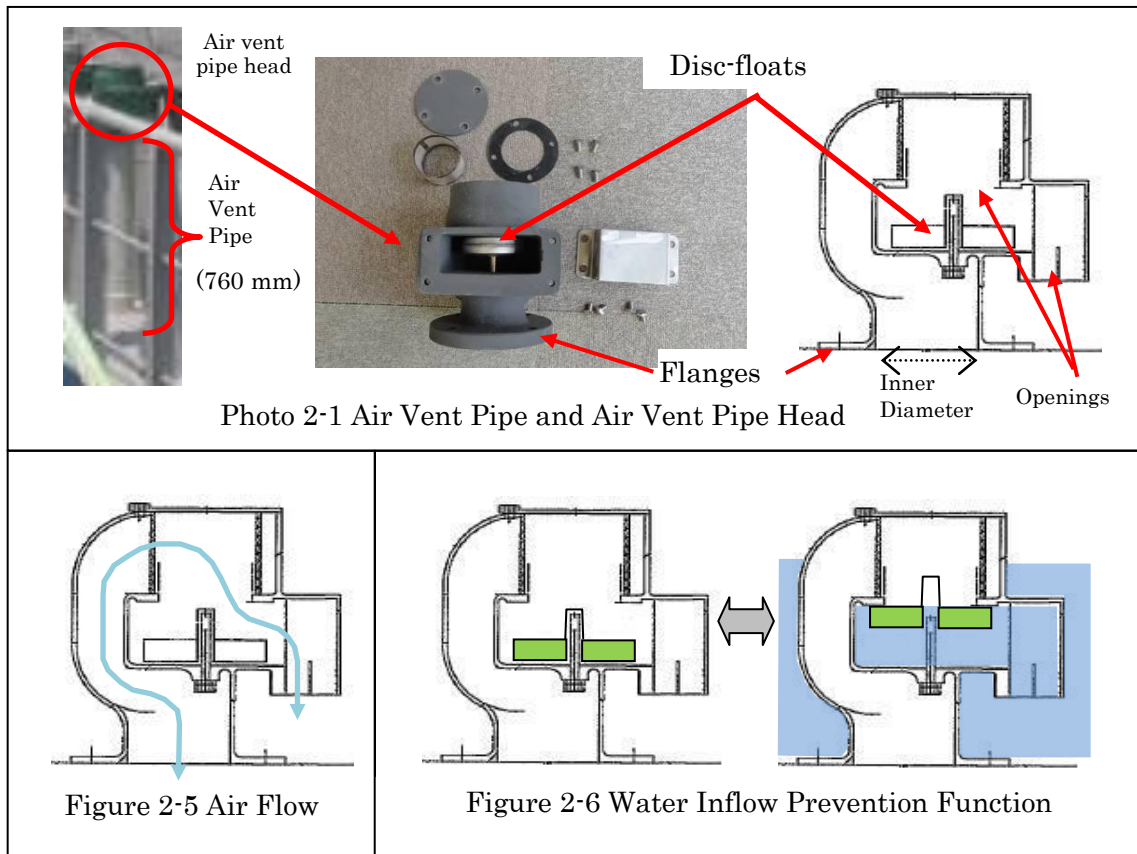


Figure 2-4 Air Vent Piping Arrangement on the Port Side
(Arrangement on the starboard side is same except fuel oil service tank)



(8) Fuel Oil Service Tank

According to the reply to the questionnaire by the Company A, fuel oil service tank was installed on the port side of the engine room having capacity of about 900 liters and fuel oil was supplied to the main engine and the diesel engine generator and other equipment.

(9) Life Raft

- 1) According to the reply to the questionnaire by the Company A, the Life Raft for the Vessel was an inflatable type life raft designed for 15 people and for tanker.
- 2) According to the statement of the person in charge of the manufacturer and the reply to the questionnaire by Class NK, the performance of the Life Raft and automatic release device was as follows:
 - a) The automatic release device of the life Raft was so designed as to operate at the working pressure of approximately 0.28 MPa.
 - b) When the Life Raft was inflated, it would not always be expanded in the position where its tent turns upward even on the calm sea.
 - c) The Life Raft was equipped with the painter, weak link and automatic release device. It was so structured that when a ship founders and the water pressure equivalent to the working pressure is applied to the automatic release device, it automatically operates to release the container storing a life raft from its cradle and to pull the painter by the buoyancy of the container causing a life raft to inflate. Besides, the Life Raft was so designed as to be detached from a ship when a ship founders and the weak link connected with the painter is ruptured by the buoyancy of an inflated life raft.
 - d) The Life Raft was furnished with a knife outside the tent near the entrance but it is somewhat likely that there was a difficulty to find the knife when the Life Raft expanded turning upside down.

- e) The maintenance of the Life Raft was carried out by a maintenance service company approved by the Ministry of Land, Infrastructure, Transport and Tourism in February 2009.

(10) Other Information

- 1) According to the statements of the Officer, the Boatswain and the Engineer, at the time when this accident occurred, there was no malfunction and failure found with the ship hull, engines and machineries.
- 2) According to the statements of the person in charge of the Company A, when signing the contract to build the Vessel with the Company B, they required for the construction of a vessel based on the specifications of greater coasting area with main engine of 1,176 kW.
- 3) According to the statements of the person in charge of the Company B, other information was as follows:
 - a) The Vessel was in compliance with the relevant laws and regulations, and with the rules of Class NK.
 - b) When designing and building the Vessel, there was no request from the Company A for the design to take the navigation related features into account.
 - c) The Company B conducted the official sea trial with the trim by stern of about 0.7 m and after commissioning of the Vessel, they were using the Vessel with the trim of about 1 m. However, they considered that the maneuverability of the Vessel was not affected by the change in trim.

2.6 Information on Navigation

(1) Safety Management Rule of the Company A

According to the reply to the questionnaire by the Company A, the operation standard provided in the Safety Management Rule of the Company A was basically as follows:

1) Operating Standard

a) Judgement on whether depart or not

Prior to the departure of a ship, a master must make a judgement on whether the ship should set sail or not and if the master recognizes that weather and sea conditions in the departure port fell into either of the conditions wherein wind speed exceeds 18 m/s or wave height exceeds 3 m or visibility is less than 1,000 m, he must suspend the ship's departure for the destination.

The master, prior to the departure, should check the information on weather and sea conditions (except visibility) which the ship may encounter and if he recognizes the risk that wind speed may exceed 20 m/s or wave height may exceed 3.5 m, and either of these conditions can possibly be realized, the master must suspend the ship's departure.

When the master made decision to suspend the ship's departure, he must take the appropriate measures for ship's maintenance, harborage and others.

b) Judgement on normal navigation

When the master continues normal navigation, recognizing the risk that the accident of shifting or tumbling of the loaded cargoes may occur due to the oscillation of the ship, he must take appropriate measures such as slowdown, alteration of course, and change of route.

The master, while the ship is at sea, should check the information on weather and sea conditions (except visibility) in her adjacent water and he recognizes the risk that wind

speed may exceed 25 m/s or wave height may exceed 3.5 m and either of these conditions may be realized, the master must stop the continuation of voyage for the destination and take either of the measures such as reversing the course, seeking a shelter, provisionally calling at port. However, as long as the master determines that the ship can continue safety navigation to the destination by changing the route, above shall not apply.

2) Inspection and Maintenance of Transportation Facilities

(Confirmation of the results of ship inspection and survey)

Article 36: Ship manager and shipowner shall confirm that a ship underwent ship inspection provided in the laws and regulations and passed the inspection, and that the ship is in a position to have no problem with the navigation.

(Inspection and maintenance of ship)

Article 37: Master shall conduct inspections for ship's hull, engines, various facilities and equipment in accordance with "Confirmation Table of Inspection before Ship's Departure," and "Confirmation Table of Inspection before Port Call."

2. Master, when finding abnormality during the above inspections, shall immediately report to the ship manager and shipowner of the outline of the same and shall take measures for restorative maintenance.

3. Shipowner, when receiving the report in the preceding paragraph, shall immediately report to the parties concerned of the said situation and shall take the measure for restorative maintenance, and the ship manager shall supervise it.

(2) The Vessel's Navigation Features

According to the statement of the Vessel's substitute master who got on board during the Master' leave, the Officer and the engineering personnel of the Company A, the Vessel's navigation status was as follows:

The Vessel, requiring about 48 hours to perform a voyage from Oita Port to Niigata Higashi Port, repeated the same voyage three times in about two months since November last year till this accident.

The Vessel had navigated heeling to the side which waves were hitting on her past voyages performed up to that time and she once had heeled by about 20°.

The Vessel had higher stability in comparison with the other chemical tankers of the same size and she restored to the original state quickly from her heel position. Thus, she was considered a safe ship to board.

According to the type of contract with the shipper, this voyage did not need to be performed rapidly.

Since the Vessel had listed on her ballast voyage performed soon after her commissioning, she was inspected during her guaranty dock by the Company B to find that the void space was filled with sea water and the air vent pipes installed on the void space were removed.

Since sea water had pooled in the side ballast tanks and ballast tanks before this accident occurred, the crew members had been studying the countermeasure for the air vent pipes, but they failed to report it to the engineering personnel of the Company A.

As for the draft of the Vessel, in consideration of her drainage condition, it was about 3.30 m at fore, and about 4.60 m at aft with the trim by stern of about 1.30 m which was normalized.

2.7 Weather and Sea Condition

2.7.1 Meteorological Observation

(1) The data observed, at the time when this accident occurred, by the Oogata Regional Observation Post located at about 57 km south-southeast from the site of the accident was as follows:

- At 02:00, Temperature 6.8 °C, Average wind speed 2.4 m/sec, Wind direction south-west, Maximum instantaneous wind speed 8.3 m/s, Wind direction west
- At 03:00, Temperature 6.0 °C, Average wind speed 5.9 m/s, Wind direction west-southwest, Maximum instantaneous wind speed 15.0 m/s, Wind direction west
- At 04:00, Temperature 5.4 °C, Average wind speed 3.6 m/s, Wind direction south-west, Maximum instantaneous wind speed 13.4 m/s, Wind direction west
- At 05:00, Temperature 6.5 °C, Average wind speed 5.0 m/s, Wind direction west-southwest, Maximum instantaneous wind speed 12.5 m/s, Wind direction west-southwest
- At 06:00, Temperature 4.9 °C, Average wind speed 8.4 m/s, Wind direction west-southwest, Maximum instantaneous wind speed 17.0 m/s, Wind direction west
- At 07:00, Temperature 6.0 °C, Average wind speed 6.8 m/s, Wind direction west-southwest, Maximum instantaneous wind speed 15.4 m/s, Wind direction west
- At 08:00, Temperature 5.4 °C, Average wind speed 7.5 m/s, Wind direction west-southwest, Maximum instantaneous wind speed 15.2 m/s, Wind direction west-southwest
- At 09:00, Temperature 4.4 °C, Average wind speed 8.2 m/s, Wind direction west-southwest, Maximum instantaneous wind speed 15.1 m/s, Wind direction west

(2) According to Japan Meteorological Agency (JMA), local marine warning of off Sado sea area^{*21} and off Noto sea area^{*22} published on the day of occurrence of this accident at about 11:30, was as follows:

Marine warnings: Near Gale

Around off Sado and off Noto, west or north-west wind is strong, maximum wind speed is 30 kn (15 m/s).

(3) According to JMA, local marine forecast of off Noto sea area published on the day of occurrence of this accident at about 07:00 was as follows:

Off Noto:

Marine warnings (continuing): Near Gale

Wind: south-west later north 30 kn (15 m/s)

Weather: cloudy partly snow or rain, thunder in some area

Visibility: below 3 M (6 km), 0.5 M (1 km) in some area

Wave: 3 m later 4 m

(4) According to the wave estimation database for the coastal area of Japan published by Japan Weather Association (hereinafter referred to as “Wave Estimation Database”), the weather and sea conditions at the time when this accident occurred were as follows:

At 02:20, (The position where the Vessel passed in the vicinity of Rokkozaki: 37°34.0' N,

^{*21} “Off Sado Sea Area” is a central part of Sea of Japan and is the sea area surrounded by the lines, one of which is the line, passing the midpoint of the line to connect Tobishima and Kurishima at a shortest distance which is parallel to the line drawn from the border line between Aomori Prefecture and Akita Prefecture at an angle of 315°, and south of the other line passing the point 138° E 42° N, and the point 134° E 39° N, and the line drawn from the tip of the cape Torigakubi (Niigata Prefecture) at an angle of 315°.

^{*22} “Off Noto Sea Area” is a central part of Sea of Japan and is the sea area to cover west of the line drawn from the tip of the cape Torigakubi (Niigata Prefecture) at an angle of 315° and south of the line passing the point 138° E 42° N and the point 134° E 39° N.

137°18.0' E)

Wave height 2.22 m, period 5.3 s, direction 288°, Wind direction 268°, speed 13.0 m/s

At 04:00, (The position where the heel of the Vessel increased: 37°38.0' N, 137°40.0' E)

Wave height 2.66 m, period 7.2 s, direction 293°, Wind direction 274°, speed 12.8 m/s

At 05:30, (The position of midpoint between 04:00 and 07:00: 37°40.0' N, 137°54.0'E)

Wave height 2.79 m, period 7.4 s, direction 293°, Wind direction 279°, speed 12.8 m/s

At 07:00, (The position where the Vessel foundered: 37°42.0' N, 138°06.0' E)

Wave height 2.95 m, period 7.3 s, direction 285°, Wind direction 285°, speed 12.3 m/s

- (5) According to the reply to the questionnaire by JCG, the weather and sea conditions at the time when their rescue operation was conducted on the day of occurrence of this accident were as follows:

Weather snowstorm, Wind direction north-west, speed 12 m/s, Wave direction north-west, height 4 m, Temperature 3 °C, Sea water temperature 13 °C, and Visibility 5 km

2.7.2 Observations by the Crew Members

According to the statement of the Boatswain, at around 02:20, wind direction was west, wind speed was about 20 m/s, wave direction was south-west, wave height was about 2.5 to 3.0 m, and the wave direction and the wave height remained unchanged since he took over the watch duty.

According to the statement of the Officer, at around 04:00, it was rainy, wind direction was west, wind speed was about 12 m/s, wave direction was north-west to north-northwest, and wave height was about 2.5 to 3.0 m.

2.8 Analytical Investigation into the Foundering Accident of Chemical Tanker

The analytical investigation pertaining to the foundering accident of the chemical tanker was entrusted to NMRI.

2.8.1 Analysis of Inflow from Air Vent Pipe Head

Since the sea water had flowed into the ballast tanks on the voyage performed in November 2010, it was probable that sea water flowed into the ballast tanks again on this voyage. In order to investigate the situation of water inflow into the ballast tanks from the air vent pipes installed on the upper deck which were upper surfaces of the ballast tanks of the Vessel, the experiments were conducted and the following results were obtained.

- (1) Situation of Water Inflow from the Air Vent Pipe when the Rolling Motion Increased (at around 04:00)

When the rolling motion increased (at around 04:00) as described in the paragraph 2.8.3 (2) below, the disc float type air vent pipe head of inner diameter 100 mm was in such a situation where sea water remained on the port side upper deck and the port side expansion trunks, the heel of the Vessel to port increased and caused the air vent pipe heads repeatedly to submerge in the water due to the waves. Therefore, in order to simulate the same situation, an air vent pipe

head was submerged and raised in the water tank and the amount of water inflow from the air vent pipe head was measured under the following conditions.

1) The experimental conditions applied when the air vent pipe head was submerged in the water tank were as follows:

The depth from the water surface to the flange was 1.02 m.
 Submerging period was 4.2 seconds.

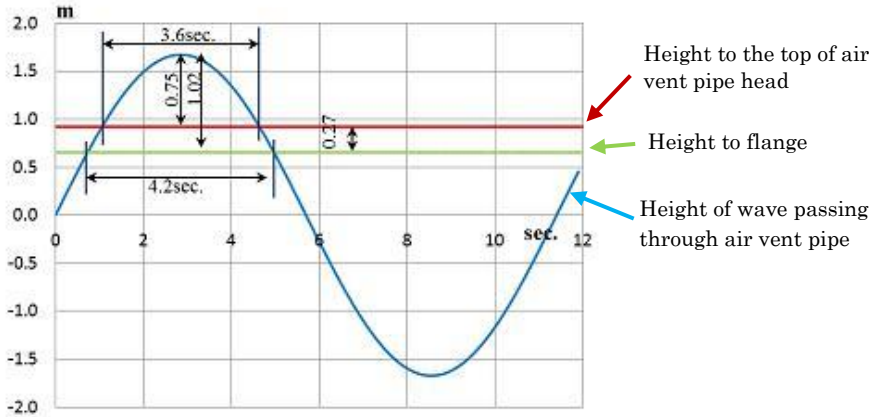


Figure 2-7 Situation of Wave Passing through Air Vent Pipe

2) A heel angle of air vent pipe head was 0°, and 15° & 30° with an opening turned downward.

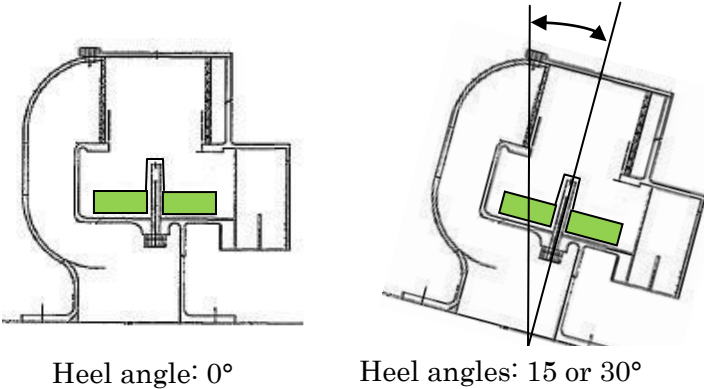


Figure 2-8 Heel Angles of Air Vent Pipe Head

- 3) The disc float was tested in the following positions.
- a) In a position to operate properly (hereinafter referred to as "proper position"), and
 - b) In a fixed position so that the disc float will not rise to the water surface on the assumption that sea water flows in, due to the failure of water inflow prevention function (hereinafter referred to as "fixed position").

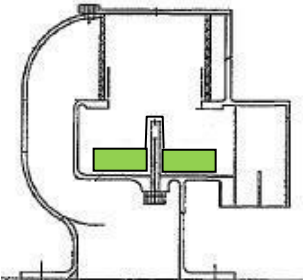


Figure 2-9 Fixed Position (Disc float was fixed in the position shown in the figure)

The amount of inflow water was shown in the following table. The measurement was executed twice under each condition and the average figures were written below.

Unit: ℓ

		Disc Float	
		proper position	fixed position
Heel Angle	0°	0.56	16.46
	15° with opening downward	0.47	19.54
	30° with opening downward	0.21	17.86

In this experiment, it was verified that when the disc float was in a fixed position and submerged for about 4.2 seconds, approximately 16 to 20 liters of water flowed into the ballast tank.

(2) Situation of Water Inflow from the Air Vent Pipe in case the Air Vent Pipe Head is Covered with the Waterproof Cover

The situation of water inflow was measured under the following conditions, in case the air vent pipe head mentioned in the above (1) is covered with waterproof cover.

- 1) The depth from the water surface to the flange was 1.02 m and submerging period was 4.2 seconds.
- 2) A heel angle of the air vent pipe head was 0° and 30° with an opening turned downward.
- 3) Position of a disc float shall be in a fixed position so that the disc float will not rise to the water surface on the assumption that sea water flows in, due to the failure of water inflow prevention function.

The amount of inflow water was shown in the following table. The measurement was executed twice under each condition and the average figures were written below.

Unit: ℓ

Heel Angle	0°	0.00
	30° with opening downward	0.00

In this experiment, it was verified that in case the air vent pipe head is covered with the waterproof cover, water will not flow in from the air vent pipe.

2.8.2 Stability Calculation Results

After analyzing the stability of the Vessel at the time when this accident occurred, the following results were arrived at.

(1) The Vessel's Stability in case No Water Flowed into the Air Vent Pipe

By using the factors such as the Vessel's departure draft, stability data prepared for a master according to the provisions of the Ship Safety Act (hereinafter referred to as "Stability Data"), cargo loading conditions and fuel oil quantity at her departure, the displacement (W) was estimated to be 1,751.55 t, the metacentric height (G₀M), after taking the free water effect into consideration, to be 0.839 m, natural period of rolling to be 8.76 seconds, and the stability curve for the Vessel was estimated as per the following figure.

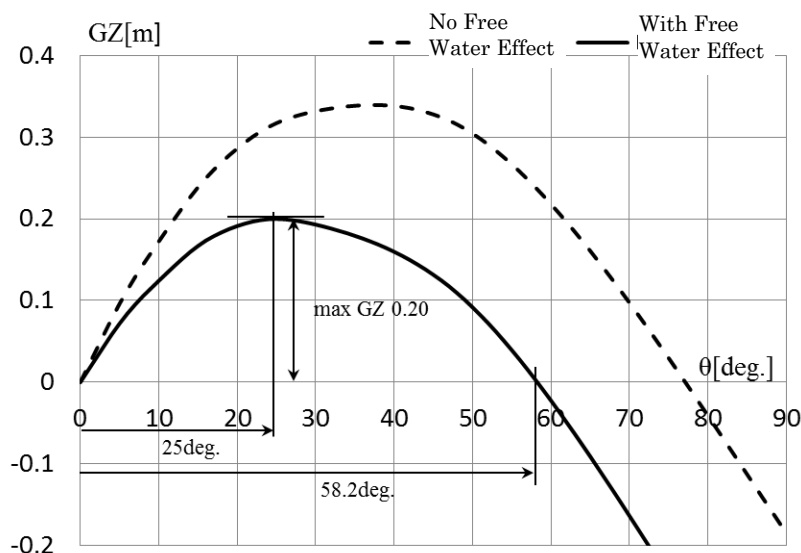


Figure 2-10 Stability Curve in Case of No Water Inflow from Air Vent Pipe

(2) Compliance with the Ship Stability Rule (Ordinance of the Ministry of Transport No.76 of December 28, 1956)

In the Stability Data, there are following descriptions with regard to the navigation to which master should pay attention.

- *The free surface effect in the tank should be reduced as much as possible. As for the free surface effect of the consuming liquid which is in the standard condition shown in the Stability Data, the biggest value among the effect in one center tank or the effect in a pair of left and right tanks shall be taken into consideration for each consuming liquid, and for other tanks, the value at the loading position shall be taken into consideration. Therefore, under the loading condition where the free surface effect becomes bigger than the above treatment, the review of the stability is needed.*

Based on the above, the verification of whether or not the Vessel complies with the Ship Stability Rule under the conditions mentioned in above paragraph (1) resulted in ascertaining that whereas the rules provide that a ship should have righting lever*23 bigger than 0.2 m at a heel angle bigger than 30°, the Vessel has righting lever of 0.19 m at a heel angle of 30° which is lower by 0.01 m.

2.8.3 Analysis of Foundering Mechanism

As to how the Vessel foundered under the weather and sea conditions when this accident occurred, the analysis was done by simulation in respect of the following points; consequently, the following results were arrived at.

- The Vessel's angle of heel affected by wind
- The Vessel's motion affected by waves (angle of heel caused by waves and situation of water inflow into ballast tanks and fuel oil service tank from air vent pipes)
- Events leading to the Vessel's foundering

(1) The Vessel's Angle of Heel Affected by Wind

As for the Vessel's heel angle to be affected by wind, the calculation was made by adding "the projected areas of side faces of machineries and equipment installed on the deck" to "the area of

*23 "Righting lever (GZ)" is a lever length of moment of couple to restore to the original position from heel position.

windage of the Vessel employed in Stability Data” and resulted in getting about 0.7° at wind speed 26 m/s (the wind speed employed in the calculation of ship stability in accordance with the rules by the Ship Safety Act).

The wind on the day of accident was side wind against the Vessel and then port quarter wind at wind speed of about 12.8 m/s and an angle of steady heel by wind was about 0.17°.

(2) The Oscillation of the Vessel Affected by Waves

The oscillation of the Vessel affected by waves at the point where she passed off Rokkozaki at around 02:20 (hereinafter referred to as “Point I”), at the point where her heel increased at around 04:00 (hereinafter referred to as “Point II”), and at the point where she reported to JCG at around 06:10 (hereinafter referred to as “Point III”), were as follows:

In the simulation, under the conditions of the Vessel’s speed and waves at each Point, the calculations were made for the Vessel’s situation generating her rolling angle (the amount of water flowed into the ballast tanks and the amount of the sea water remaining on the expansion trunks) and at the same time the rolling period and the natural period were computed.

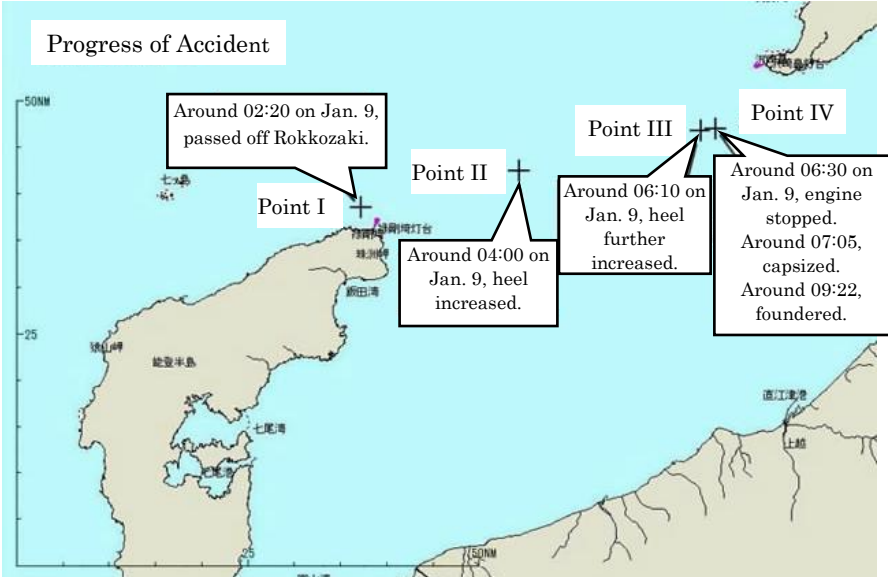


Figure 2-11 Points of Calculation

1) Point I

According to the statements of the crew members that the Vessel was sailing at the speed of about 11.0 kn and the Wave Estimation Database at Point I, it was calculated that she was in following waves from port quarter at an angle of encounter of about 35°, with the encounter period of about 12.07 seconds, natural period of rolling of about 10.08 seconds and she was rolling to port at a heel angle of about 1.2° to 7.8°.

Based on the assumption that the Vessel had a steady heel to port at an angle of about 4.5° at Point I, it is probable that about 24.8 tons of sea water washed on the port side of the upper deck and the expansion trunks to remain there causing about 15 tons of sea water to flow into the port side ballast tanks, and that, as shown in the following figure, the waves coming from the port side reached over the expansion trunks and the air vent pipes of the port side ballast tanks and allowed to submerge the air vent pipe heads in the water.

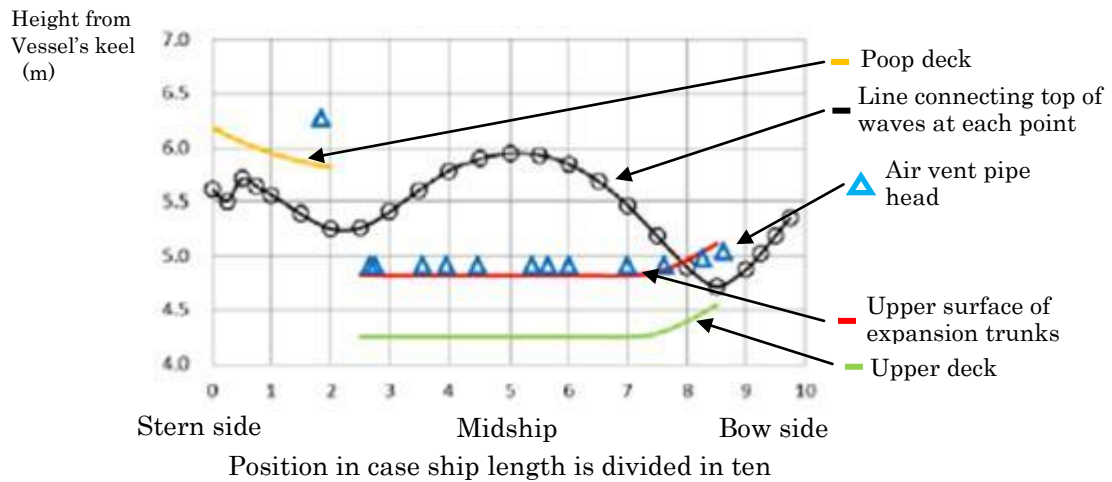


Figure 2-12 Calculation Results when Vessel has Steady Heel to Port at an Angle of about 4.5°
2) Point II

According to the statements of the crew members that the Vessel was sailing at speed about 9.8 kn and the Wave Estimation Database at Point II, it was calculated that she was in following waves from port quarter at the angle of encounter of about 35°, with the encounter period of about 11.39 seconds, natural period of rolling of about 10.61 seconds and she was rolling to port at a heel angle of about 24.1° and to starboard at about 12.5°.

Based on the assumption that the Vessel had a steady heel to port at an angle of about 5.8° at Point II, it is probable that about 24.8 tons of sea water washed on the port side of the upper deck and the expansion trunks to remain there causing about 17.1 tons of sea water to flow into the port side ballast tanks, and that, as shown in the following figure, the waves coming from the port side reached over the air vent pipes of the port side ballast tanks and the air vent pipes of the fuel oil service tank on the poop deck and allowed to submerge respective air vent pipe heads in the water.

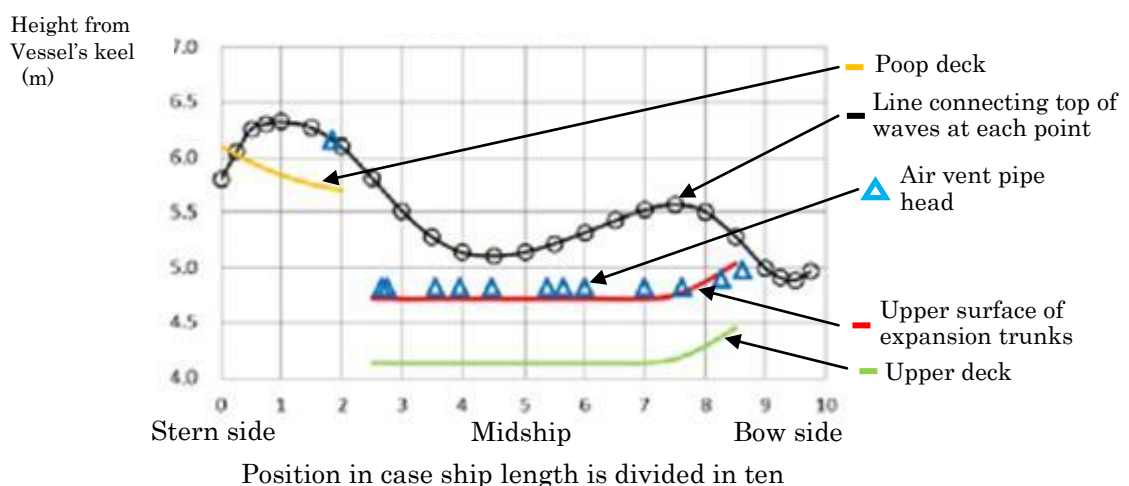


Figure 2-13 Calculation Results when Vessel has Steady Heel to Port at an Angle of about 5.8°

However, in case that water did not flow in the port side ballast tanks, the waves coming from the port side did not reach the air vent pipes of the ballast tanks and service tanks as shown in the following figure.

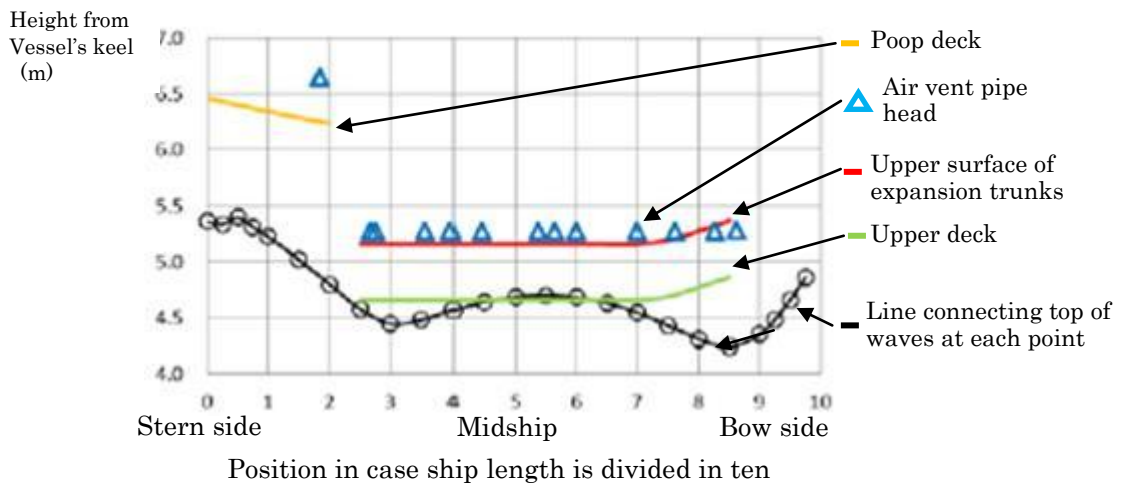


Figure 2-14 Calculation Results when Vessel has Steady Heel 0°

3) Point III

According to the statements of the crew members that the Vessel was sailing at speed about 9.0 kn and the Wave Estimation Database at Point III, it was calculated that she was in following waves from port quarter at the angle of encounter of about 35°, with the period of encounter of about 11.40 seconds, and had a steady heel to port at an angle of about 16.5°.

It is probable that about 31.5 tons of sea water washed on the port side expansion trunks and the port side poop deck to remain there causing about 52.1 tons of sea water to flow into the port side ballast tanks.

The Vessel's stability curve, as shown in the figure 2-10, when the steady heel increases, turns out to be the one having an intersection of a heel angle and the stability curve as a coordinate origin and the righting lever decreases as the steady heel increases.

The Vessel was in the situation where her righting lever diminished to nearly zero, when the angle of steady heel to port was about 16.5°, as shown with black stability curve. However, since the entrance on the poop deck kept closed, the calculation of her righting lever was done by adding the buoyancy of the accommodation quarters on the poop deck to find that she was in the situation where, as shown by red stability curve, with the heel angle of between about 16.5° and about 47.0°, her righting lever became almost zero and stabilized, and that she could be settled in a position with a steady heel at any angle within this range. The Vessel had the risk of capsizing by losing stability when her steady heel angle exceeded about 47.0°.

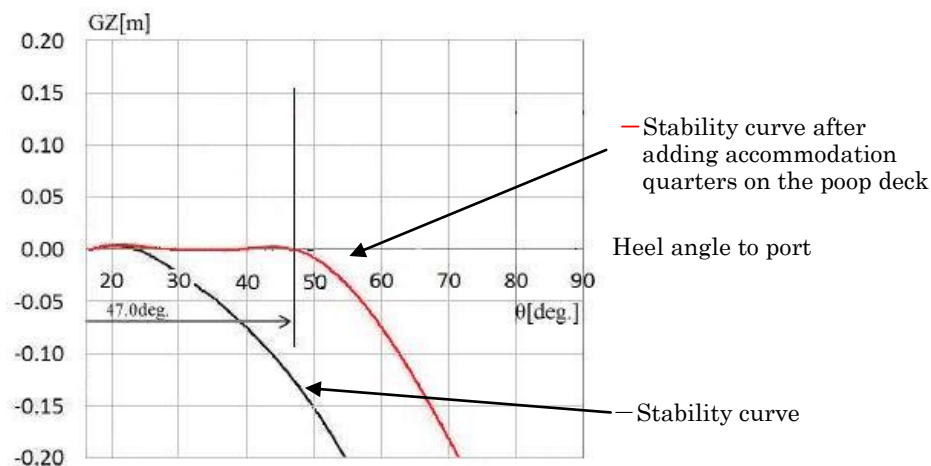


Figure 2-15 Vessel's Stability Curve with Steady Heel at an Angle of 16.5°

The calculations for the Vessel's natural period of rolling and her rolling motion at Point III could not be carried out due to excessive heel.

(3) Events Leading to Foundering

When passing Point I, the Vessel had displacement of about 1,750 tons and if the sea water had entered the ballast tanks of both sides, No.3 fresh water tanks of both sides, the engine room and the steering gear room later, the estimated amount of flowed-in water would have been about 750 tons and the total displacement would have been about 2,500 tons. The calculations were done by multiplying the flooding ratio*²⁴ 0.95 for ballast tanks and fresh water tanks, and by multiplying the said ratio 0.85 for the engine room and the steering gear room that were used in the stability calculations according to the provisions of the Ship Safety Act, and as a consequence, arrived at the conclusion that these events lead to the foundering of the Vessel owing to the weight of displacement greater than the buoyancy.

2.9 Situation of Air Vent Pipe Heads Applied to the Other Ships

As a result of research on air vent pipe heads for other ships, there was an air vent pipe head found in which the casting section to cover a disc float was rusty as shown in the following photo, and particularly the thick rust generated inside the pipe head interrupted the movement of the disc float and rendered the disc float incapable of moving up to the highest point to shut the opening of the air vent pipe head.



2.10 Similar Accident Case

According to the judgement by the former Marine Accidents Inquiry Agency, there was one accident of foundering of a chemical tanker similar to this accident which occurred between January 1991 and September 2008 and it actually took place in April 2005.

(1) Situation of Freeboard at the Time of Departure from Port, Speed and Wave Height when the Accident Occurred

The chemical tanker which met the accident was of gross tonnage 198 tons, and of overall length 49.5 m.

The freeboard at the time of departure from port was about 0.3 m with full load condition.

The vessel speed when the accident occurred was about 5 kn.

*²⁴ "Flooding Ratio" is the percentage of capacity which water occupies in the total capacity.

The wave height when the accident occurred was about 3 to 4 m.

(2) Situation of Accident

Foundering of this vessel took place in the following manner.

Before navigation with very low freeboard and with full load, the inspection of the air vent pipe heads on the deck had not been done thoroughly and the openings of air vent pipe heads had not been fully shut. While the vessel was sailing at the southern part of Sagaminada where, gale and high seas warnings being published, northeasterly wind was blowing and high waves were hitting the deck causing sea water to remain onboard, no measures had been taken for the evacuation from stormy weather and the sea water that flowed into the forecastle, the ballast tanks of the fore starboard side and the void space of the vessel through insufficiently waterproofed openings and air vent pipe heads caused the vessel to lose buoyancy leading to the accident.

3 ANALYSIS

3.1 Situation of the Accident Occurrence

3.1.1 Course of the Events

According to 2.1, it is probable that the course of the events was as follows:

- (1) On January 6, 2011, the Vessel, manned with the Master and four crew members, fully deballasted and loaded approximately 1,000 tons of vinyl acetate monomer at Oita Port, and then at around 18:30, departed from Oita Port. However, due to the bad weather, the Vessel anchored at off the Oita Airport and on January 7, at around 08:00, departed from there heading to Akadomari Port.
- (2) The Vessel, after passing off Saruyama misaki at around 23:30 on January 8, passed off Rokkozaki at around 02:20 on January 9, and she was sailing in following waves with west wind, at engine revolution of about 290 RPM and at speed of about 11.0 kn.
- (3) At around 04:00, the Vessel was sailing in following waves from port quarter with west wind and with the course of about 078° at speed of about 9.8 kn.
- (4) The Vessel's air vent pipes for the port side ballast tanks and the fuel oil service tank repeatedly submerged in the water.
- (5) The Vessel stopped rolling to starboard and her heel to port and rolling increased.
- (6) The Master, in order to head the Vessel against waves to reduce the waves washing over the upper deck, reduced the engine revolution to about 250 RPM and attempted to turn to port at speed of about 9.0 kn, but failed to head her bow against waves.
- (7) The Vessel, since the entrance hatch to the pump room installed on the port side fore poop deck was submerged in the sea water, was not able to deballast.
- (8) The Vessel's fuel oil service tank was inundated with sea water causing the main engine and then diesel engine generator to stop.
- (9) At around 07:05, the port side end of the boat deck of the Vessel came to be submerged under sea surface due to her list to port and it was not long before she turned over to port and capsized.

- (10) The Vessel, after listing and sinking about 7 to 8 m underwater, rose to the surface with her bottom turned upward.
- (11) The Vessel was positioned almost vertical to the surface of water with her bow turned upward and foundered at around 09:22.

3.1.2 Date, Time and Location of the Accident Occurrence

According to 2.1, it is probable that this accident occurred at around 09:22 on September 9, 2011 and the location of the accident was around 216° true, 16.0 km from Sawazakihana lighthouse located at Sado City.

3.1.3 Damage to Vessel

According to 2.3, the Vessel foundered and became total loss.

3.1.4 Injuries to Persons

According to 2.2, the Chief Engineer died by drowning, the Master went missing, and the Officer, the Boatswain and the Engineer suffered hypothermia and other diseases.

3.2 Causal Factors of the Accident

3.2.1 Crew Members and Vessel Conditions

(1) Crew Members

According to 2.4, the situation of crew members was as follows:

The Master, the Officer, the Boatswain, the Chief Engineer and the Engineer had legal and valid certificates of competency.

It is probable that the Master, the Officer, the Boatswain, the Chief Engineer and the Engineer were in good health.

It is probable that Master, the Officer, the Boatswain, the Chief Engineer and the Engineer had sailed in the vicinity of the location of the accident many times.

(2) Vessel Condition

According to 2.1 and 2.5.2, it is probable that the Vessel's conditions were as follows:

- 1) The sea water flowed in the ballast tanks on her voyage in November 2010.
- 2) Other than the above 1), the Vessel's hull, main engine and equipment had no defects or malfunctions.

3.2.2 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 at the time when the Vessel capsized

At 02:20, (37°34.0' N, 137°18.0' E)

Wave height 2.22 m, Wave period 5.3 s, Wave direction 288°, Wind direction 268°,
Wind speed 13.0 m/s

At 04:00, (37°38.0' N, 137°40.0' E)

Wave height 2.66 m, Wave period 7.2 s, Wave direction 293°, Wind direction 274°,
Wind speed 12.8 m/s

At 05:30, (37°40.0' N, 137°54.0' E)

Wave height 2.79 m, Wave period 7.4 s, Wave direction 293°, Wind direction 279°,
Wind speed 12.8 m/s

At 07:00, (37°42.0' N, 138°06.0' E)

Wave height 2.95 m, Wave period 7.3 s, Wave direction 285°, Wind direction 285°,
Wind speed 12.3 m/s

(2) Weather Conditions at the time when the Vessel foundered

At 09:00, Temperature 4.4 °C, Average wind speed 8.2 m/s,

Wind direction west southwest, Maximum instantaneous wind speed 15.1 m/s,

Wind direction west

3.2.3 Analysis of Air Vent Pipe Head of Air Vent Pipe

According to 2.1, 2.5.2(7), 2.6, 2.8.1 and 2.8.2, the analysis was as follows:

- (1) The Vessel underwent inspection of the air vent pipes during the special survey in February 2009.
- (2) The air vent pipes were removed and restored by the ship repair company when the Vessel was docked in February 2009, but the information on the maintenance and inspection was unavailable.
- (3) It is probable that the crew members had not overhauled the air vent pipe heads since March 2009 until the accident occurred.
- (4) It is probable that the ballast tanks of the Vessel were flooded with sea water on her voyage of November 2010.
- (5) It is probable that, after the ballast tanks were flooded with sea water on her voyage of November 2010, her crew members had been studying the countermeasures to prevent water inflow through the air vent pipe heads, but no such measures had been taken.
- (6) It is probable that, while the air vent pipe heads were in the situation mentioned in above 3.1.1(4), the amount of sea water that flowed into the ballast tank through each air vent pipe head when single wave coming would have been within about 0.6 liters in case that the water inflow prevention function had been working and the amount of sea water under same conditions would have been about 16 to 20 liters in case that the water inflow prevention function had not been working.
- (7) It is probable that, as mentioned in above (5), the water inflow prevention function did not work because no countermeasures to prevent water inflow through the air vent pipes had been taken since the ballast tanks were flooded.
- (8) It is somewhat likely that the Master failed to report to the Company A of the water inflow into the ballast tanks which took place on her voyage of November 2010.

3.2.4 Analysis of Operation Standard

According to 2.6 and 2.7, it is probable that the weather and sea conditions at the time when the Vessel departed and when she was at sea did not deviate beyond the conditions provided in the operating standard to stop the continuation of voyage.

3.2.5 Analysis of Loading Conditions

According to 2.8.2(2), whereas a vessel should have righting lever of bigger than 0.2 m with a heel angle bigger than 30° as prescribed in the regulations for ship stability, the Vessel had righting

lever of 0.19 m with a heel angle of 30° which is lower than the value of the said regulations. However, it was not possible to determine how this factor was implicated in the causes of this accident.

3.2.6 Analysis of Flooding and the Vessel's Rolling Motion

According to 2.8.3, it is probable that the analysis was as follows:

- (1) When the Vessel, after passing off Saruyama misaki, was sailing off Rokkozaki on January 9, at around 02:20, sea water flooded upon the port side of the upper deck and the expansion trunks to continuously remain onboard. Since the sea water flowed in the port side ballast tanks, the Vessel had a steady list to port at an angle of about 5° and was rolling to port by an angle of about 1° to 8°.
- (2) At around 04:00, the Vessel was sailing off west south-west of Sado Island and sea water washed on the port side upper deck and the port side expansion trunks, and continuously remained onboard. Since the sea water flowed in the port side ballast tanks, her steady list and rolling to port increased.
- (3) At around 06:10, the Vessel was sailing off south-west of Sado Island and sea water flooded upon the port side expansion trunks and the port side poop deck, and continuously remained onboard. Since the sea water flowed into the port side ballast tanks, her port list increased and caused her, after passing Saruyama misaki, to repeatedly submerge the air vent pipe heads of the air vent pipes of the port side ballast tanks and to continue the inflow of sea water into the port side ballast tanks.
- (4) The Vessel, under the conditions mentioned in above (3), came into the situation where she lost the stability and the righting lever stabilized at almost zero with a list angle in the range of 17° to 47°.

3.2.7 Analysis of Capsizing

According to 2.1, 2.8.3 and 3.1, it is probable that the analysis was as follows:

- (1) At around 23:30, on January 8, the Vessel passed approximately 3 M off north-west of Saruyama misaki.
- (2) At around 02:20, on January 9, the Vessel was sailing off Rokkozaki in following waves from port quarter at the angle of encounter of about 35°, with her steady list to port and at speed of about 11.0 kn.
- (3) Since after the Vessel passed off Saruyama misaki, the weather and sea conditions remained nearly the same until she reached off Rokkozaki, the air vent pipe heads of No.2 to No.4 port side ballast tanks repeatedly submerged in the water.
- (4) At around 04:00, the Vessel was sailing off west southwest of Sado Island in following waves from port quarter at the angle of encounter of about 35°, and at speed of about 9.8 kn.
- (5) The air vent pipe heads of the air vent pipes of the port side ballast tanks and that of the fuel oil service tank repeatedly submerged.
- (6) At around 06:10, the Vessel was sailing off south-west of Sado Island in following waves from port quarter at the angle of encounter of about 35° and at speed of about 9.0 kn, and her list to port was increasing. As a consequence, after the Vessel passed Saruyama misaki, the air vent pipe heads of the air vent pipes of the port side ballast tanks repeatedly submerged and the inflow of sea water into the port side ballast tanks continued.

- (7) Since sea water flowed into the fuel oil service tank, the main engine and then the diesel engine generator stopped.
- (8) At around 07:05, the Vessel listed to port to the extent that the port side end of the boat deck submerged under sea surface.
- (9) It was not long before the Vessel turned over to port and capsized.

3.2.8 Analysis of Foundering

According to 2.8.3, it is somewhat likely that about 750 tons of sea water flowed into the Vessel and the ballast tanks of both sides, No.3 fresh water tanks of both sides, the engine room and the steering gear room were flooded, and then Vessel foundered.

3.2.9 Analysis of Life Raft

According to 2.1 and 2.5.2(9), the analysis was as follows:

- (1) The Vessel had special survey in February 2009 and the maintenance of the Life Raft was carried out by a maintenance service company approved by Ministry of Land, Infrastructure, Transport and Tourism.
- (2) It is probable that, since the Vessel sank about 7 to 8 m in a capsized position, the automatic release device of the Life Raft operated and inflated automatically, and rose to the surface in a position turned upside down.
- (3) It is probable that a painter of the Life Raft was bound up with a part of the Vessel hull in view of the fact that the Life Raft was pulled toward the Vessel.
- (4) The Officer, the Boatswain and the Engineer attempted to turn over the Life Raft but failed to do so due to high waves and gave up turning it over in order to conserve their physical strength.
- (5) It is somewhat likely that the Officer, the Boatswain and the Engineer, since the Life Raft rose to the surface with the tent turned upside-down, were unable to find the knife fitted near the entrance.

3.2.10 Situation Leading to Rescue

According to 2.1, it is probable that the situation was as follows:

- (1) The Engineer reported to the Chief Engineer that sea water was coming out of the fuel oil service tank and the main engine would stop, and then immediately went up to the bridge and reported the same to the Master.
- (2) The Master ordered the crew members to put on the life jackets.
- (3) At around 06:10, the Master contacted JCG to request for rescue, and informed the engineering personnel of the Company A that the main engine would stop and the Vessel was listing and also that they had contacted JCG and all the crew members would abandon the Vessel, and requested the Company A to set up an accident countermeasures office.
- (4) The chief Engineer went up to the bridge and reported to the Master that the fuel oil service tank was flooded with sea water and the main engine would stop.
- (5) At around 06:30, the Master informed JCG that the main engine had stopped.
- (6) The crew members putting on the life jackets gathered around the Life raft installed on the starboard side of the boat deck.
- (7) The Master, while waiting for the rescue by JCG, informed them of the situation from time to time and ordered the Engineer to plunge into the sea first when the rescue team arrives and also

advised the crew members to share drinking water in case they are thrown into the sea as they feel thirsty due to sea water.

- (8) The crew members, checking each other whether they put on the life jackets or not, were unable to drop the Life Raft because the Vessel was listing to port, and they did nothing but pull the safety pin out of its cradle.
- (9) At around 07:05, since the port side end of the boat deck came to be submerged under sea surface, the Master reported to JCG of the situation.
- (10) All the crew members shifted to the exposed area of the starboard side of the navigation bridge deck to wait for the rescue at the highest possible place. It was not long before the Vessel turned over to the port.
- (11) The crew members plunged into the sea upon foundering of the Vessel. The Officer, the Boatswain and the Engineer came to the surface in the vicinity of her stern and caught hold of the Life Raft which rose to the surface with the tent turned upside-down.
- (12) The Chief Engineer came to the surface in the direction of her bow and the Officer and the Boatswain spoke to the Chief Engineer with no reply and he was carried away toward her bow.
- (13) The Officer, the Boatswain and the Engineer attempted to turn over the Life Raft which rose up to the surface with the tent turned upside-down, but failed to do so due to high waves, and gave up turning it over in order to conserve their physical strength.
- (14) The Officer, the Boatswain and the Engineer, whenever the Life Raft was pulled closer to the drifting Vessel, were trying to carry the Life Raft away from the Vessel by swimming. When the Life Raft was pulled right on the Vessel, she pushed the Life Raft up and the Officer and the Boatswain were forced to separate from the Life Raft.
- (15) At around 07:40, the patrol boat of JCG found the capsized Vessel and survivors around the Vessel, and by around 08:35, rescued four persons, the Officer, the Boatswain, the Chief Engineer and the Engineer who had been drifting around the Life Raft. Four of them were transferred to the Niigata Airport by a helicopter of JCG and then transported to a hospital.

3.2.11 Analysis of the Accident Occurrence

According to 3.1.1 and 3.2.6 to 3.2.9, the analysis was as follows:

- (1) It is probable that when the Vessel, after passing approximately 3 M off north-west of Saruyama misaki, was sailing off Rokkozaki in following waves from port quarter at the angle of encounter of about 35°, sea water flooded upon the port side of the upper deck and the expansion trunks to continuously remain onboard, and that the sea water that flowed into the port side ballast tanks made the Vessel sail with a steady list to port at an angle of about 5° and rolling to port by about 1° to 8° at speed of about 11.0 kn.
- (2) It is probable that the water inflow prevention function of the air vent pipe heads of the air vent pipes did not work because no countermeasures to prevent water inflow through the air vent pipes had been taken since the ballast tanks were flooded with water on the Vessel's voyage of November 2010.
- (3) It is probable that, after the Vessel passed off Saruyama misaki, the weather and sea conditions remained nearly the same until she reached off Rokkozaki and the air vent pipe heads of No.2 to No.4 port side ballast tanks repeatedly submerged in the water.

- (4) It is probable that the Vessel was sailing off west southwest of Sado Island in following waves from port quarter at the angle of encounter of about 35° and at speed of about 9.8 kn and her steady list and rolling to port was increasing.
- (5) It is probable that the air vent pipe heads of the port side ballast tanks and fuel oil service tank repeatedly submerged in the water.
- (6) It is probable that the Vessel was sailing off south-west of Sado Island in following waves from port quarter at the angle of encounter of about 35° and at speed of about 9.0 kn, and her list to port was increasing. It is also probable that, as a consequence, after the Vessel passed off Saruyama misaki, the air vent pipe heads of the air vent pipes of the port side ballast tanks repeatedly submerged and the inflow of sea water into the port side ballast tanks continued.
- (7) It is probable that since sea water flowed into the fuel oil service tank, the main engine and then the diesel engine generator stopped.
- (8) It is probable that the Vessel listed to port to the extent that the port side end of the boat deck submerged in the water.
- (9) It is probable that it was not long before the Vessel turned over to port and capsized.
- (10) It is somewhat likely that the ballast tanks of both sides and No.3 fresh water tanks of both sides, the engine room and the steering gear room were flooded.
- (11) It is probable that the Vessel foundered in a position almost vertical to the surface of water with her bow turned upward.

(Refer to Attachment 1 Flow Chart Showing the Events Leading to the Accident)

4 Conclusions

4.1 Findings

- (1) It is probable that when the Vessel, after passing about 3 M off north-west of Saruyama misaki, was sailing off Rokkozaki in following waves from port quarter at the angle of encounter of about 35° and at speed of about 11.0 kn, sea water flooded upon the port side of the upper deck and the expansion trunks to continuously remain onboard, and that the sea water that flowed into the port side ballast tanks made the Vessel sail with a steady list to port at an angle of about 5° and roll to port by about 1° to 8°. (3.1.1(2), 3.2.6(1), 3.2.7(2), 3.2.11(1))*²⁵
- (2) It is probable that, after the Vessel passed off Saruyama misaki, the weather and sea conditions remained nearly the same until she reached off Rokkozaki and the air vent pipe heads of No.2 to No.4 port side ballast tanks repeatedly submerged in the water. (3.2.7(3), 3.2.11(3))
- (3) It is probable that the water inflow prevention function of the air vent pipe heads of the air vent pipes did not work because no countermeasures to prevent water inflow through the air vent pipes had been taken since the ballast tanks were flooded with water on the Vessel's voyage of November 2010. (3.2.3(7), 3.2.11(2))

*²⁵ The numbers written at the end of each paragraph of this clause correspond to the numbers of major clauses and items of the chapter "3 Analysis" related to the descriptions here in this clause.

- (4) It is probable that the Vessel was sailing off west southwest of Sado Island in following waves from port quarter at the angle of encounter of about 35° and at speed of about 9.8 kn and her steady list and rolling to port was increasing. (3.1.1(3), 3.2.6(2), 3.2.7(4), 3.2.11(4))
- (5) It is probable that the Vessel was sailing off south-west of Sado Island in following waves from port quarter at the angle of encounter of about 35° and at speed of about 9.0 kn, and her list to port was increasing. It is also probable that as a consequence, after the Vessel passed off Saruyama misaki, the air vent pipe heads of the air vent pipes of the port side ballast tanks repeatedly submerged and the inflow of sea water into the port side ballast tanks continued. (3.2.6(3), 3.2.7(6), 3.2.11(6))
- (6) It is probable that the Vessel listed to port to the extent that the port side end of the boat deck submerged in the water and that it was not long before the Vessel turned over to port and capsized. (3.1.1(9), 3.2.7(8), 3.2.7(9), 3.2.10(9), 3.2.10(10), 3.2.11(8), 3.2.11(9))
- (7) It is probable that the Vessel foundered in a position almost vertical to the surface of water with her bow turned upward. (3.1.1(11), 3.2.11(11))

4.2 Probable Causes

It is probable that this accident occurred in the following manner.

When the Vessel was sailing off Saruyama misaki toward Akadomari Port in following waves from port quarter, the water inflow prevention function of the air vent pipe heads of the air vent pipes of the port side ballast tanks failed to function and it allowed sea water, that had flooded upon the port side of the upper deck and the expansion trunks and to continuously remain onboard, to flow into the port side ballast tanks. The flowed-in sea water in the ballast tanks increased the list of the Vessel to port and caused the air vent pipe heads of the air vent pipes to be repeatedly submerged. The sea water that flowed continuously into the port ballast tanks from the air vent pipes increased the port list to consequently capsize and founder the Vessel.

It is probable that the reason why the water inflow prevention function of the air vent pipe heads failed to work was that the ballast tanks had been flooded during the voyage of November 2010, but no flood preventive measures for the air vent pipes had been taken since then.

4.3 Other Findings of Safety Related Issues

It is probable that the Vessel, having a structure to change over the operation of ballast lines inside the pump room, was unable to deballast the sea water that flowed into the ballast tanks because the entrance hatch to the pump room was submerged in the water and there was no other access to the pump room. However, it is somewhat likely that if the Vessel had been able to deballast the water in the ballast tanks, she could have reduced her list to port and could have prevented or reduced water inflow into the ballast tanks through the air vent pipes.

5 SAFETY ACTIONS

With regard to this accident, it was probable in the process of investigation of the accident that when the Vessel was sailing off Saruyama misaki toward Akadomari Port in following waves from port quarter, sea water flowed into the ballast tanks from the air vent pipe heads of the air vent pipes and increased her list to port causing her to consequently capsize and founder. Based on

these findings, it was necessary to instruct the parties concerned in an early stage to maintain the air vent pipe heads.

5.1 Opinions Stated by JTSB to Minister of Land, Infrastructure, Transport and Tourism

On June 29, 2012, opinion was stated to Minister of Land, Infrastructure, Transport and Tourism as follows:

JTSB, in view of the development of this accident, expressed its opinions to the Minister of Land, Infrastructure, Transport and Tourism pursuant to article 28 of the Act for Establishment of the Japan Transport Safety Board as follows:

When the vessel with low freeboard is navigating under the condition where the green water hits the expansion trunk, the waves wash over the upper deck and expansion trunks causing the sea water to remain onboard and it may sometimes make the vessel heel and make the sea water flow into the ballast tanks through the air vent pipes on the upper deck. Therefore, it is necessary for the Minister to instruct shipowners and operators to fully maintain the air vent pipe heads of the air vent pipes.

5.2 Safety Actions Taken

5.2.1 Safety Actions Taken by Ministry of Land, Infrastructure, Transport and Tourism

On June 29, 2012, Maritime Bureau of Ministry of Land, Infrastructure, Transport and Tourism informed the Japanese Shipowners' Association and the Japan Federation of Coastal Shipping Associations to make the following public.

On January 9, 2011, the accident occurred, wherein the chemical tanker (SEIYO, 499 gross tonnage) foundered off about 16 km south-west of Sawazakihana, Sado City, Niigata Prefecture, and one died and one went missing. According to the JTSB, the sea water that flowed into the ballast tanks through the air vent pipes installed on the upper deck was pointed out as a cause of the accident.

Particularly, when the vessel with low freeboard is navigating under the condition where the green water hits the expansion trunks, the waves wash over the upper deck and expansion trunks causing the sea water to remain onboard and it may sometimes make the vessel heel and make the sea water flow into the ballast tanks through the air vent pipes on the upper deck. Therefore, it is necessary to fully maintain the air vent pipe heads of the air vent pipes.

In this respect, it would be appreciated if you could advise members of your organization to thoroughly perform maintenance of the air vent pipe heads of the air vent pipes.

Attached Figure 1 Map

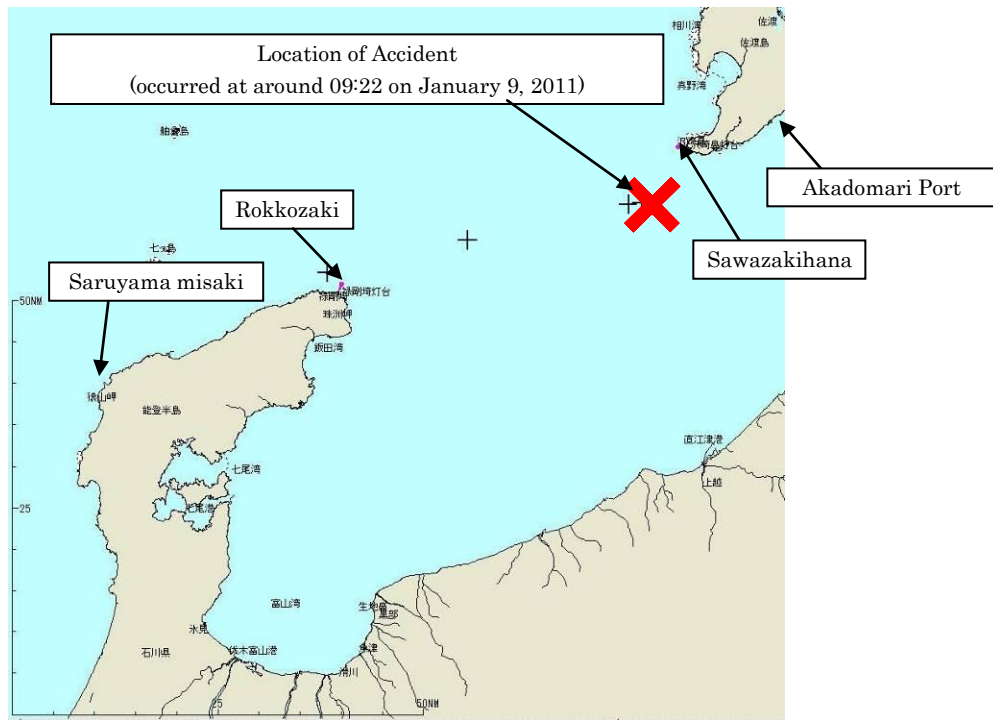


Photo 1 the Vessel



Attachment 1 Flow Chart Showing the Events Leading to the Accident

