

MA2018-10

**MARINE ACCIDENT  
INVESTIGATION REPORT**

October 25, 2018



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.

Kazuhiro Nakahashi  
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: Cargo Ship TAI YUAN

IMO number: 9379222

Gross tonnage: 1,972 tons

Accident type: Fire

Date and time: Around 13:20, April 24, 2017 (local time, UTC +9 hours)

Location: Berth No. 16, Hakozaki Wharf, Hakata Port, Fukuoka City, Fukuoka Prefecture

Around 101° true bearing, 1.2 nautical miles from East Passage No. 6 Light Beacon, Hakata Port  
(approximately 33°38.5'N, 130°24.4'E)

September 19, 2018

Adopted by the Japan Transport Safety Board

Chairman Kazuhiro Nakahashi

Member Yuji Sato

Member Kenkichi Tamura

Member Toshiyuki Ishikawa

Member Makiko Okamoto

## SYNOPSIS

### < Summary of the Accident >

At around 13:20 on April 24, 2017, as the cargo ship TAI YUAN, with a master and ten other crew members aboard, was waiting to begin loading of waste metal and other miscellaneous scrap at the No. 16 Berth of Hakozaki Wharf, Hakata Port, Fukuoka City, Fukuoka Prefecture, a fire broke out in the aft cargo hold.

At around 04:54 on the following day, April 25, TAI YUAN foundered during firefighting and became a total loss. An oil spill occurred, but there were no fatalities or injuries.

### < Probable Causes >

It is probable that the accident occurred when, as the Vessel was moored for the purpose of cargo-handling at Hakata Port, a fire that broke out within the scrap loaded into the aft cargo hold spread because firefighting by water-spraying was ineffective and appropriate firefighting methods using the Vessel's carbon dioxide gas firefighting equipment were not employed.

It is probable that effective firefighting methods using the carbon dioxide gas firefighting equipment were not employed because the Master did not think of using the carbon dioxide gas firefighting equipment.

It is probable that the Master did not think of using the carbon dioxide gas firefighting equipment because he did not have experience with fire drills for a fire in the Vessel's cargo holds and because the Vessel and Company A did not share information on effective firefighting methods

for times of fire.

It is somewhat likely that firefighting by water-spraying was not effective because the sprayed water was blocked by the scrap's surface layer and did not reach the fire's origin.

Regarding the fire that broke out inside the scrap, it is somewhat likely that a spark created by contact between metal objects, a battery, etc., was the source of the fire, and that the source ignited combustible material. However, it was not possible to determine the circumstances leading up to the fire.

### < Safety Recommendations >

It is probable that the accident occurred when a fire that broke out within the scrap loaded into the aft cargo hold spread because firefighting by water-spraying was ineffective and appropriate firefighting methods using TAI YUAN's carbon dioxide gas firefighting equipment were not employed.

It is probable that effective firefighting methods using the carbon dioxide gas firefighting equipment were not employed because the Master did not think of using the carbon dioxide gas firefighting equipment because the Master did not have experience with fire drills for a fire in TAI YUAN's cargo holds and because TAI YUAN and Miki Shouji Co., Ltd. did not share information on effective firefighting methods for times of fire.

Additionally, it is probable that, as a result of the accident, oil that spilled from the foundered TAI YUAN spread through a large area of Hakata Bay and caused harm to the fishing industry.

In view of the result of this accident investigation, the Japan Transport Safety Board recommends that Tai Yuan (Hong Kong) International Shipping Co., Ltd., which is the owner of TAI YUAN, take the following measures for the purpose of preventing the occurrence of a similar accident and reducing damage:

Tai Yuan (Hong Kong) International Shipping Co., Ltd. shall provide thorough instruction to masters of its vessels to unfailingly execute the following measures and shall also implement training in accordance with said measures:

- (1) Build a thorough system for appropriate and smooth firefighting in case of fire with the loading business by considering and determining effective firefighting methods in accordance with the cargo's characteristics beforehand and conveying this information to the loading business.
- (2) Pay full attention to the following points regarding firefighting methods for fires within piled scrap:
  - 1) Firefighting by water-spraying may not be effective because the sprayed water can be blocked by the scrap's surface layer and not reach the fire's origin.
  - 2) Insulation material and other combustible items with low specific gravity may float in a burning state even when the water level in the cargo holds rises from continuous water-spraying and continue to burn on the water's surface.
  - 3) Firefighting using carbon dioxide gas firefighting equipment is effective.
  - 4) When a vessel has multiple cargo holds, measures such as immediately closing and sealing the hatch covers of cargo holds other than the cargo hold with the fire shall be taken to prevent the spread of fire.
- (3) Reliably provide information on firefighting equipment aboard the vessel to the firefighting organization.
- (4) Implement measures as soon as possible to control oil, such as closing air vents and setting

up oil fences, whenever the danger of an oil spill from a vessel arises.

# 1 PROCESS AND PROGRESS OF THE INVESTIGATION

## 1.1 Summary of the Accident

At around 13:20 on April 24, 2017, as the cargo ship TAI YUAN, with a master and ten other crew members aboard, was waiting to begin loading of waste metal and other miscellaneous scrap at the No. 16 Berth of Hakozaki Wharf, Hakata Port, Fukuoka City, Fukuoka Prefecture, a fire broke out in the aft cargo hold.

At around 04:54 on the following day, April 25, TAI YUAN foundered during firefighting and became a total loss. An oil spill occurred, but there were no fatalities or injuries.

## 1.2 Outline of the Accident Investigation

### 1.2.1 Setup of the Investigation

The Japan Transport Safety Board (JTSB) appointed an investigator-in-charge and two other marine accident investigators to investigate this accident on April 25, 2017.

Three local marine accident investigators (Moji Office) were also joined the accident investigation.

### 1.2.2 Collection of Evidence

|   |                                       |
|---|---------------------------------------|
| April 25, 2017:   | On-site investigations                |
| April 26, 27, June 6 - 8, and July 7, 8, 2017   | On-site investigations and interviews |
| April 28, July 14, 2017, and May 14, 15, 2018   | Interviews                            |
| June 12, 15, July 28, August 4, 18, September 7, November 17, 2017, February 5, 20, March 8, 29, and May 22, 2018 | Collection of questionnaire           |

### 1.2.3 Comments of Parties Relevant to the Cause

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

### 1.2.4 Comments from Flag State

Comments on the draft report were invited from the flag state of TAI YUAN.

## 2 FACTUAL INFORMATION

### 2.1 Events Leading to the Accident

According to the statements of the Master, Chief Officer, and able seaman who was on cargo-handling duty (hereinafter referred to as “Able Seaman A”) of TAI YUAN (hereinafter referred to as “the Vessel”); the person in charge at Miki Shouji Co., Ltd., which was the shipper and loading business (hereinafter referred to as “Company A”); four workers of Company A (hereinafter referred to as “Worker A,” “Worker B,” “Worker C,” and “Worker D”); the person in charge at the Fukuoka City Fire Prevention Bureau; and the person in charge at the Fukuoka City Port & Airport

Bureau and the reply to the questionnaire of the Fukuoka City Fire Prevention Bureau, the events leading to the accident, foundering, and fire extinguishing were as follows.

At around 08:15 on April 21, 2017, the Vessel, with her Master, Chief Officer, Able Seaman A, and eight other crew members onboard (all nationals of the People's Republic of China) aboard, moored starboard-side alongside in ballast condition at Berth No. 16 of Hakozaki Wharf, Hakata Port (hereinafter referred to as "the Berth"), for the purpose of loading a cargo of "waste metal and other miscellaneous scrap originating from offices, homes, etc." (hereinafter referred to as "scrap").

From around 09:00 on April 21 to the morning of April 22, the Vessel loaded scrap into her aft cargo hold and fore cargo hold, and in the afternoon, the Vessel loaded scrap into her fore cargo hold.

The Vessel did not conduct cargo-handling on April 23, as it was a non-business day for Company A.

In the morning of April 24, the Vessel's Master instructed the person in charge at Company A to conduct loading of the fore cargo hold for the purpose of adjusting trim. Subsequently, loading in this cargo hold commenced at around 8:30 and work was then discontinued for Company A's noontime break at around 12:00.

The person in charge at Company A instructed Company A's workers to conduct loading of the aft cargo hold in the afternoon.

Worker A went from Company A's office to the Vessel after the noontime break at around 13:00, climbed aboard a "hydraulic excavator that was loaded into the aft cargo hold" (hereinafter referred to as "the Hydraulic Excavator"), and was preparing to conduct loading work that included smoothing out the scrap in the area of the forward side of the aft cargo hold when, at around 13:20, he saw a small amount of white smoke rising from within the scrap in the port aft section of the aft cargo hold.

Worker A immediately notified an employee of Company A that a fire had broken out by transceiver and asked for the preparation of a water truck.

A clerical worker of Company A received the report from Worker A and immediately called the fire department.

Worker A stayed within the aft cargo hold, remaining aboard the Hydraulic Excavator, and was watching the area from which the smoke was rising when he saw something red resembling flame in a place that was slightly to the area's starboard side.

Worker B had boarded a hydraulic excavator that was stopped at the Berth and was arranging the scrap scheduled to be loaded next when he received the communication from Worker A and looked at the Vessel, whereupon he observed white smoke rising from the aft cargo hold. He immediately came down from the hydraulic excavator and boarded the Vessel.

Meanwhile, Able Seaman A was on cargo-handling duty in the wheel house from around 12:30 when he noticed smoke rising from the aft cargo hold at around 13:20. He immediately headed to the upper deck while notifying crew members in the Vessel of the fire by calling out in a loud voice.

The Master and the Chief Officer had finished lunch and were taking a break in their respective cabins when they heard Able Seaman A calling out. They went down to the upper deck and observed smoke rising from the aft cargo hold.

The Master and Worker B instructed crew members who had assembled on the upper deck to spray water on the aft cargo hold, and water-spraying began from fire hoses connected to three fire hydrants on the port side of the Vessel's upper deck began.

Worker C and Worker D, who were doing separate work in an "open storage yard serving as

the storage place for the scrap” (hereinafter referred to as “the Yard”), received the communication from Worker A and immediately boarded a water truck that was parked next to Company A’s office and headed to the Berth, when they observed blackish smoke rising from the aft cargo hold.

Worker C and Worker D stopped the water truck at the Berth and, together with Worker B, who had come down from the Vessel, sprayed water at the aft cargo hold and the starboard plating shell of the Vessel with a water cannon installed on the roof of the water truck and fire hoses that were connected to hydrants on either side of the truck.

Worker A subsequently had his vision blocked by smoke filling the aft cargo hold and could not tell if water-spraying into the aft cargo hold from the Vessel had begun. When he asked about this on the transceiver, he received a response indicating that water-spraying into the aft cargo hold had already begun. He therefore came down from the Hydraulic Excavator, climbed up to the upper deck via a ladder that was installed on the forward side of the aft cargo hold, told the Vessel’s crew members who were spraying water on the port side of the upper deck where the fire had broken out, and joined the firefighting.

The Vessel’s crew members and Worker A continued spraying water into the aft cargo hold until they handed over firefighting to a fire company of the Fukuoka City Fire Prevention Bureau (hereinafter referred to as “the Fire Company”) that arrived at the Vessel at around 14:04. They moved to the Vessel’s forecastle deck, which was upwind, in accordance with instructions from the Fire Company and watched the firefighting until around 14:34, when they left the Vessel in accordance with instructions from the Fire Company.

The Fire Company decided, based on its experience in past firefighting on ship fires, to use a firefighting tactic centered on “spraying protein foam from a large aerial-platform chemical-spray fire truck” (hereinafter “the protein foam spraying”).

As it made preparations for the protein foam spraying that included hooking up a pumper truck and truck carrying the protein foam solution to a large aerial-platform chemical-spray fire truck, the Fire Company sprayed water on the aft cargo hold and plating shell of the Vessel to suppress the fire’s force. However, the area of activity was limited by the scrap piled on the Berth and the Yard and thus the preparations took more time than is normal.

At around 14:52, the Fire Company observed the Vessel list to port and had firefighters on the Vessel withdraw.

With no firefighters aboard the Vessel, the Fire Company was having difficulty ascertaining the fire’s spread in the aft cargo hold in the rising thick smoke when, at around 15:12, the Fire Company observed that the fire had spread to the Hydraulic Excavator and to the fore cargo hold.

The Fire Company completed its preparations for the protein foam spraying and then commenced protein foam spraying into the aft cargo hold and fore cargo hold.

While observing the circumstances of the Vessel’s listing and foundering and the fire’s force, the Fire Company subsequently conducted protein foam spraying and water-spraying into the cargo holds and sprayed cooling water onto the Vessel’s plating shell to prevent the Vessel’s foundering; however, it could not extinguish the fire and the fire’s force did not abate.

The Fire Company thought that, although it was possible that the Vessel would founder if firefighting activities continued as is, the danger of ignition and burning of fuel oil could not be discounted. At around 00:35 on April 25, the Fire Company asked the Master, through interpretation provided by the person in charge at Company A, for approval to continue spraying water and communicated this fact to Fukuoka City, which is the port management body.

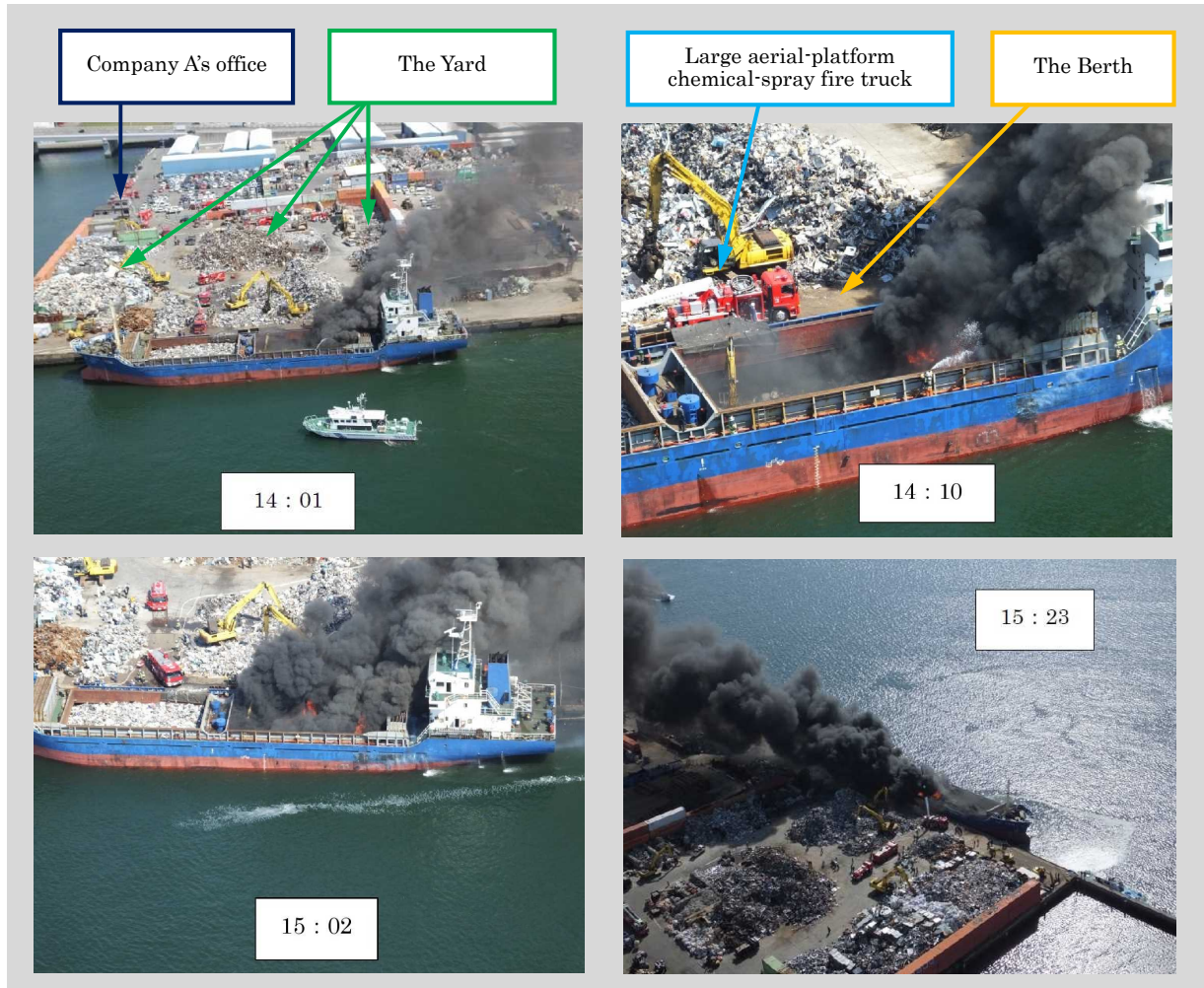
The Master consulted with Tai Yuan (Hong Kong) International Shipping Co., Ltd.



(hereinafter referred to as “Company B”), which is the Vessel’s owner, by telephone and then approved the continuation of water-spraying.

The Vessel continually underwent firefighting by the Fire Company but, at around 04:45, foundered from her port bow side. She settled on the bottom with only her wheel house above the water. The fire was extinguished.

(See Figure 1)





Photos provided by the Fukuoka City Fire Prevention Bureau

Figure 1 Circumstances of the Vessel's Fire and Foundering

The date and time of occurrence of the accident were at around 13:20 on April 24, 2017, and the location was at around 1.2 nautical miles at 101° true bearing from the Hakata Port East Passage No. 6 Light Beacon.  
 (See Annex Figure 1 Outline Map of the Accident Location)

## 2.2 Injuries to Persons

According to information provided by Japan Coast Guard, there were no fatalities or injuries.

## 2.3 Damage to Vessel

According to the onsite investigations and statement of the person in charge at the ship-breaking company, the Vessel had paint burn damage and heat deformation to her cargo holds' walls, pipes, and plating shell, but there were no breaches, cracks, or other such damage to the Vessel's plating shell.

Additionally, the Hydraulic Excavator had burn damage and heat deformation.

(See Figure 2)



Aft side of the Cargo Hold



Aft-side bulkhead of the Cargo Hold



Forward-side bulkhead of the Cargo Hold



Aft side of the fore cargo hold



Forward side of the fore cargo hold



Starboard plating shell



The Hydraulic Excavator

Figure 2 Damage to the Vessel and the Hydraulic Excavator

## 2.4 Crew Information

### (1) Gender, Age, and Certificate of Competence

1) The Master: Male, 53 years old, national of the People's Republic of China

Endorsement attesting the recognition of certificate under STCW regulation I/10 (issued by Belize)

Date of Issue: December 12, 2016

(Valid until June 21, 2021)

2) Worker A: Male, 38 years old

3) Person in charge at Company A: Female, 40 years old

### (2) Sea-going Experience, etc.

According to the statements of the Master, Worker A, and the person in charge at Company A, these were as follows.

#### 1) The Master

The Master first served aboard cargo ships as an able seaman in 1988, became a third officer the following year in 1989, and became a master in 1992.

He served as a master of bulk carriers transporting scrap in 2003 and served aboard the Vessel since December 2016.

He had previous experience entering the berths of Hakozaki Wharf.

#### 2) Worker A

Worker A had joined Company A around ten years before. He operated hydraulic excavators when scrap was accepted or loaded. He had work experience at the berths at Hakozaki Wharf and other offices of Company A.

He was a kind of leader for other workers during cargo-handling.

#### 3) Person in charge at Company A

The person joined Company A about ten years before. She gave instructions to workers concerning acceptance and loading of scrap.

She was fluent in Chinese.

## 2.5 Vessel Information

### 2.5.1 Particulars of Vessel

IMO number: 9379222

Port of registry: Belize

Owner: Company B (People's Republic of China)

Management company: YUN XING SHIPPING CO., LTD (People's Republic of China)

Classification Society: Bureau Veritas S.A.

Gross tonnage: 1,972 tons

L×B×D: 81.00 m x 13.60 m x 6.80 m

Hull material: Steel

Engine: Diesel engine x 1

Output: 1,323 kW

Date of launch: December 22, 2006

### 2.5.2 Information concerning the Vessel's Cargo Holds

According to the onsite investigations, the statements of the Master and person in charge at Company A, the reply to the questionnaire of the Fukuoka City Fire Prevention Bureau, and

the Vessel's capacity plans and fire control plans, the situation concerning the cargo holds was as follows.

The Vessel was a two-hold bulk carrier that transported scrap and other various types of cargo. The fore cargo hold and the aft cargo hold were separated by one steel bulkhead. The capacity of the fore cargo hold was 2,312 m<sup>3</sup> and the capacity of the aft cargo hold was 2,162 m<sup>3</sup>. At the time of the accident, the fore cargo hold had been loaded to approximately 80% and the aft cargo hold had been loaded to around 50%.

The Vessel was equipped with bellows-type hatch covers on the fore cargo hold and on the aft cargo hold. At the time of the accident, both hatch covers were in an open state and would have required approximately ten minutes to close.

It should be noted that, when Worker A left the aft cargo hold, the Hydraulic Excavator's arm was up and at a height that exceeded the height of the upper edge of the aft cargo hold's hatch coaming.

### 2.5.3 Information concerning the Vessel's Firefighting Equipment

According to the onsite investigations, the Vessel's fire control plans, and the reply to the questionnaire of the ship-breaking company, and the Vessel's firefighting equipment was as follows.

The Vessel was equipped with fire hydrants as well as carbon dioxide gas firefighting equipment.\*<sup>1</sup> Carbon dioxide gas discharge nozzles were installed in the fore cargo hold, the aft cargo hold, the engine room, and other compartments. Carbon dioxide gas cylinders, pipes to the carbon dioxide gas cylinders to each compartment and operating levers were arranged in the control room on the upper deck's starboard side and set up to allow operation of said equipment in each compartment.

After the accident, the operating levers for the carbon dioxide gas firefighting equipment were found to be in the "closed" state for both the fore cargo hold and the aft cargo hold on the raised Vessel.

It should be noted that, according to the statements of Worker A and the person in charge at Company A and the reply to the questionnaire of the Fukuoka City Fire Prevention Bureau, Worker A, the person in charge at Company A, and the Fire Company were not given information on the carbon dioxide gas firefighting equipment installed on the Vessel by the Vessel's crew members.

(See Figure 3 and Figure 4)

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\*<sup>1</sup> "Carbon dioxide gas firefighting equipment" refers to equipment installed for property under fire prevention measures that extinguishes fire when discharged carbon dioxide lowers the oxygen density around the property under fire prevention measures and when heat from the fire is removed with the carbon dioxide's heat capacity and latent heat of vaporization.

When the specific gravity of air is 1, the specific gravity of carbon dioxide is 1.53.

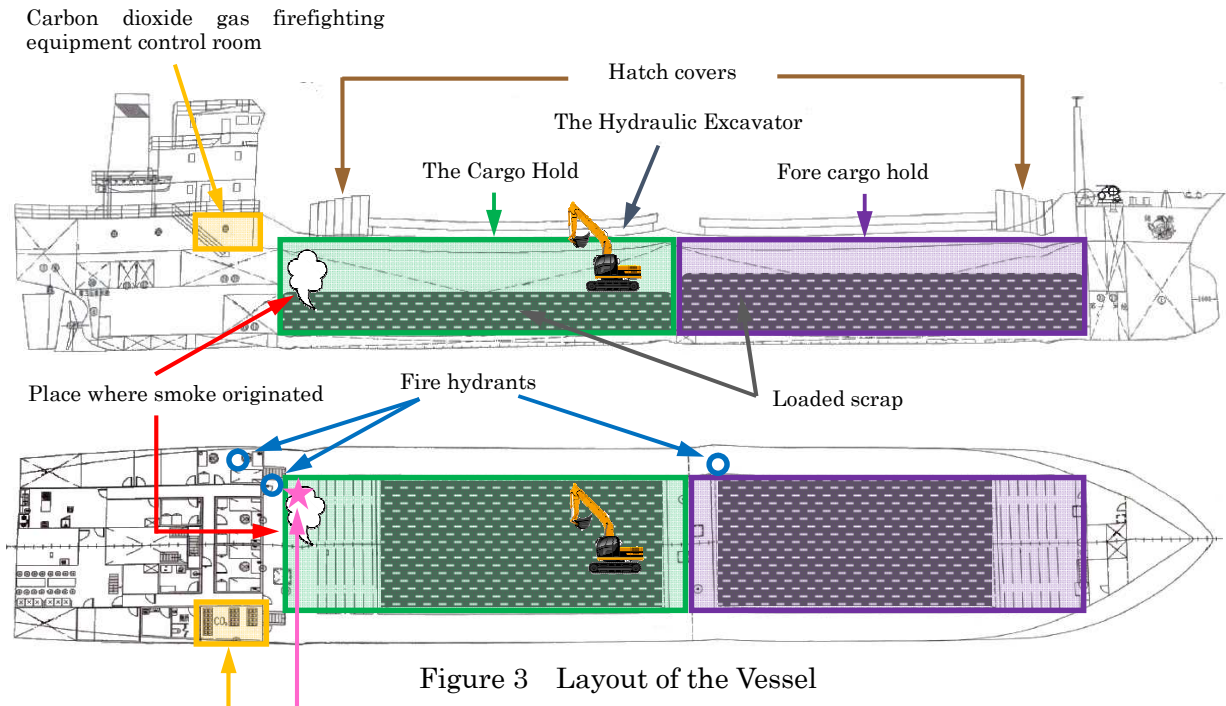


Figure 3 Layout of the Vessel

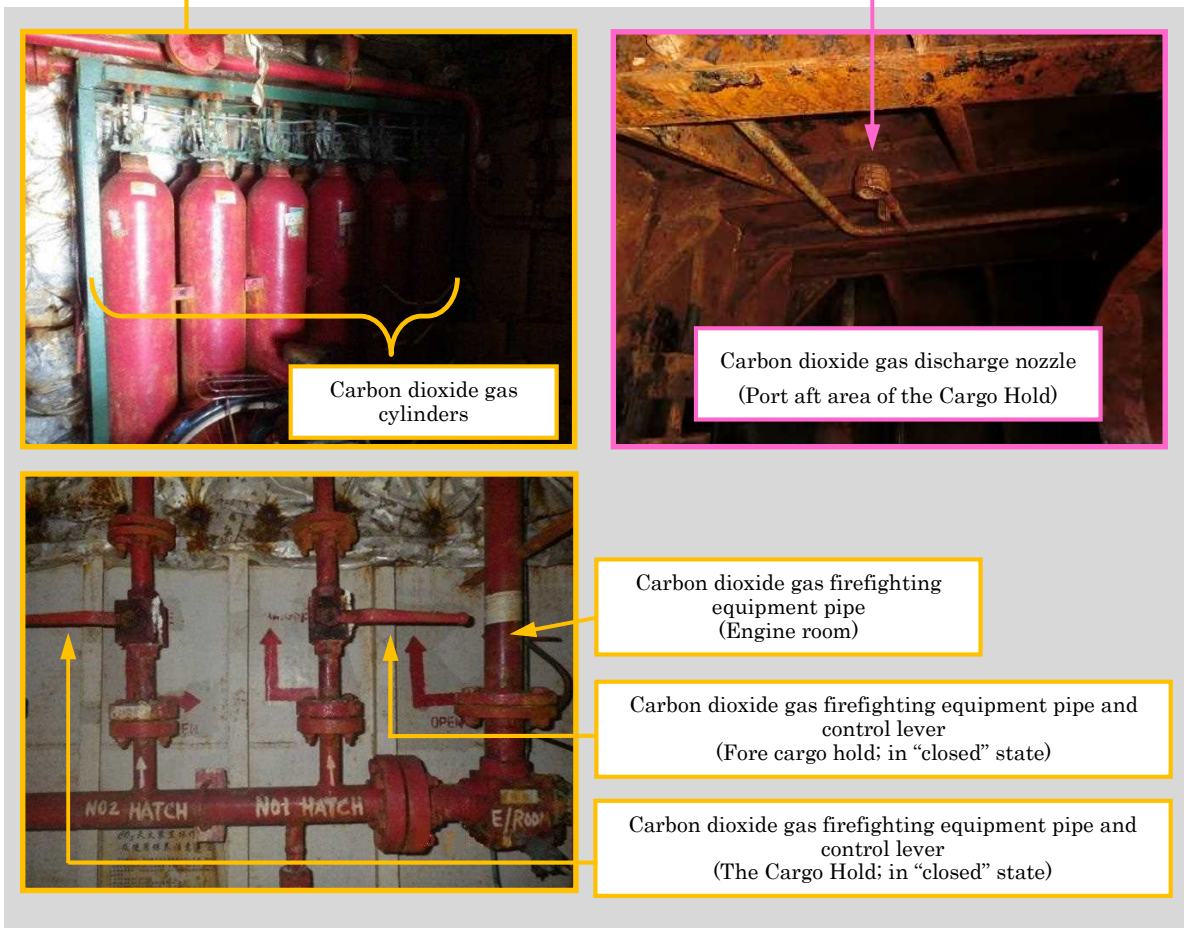


Figure 4 State of the Carbon Dioxide Gas Firefighting Equipment

#### 2.5.4 Fuel Oil Load Conditions

According to information provided by Japan Coast Guard, the Vessel carried 84.2 kl of fuel oil C, 20.0 kl of fuel oil A, and 0.6 kl of lubricating oil at the time of the accident.

#### 2.5.5 Other Information on the Vessel

According to the statement of the Master, there were no malfunctions or failures with the hull, engine, firefighting equipment, or other machineries.

According to the onsite investigations and reply to the questionnaire of the salvage company, after the accident, work to raise the cargo was conducted between June 7 and 11 and work to raise the hull was conducted on July 7, both operations being conducted by the salvage company. The raised hull was towed to the yard of a ship-breaking company in Kitakyushu City, Fukuoka Prefecture, and demolished.

#### 2.6 Information concerning the Cargo

The scrap in the aft cargo hold that was raised from the foundered Vessel was found to contain waste metal as well as a mix of dry cell batteries, lithium batteries, button cells, kerosene cans, and other items. It also contained a large mixture of insulation material, plastic products, rubber products, vinyl products, wood chips, pieces of paper, and other items.

In addition, a large quantity of floating insulation material and other items was observed on the ocean's surface after the scrap was raised.

(See Figure 5)



Raised Scrap from the Cargo Hold



Batteries and kerosene cans



Rubber tire



Vinyl umbrella



Figure 5 Cargo Raised from the aft cargo hold

### 2.7 Information concerning the Loading Work by Company A

According to the onsite investigations and the statement of the person in charge at Company A, the situation was as follows.

Company A stored scrap it purchased from a supply business at the Yard, separating it into areas for iron, aluminum, copper, miscellaneous industrial items, miscellaneous electronic appliances, etc. When it received an order from outside of Japan, it extracted scrap from each area in accordance with the order's content and piled it in spaces at the Berth.

Company A loaded the scrap piled at the Berth by grabbing it with the bucket of a hydraulic excavator on the Berth and dropping it into the cargo holds.

A hydraulic excavator loaded into the cargo hold crushed the scrap with its fork claw and compressed and evened it out by driving on top of it so as to permit the loading of more scrap.

Company A was conducting the same work described above when it loaded the Vessel.  
(See Figure 6)







The fork claw of the Hydraulic Excavator

Figure 6 Hydraulic Excavators for Berths and aft cargo holds

## 2.8 Information on Fire Countermeasures

### (1) The Vessel

According to the Vessel's fire drill record book, fire drills by the Vessel that were held in November 2016 and thereafter can be summarized as follows.

| Drill date       | Place               | Content   |
|------------------|---------------------|---|
| November 1, 2016 | Bow section         | Water-spraying  |
| December 8, 2016 | Engine room         | Carriable fire extinguishers, water-spraying, carbon dioxide gas firefighting equipment |
| January 15, 2017 | Accommodation space | Water-spraying  |
| February 4, 2017 | Engine room         | Carriable fire extinguishers, water-spraying, carbon dioxide gas firefighting equipment |
| March 3, 2017    | Accommodation space | Water-spraying  |
| April 2, 2017    | Bow section         | Water-spraying  |

The Vessel conducted fire drills every month. However, the Vessel had not conducted a fire drill for a cargo hold fire since December 2016, when the Master came aboard the Vessel.

### (2) Company A

According to the statements of Worker A and the person in charge at Company A, the situation was as follows.

- 1) Company A had at least the number of fire extinguishers specified by Fukuoka City, which is the port management body, ready at the Yard. For the water truck that is parked next to the office, Company A ran engine for approximately ten minutes prior to the start of business each day to check its start-up and charge the battery.
- 2) Company A routinely asked the crew members of cargo ships to connect fire hoses to fire hydrants before beginning cargo-handling work. Company A had taken the same measure at the time of the accident, but it did not share information on the firefighting equipment aboard the Vessel, characteristics of the scrap, and method of firefighting in the event of a fire with the Vessel's crew members.

## 2.9 Information concerning Scrap Fires

### 2.9.1 Information concerning Scrap Fires in a Literary Source

According to a literary source,<sup>\*2</sup> the following is provided concerning assessment of the causes of scrap fires and consideration of firefighting methods.

(1) Assessment of a fire's cause

1) Fire outbreak situations

- a A source of fire is generated from some cause. It ignites combustible material and immediately spreads.
- b A source of fire is generated from some cause. It ignites combustible material and then, due to surrounding circumstances, enters a state of flameless combustion before becoming combustion with flame after the passage of time.
- c A place of heat is generated from some cause. The place ignites or ignites combustible material after heat builds up with the passage of time.

2) Fire sources

- a Sparks created by contact between metal objects
- b Electrical cause created by a battery or electrical cell
- c Metal and acid reaction
- d Oxidation heat from unsaturated oil

3) Combustible materials

- a Combustible liquid
- b Combustible gas
- c Pieces of plastic, pieces of paper, pieces of cloth, tires, electrical wires

(2) Consideration of firefighting methods

*As for the firefighting tactics for metal scrap fires, which mainly involve combustion of ordinary combustible material, it is appropriate to consider the firefighting tactics used for piled combustible material fires.*

*The difficulty in extinguishing piled combustible material fires comes from the fact that there is no way to effectively cool the fire source, which is deep within the piled material layer.*

*In general, extinguishing agents can be largely classified into water-based agents, such as water and foam, and gas-based agents, such as inert gas and halide.*

*Water-based extinguishing agents suppress the generation of combustible gases and combustible vapors on the combustible material's surface and thus extinguish the fire by mainly cooling or covering the combustible material's surface. Therefore, the extinguishing agent cannot effectively extinguish the fire unless it directly reaches the surface of the combustible material.*

*On the other hand, gas-based extinguishing agents extinguish the fire mainly by slowing the gas-phase combustion reaction speed. Gas has excellent penetration into piled material layers and therefore can effectively stop flame combustion inside closed spaces, such as silos and containers. Even if a sufficient quantity to completely extinguish the fire cannot be obtained, gas-based extinguishing agents work to dilute combustible gas and vapor within the space and reduce the danger of explosion. Even with open spaces, if the fire is within an area that is only open at the top, such as a garbage pit, a gas-based extinguishing agent can be made to penetrate into the piled material layer by using a gas that is heavier than air. In this study, there is the possibility that this technology can be applicable to the cargo holds of ships that*

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<sup>\*2</sup> "Development of appropriate management measures for mixed metal scrap export from the perspective of hazardous materials control, fire prevention and material recovery" (National Institute for Environmental Studies and others, published March 2011)

carry metal scrap.

(See Figure 7)

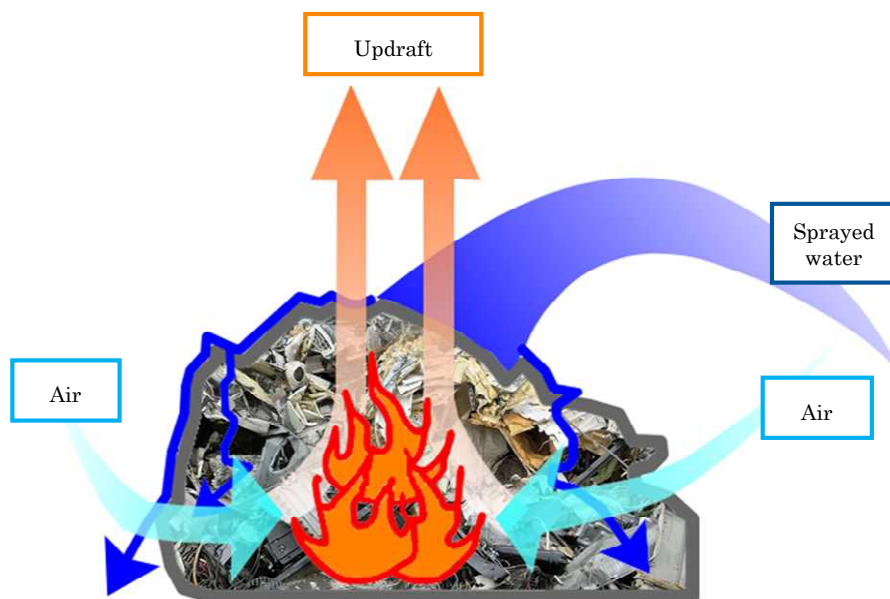


Figure 7 Conceptual Image of a Fire Inside Piled Scrap

### 2.9.2 Circumstances of Past Scrap Fires at Company A

According to the statements of the person in charge at Company A and person in charge at the Fukuoka City Port & Airport Bureau, the circumstances were as follows.

On September 6, 2016, Company A was loading scrap when a fire broke out in a cargo hold of a cargo ship that was docked at the Berth. However, the fire was extinguished about one hour after its started due to firefighting by a fire company.

The person in charge at Company A thought that the fire of this accident would also be extinguished quickly, as the amount of smoke from the fire of this accident was less compared to that of the aforementioned accident.

## 2.10 Weather and Sea Conditions

### 2.10.1 Weather Observations

Meteorological observations at the Fukuoka District Meteorological Observatory, which is located approximately 7.2 km south-southwest from the accident site were as follows.

13:00 Weather: Fine Wind direction: N Wind speed: 4.7 m/s Temperature: 22.4°C  
Humidity: 44%

### 2.10.2 Tide Data

According to the tide table published by Japan Coast Guard, the tide and the height of tide in Hakata Higashi-hama was as follows.

(See Figure 8)

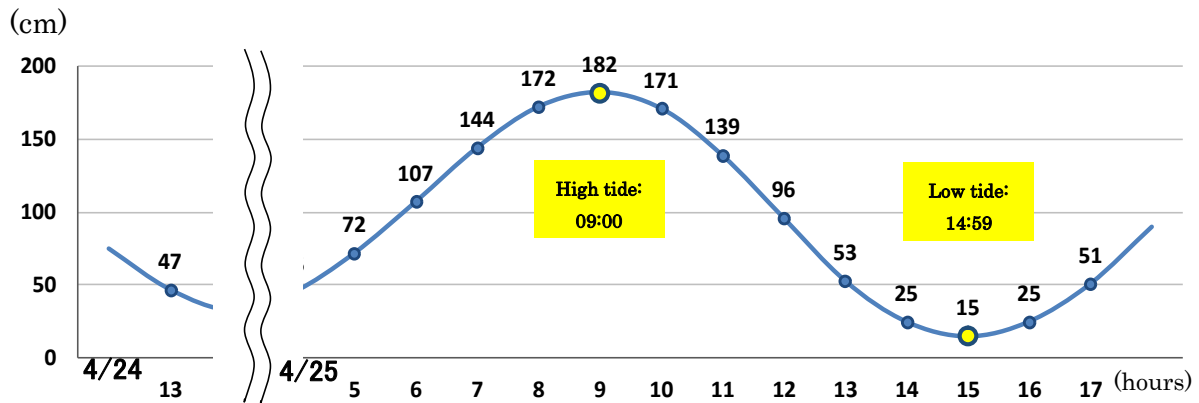


Figure 8 Changes in High/Low Tide and Height of Tide

## 2.11 Information concerning the Environmental Impact of Oil Spillage and Control of Spillage

### 2.11.1 Circumstances of Oil Spillage and Measures to Prevent its Spread

According to the onsite investigations, the statements of the person in charge at the Fukuoka City Port & Airport Bureau and the person in charge at the company that installed the oil fence, the replies to the questionnaire of the Fukuoka City Port & Airport Bureau and the insurance company, and Chart No. 1227 issued by Japan Coast Guard, the circumstances were as follows.

#### (1) Circumstances of the Oil Spill from the Vessel

Spilling oil was observed following the Vessel's foundering. According to the salvage company, the air vent pipe of the fuel tank was closed at around 17:25 on April 25. (See Figure 9)



Figure 9 Circumstances of the Oil Spill from the Vessel

On a later day, the salvage company conducted work to siphon out oil from the Vessel's fuel tanks and removed an estimated amount of 41.2 kl.

#### (2) Circumstances of Measures to Prevent Spreading Oil

At around 00:35 on April 25, Fukuoka City received a communication from the Fire Company stating that the Vessel could founder. However, there was information that the situation was at a stage whereby oil spillage from the Vessel was a possibility, and that the danger of ignition and burning of the Vessel's fuel oil could not be discounted. Fukuoka City therefore decided that setting up an oil fence would be difficult at that time and continued to

wait.

Fukuoka City subsequently received information that the Vessel had foundered and it instructed Company B to implement measures to control the oil. However, Company B responded that taking immediate action was difficult. Therefore, Fukuoka City asked an oil fence installation company to set up an oil fence at around 05:40.

Fukuoka City set up oil fences in two locations on its own at around 09:00 for the purpose of preventing the flow of oil into the Tatara River, which flows on the north side of the accident site, and other areas.

Although an oil fence encircling the Vessel's seaward side was set up by the oil fence installation company at around 10:00, oil was observed flowing out from point of contact between the oil fence and the Berth. Therefore, at around 15:00, Company B requested the oil fence installation company to set up an oil fence on the Vessel's berth side, which was done at around 17:00. Subsequently a total of four additional oil fences encircling the Vessel's seaward side were set up.

It should be noted that the Berth's height was approximately 3.15 m above the reference level for height of tide, and that the Berth had a shape that jutted out toward the sea for approximately 2 m below its upper edge (approximately 1.15 m above the reference level for height of tide). The sea area in front of the Berth had been dug down to a depth of approximately 10 m (below the reference level for height of tide).

(See Figure 10)

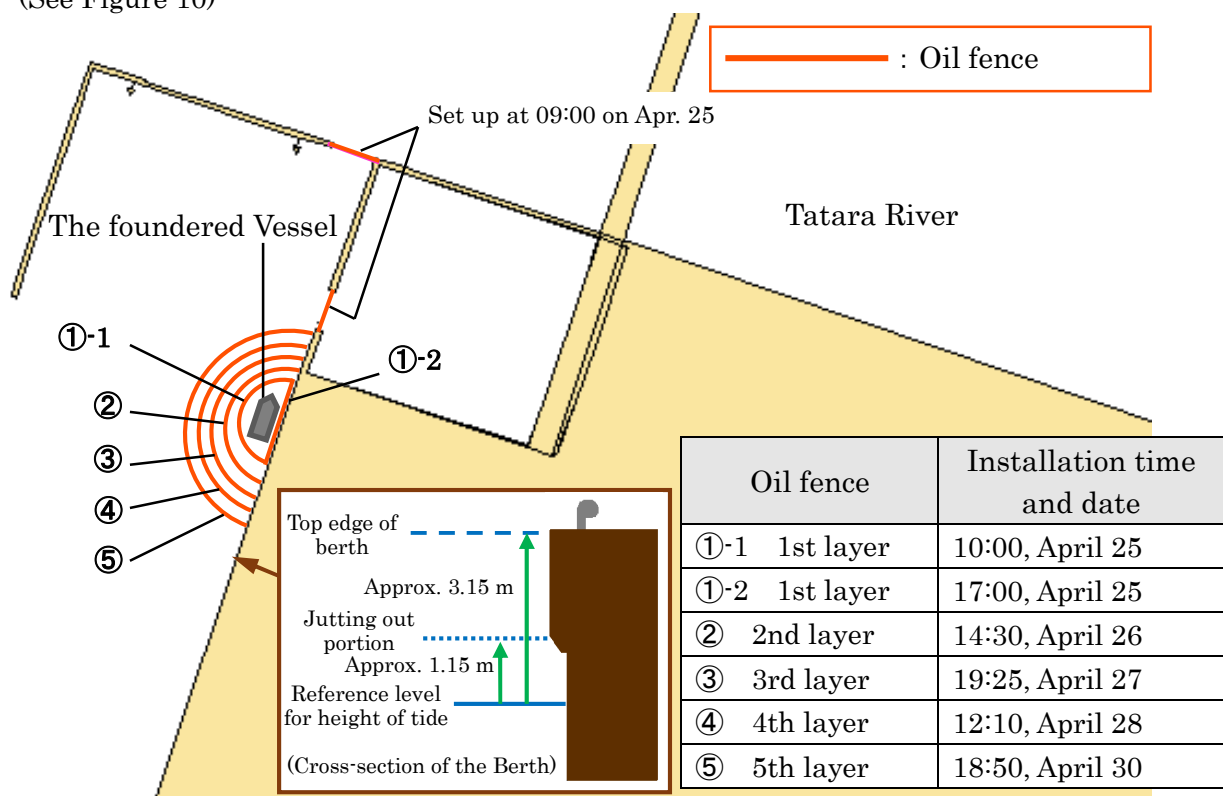


Figure 10 Circumstances of the Installation of the Oil Fences and Berth

### (3) Recovery of Oil within the Oil Fences

The salvage company conducted oil recovery work within the oil fences that were set up around the Vessel and recovered an estimated amount of 39.1 kl.

### 2.11.2 Provisions concerning Control Measures when a Discharge of Oil Occurs

The following provisions are established in Article 39 of the Act on Prevention of Marine Pollution and Maritime Disaster (Act No. 136 of 1970).

*(Control measures, etc., when a discharge of a large quantity of oil or hazardous liquid substance occurs)*

*Article 39 (1) When a discharge of a large quantity of oil or hazardous liquid substance occurs, the following person shall immediately implement emergency measures to prevent the spread of the discharged oil or hazardous liquid substance, prevent the continuing discharge of the oil or hazardous liquid substance, and remove the discharged oil or hazardous liquid substance (hereinafter referred to as “control of discharged oil, etc.”) as stipulated by Ordinance of the Ministry of Land, Infrastructure, Transport and Tourism.*

*(i) The master of the vessel on which the oil or hazardous liquid substance that was discharged was loaded or the manager of the facility at which the oil or hazardous liquid substance that was discharged was managed.*

*(ii) (Omitted)*

*(2) When a discharge of a large quantity of oil or hazardous liquid substance occurs, the following persons shall immediately take necessary measures for control of discharged oil, etc., as stipulated by Ordinance of the Ministry of Land, Infrastructure, Transport and Tourism. However, this stipulation shall not apply in the event that the person specified in the preceding paragraph implemented the measures stipulated in the preceding paragraph and it is deemed possible that control of the discharged oil, etc., could be reliably carried out solely by the measures implemented by said person.*

*(i) The owner of the vessel mentioned in (i) of the preceding paragraph*

*(ii) and (iii) Omitted*

*(3) to (5) Omitted*

### 2.11.3 Extent of the Spreading Oil

According to the reply to the questionnaire of Fukuoka City Port & Airport Bureau, the situation was as follows.

#### (1) Sea areas

Floating oil was observed extending from the sea area in front of the accident site to the sea area on the western side of Island City, Fukuoka City, Fukuoka Prefecture, to the north and near Imazu Bay in Fukuoka City to the southwest. (As of April 27)

#### (2) Land areas

Oil was observed being washed ashore from Seaside Momochi Park in Fukuoka City, Fukuoka Prefecture to Iki-no-Matsubara in Fukuoka City and near Saitozaki in Fukuoka City.

#### (3) Rivers, etc.

Oil was observed being washed ashore in the western areas of the Muromi River and other rivers that drain into the southern part of Hakata Bay and attached to absorbing mats within a range of between approximately 100 m and 1.9 km from each of the rivers.

(See Figure 11)

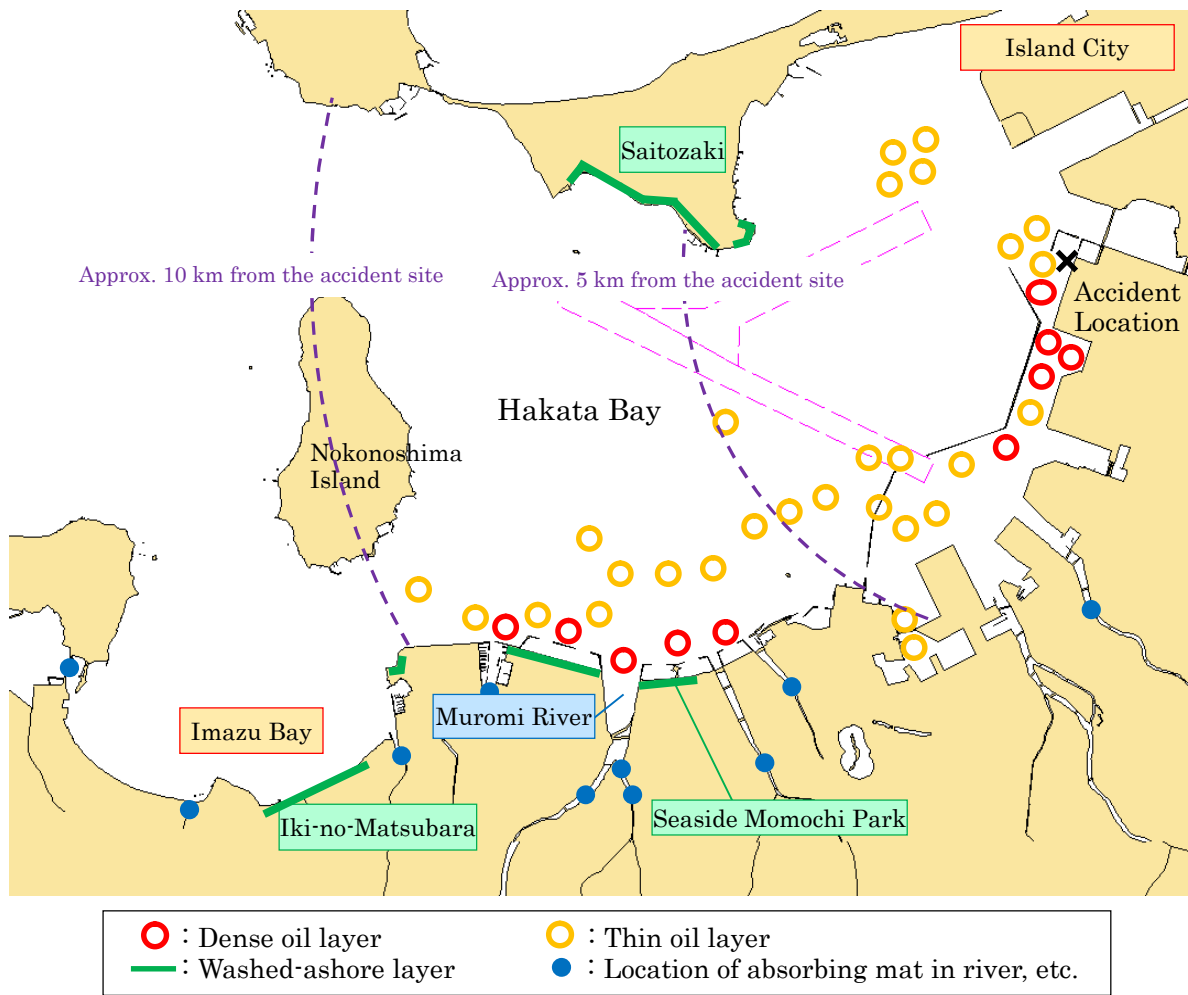


Figure 11 The Oil's Spread

#### 2.11.4 Recovery of the Spread Oil

According to the reply to the questionnaire of Fukuoka City Port & Airport Bureau, the situation was as follows.

- (1) For the oil that spread outside of the oil fences, recovery with absorbing mats, water-spraying from vessels, and dispersing the oil by operating vessels through it were conducted in the sea areas and rivers, and removal of contaminated seashore sand and other activities were conducted in the land areas.
- (2) A total of 101 vessels were mobilized to conduct the oil recovery and agitation work. Approximately 20,700 absorbing mats were used.

#### 2.11.5 Harm to the Fishing Industry Caused by the Oil

According to the reply to the questionnaire by the Fukuoka Fishery Cooperative, harm to the fishing industry was caused by the inability to conduct fishing, inability to sell catches as well as return of catches, and cancellation of fee-based shell fish gathering and fresh fish markets.

## 3 ANALYSIS

### 3.1 Situation of the Accident Occurrence

#### 3.1.1 Course of the Events

From 2.1 and 2.5.2, it is probable that the situation was as follows.

- (1) At around 08:15 on April 21, 2017, the vessel moored starboard-side alongside in ballast condition at the Berth for the purpose of cargo-handling of the scrap.
- (2) From around 09:00 on April 22 to the morning of April 22, the Vessel loaded scrap into her aft cargo hold and fore cargo hold, and in the afternoon, the Vessel loaded scrap into her fore cargo hold.
- (3) At around 08:30 on April 24, the Vessel began loading the scrap into the fore cargo hold the aft cargo hold and work was then discontinued for the noontime break at around 12:00, at then the fore cargo hold had been loaded to approximately 80% and the aft cargo hold had been loaded to around 50%.
- (4) Worker A went from Company A's office to the Vessel at around 13:00, climbed aboard the Hydraulic Excavator, and was preparing to work when, at around 13:20, he saw a small amount of white smoke rising from within the scrap in the port aft port section of the aft cargo hold.
- (5) Able Seaman A was on cargo-handling duty in the wheel house when, at around 13:20, he noticed smoke rising from the aft cargo hold.
- (6) The Vessel's crew members and Company A's workers conducted firefighting by spraying water using fire hoses connected to the Vessel's fire hydrants and a water truck.
- (7) The Fire Company arrived at the Vessel, took over firefighting from the Vessel's crew members and Company A's workers, and sprayed water into the aft cargo hold.
- (8) The Fire Company used a firefighting tactic centered on protein foam spraying, and as it prepared for the spraying, it sprayed water at the aft cargo hold and plating shell to suppress the fire's force.
- (9) The Vessel listed to port and the fire spread to the fore cargo hold.
- (10) The Fire Company began the protein foam spraying but could not extinguish the fire. It continued protein foam spraying and water-spraying into the cargo holds and cooling water-spraying onto the plating shell while observing the circumstances of the Vessel's listing and foundering and the fire's force.
- (11) At around 04:54 on April 25, the Vessel foundered from her port bow side. She settled on the bottom with only her wheel house above the water. The fire was extinguished.

#### 3.1.2 Date, Time and Location of the Accident's Occurrence

From 2.1, it is probable that the date and time of occurrence of the accident were at around 13:20 on April 24, 2017, and the location was at around 1.2 nautical miles at 101° true bearing from the Hakata Port East Passage No. 6 Light Beacon.

#### 3.1.3 Injuries to Persons

From 2.2, there were no fatalities or injuries.

#### 3.1.4 Damage to Vessel

From 2.3, the Vessel had paint burn damage and heat deformation to both cargo holds' walls,



pipes, and plating shell; however, it is probable that there was no damage such as breaches or cracking of the Vessel's plating shell that would cause flooding.

## 3.2 Causal Factors of the Accident

### 3.2.1 Situation of Crew Members

From 2.4, the Master possessed a legally valid certificate of competence. Additionally, it is probable that the Master had approximately 14 years of experience as a master of bulk carriers and had served on the Vessel since December of 2016.

### 3.2.2 Condition of the Vessel

From 2.5.5, it is probable that there was no malfunction or failure with the hull, engine, firefighting equipment, or machineries of the Vessel.

### 3.2.3 Weather and Sea Conditions

From 2.10, it is probable that, at the time of the accident, the weather was fine, the air temperature was approximately 22.4°C, the humidity was approximately 44%, and wind was blowing from the north with a wind force of three, and the tide was at the end of an outgoing tide, and at the time of the Vessel's foundering, the tide was at the mid-stage of an incoming tide.

### 3.2.4 Condition of the Cargo

From 2.6 and 2.9.1 (1), it is certain that mixed in with the scrap that was loaded into the aft cargo hold were waste metal and, additionally, dry cell batteries, lithium batteries, button cells, and other items that could become the source of a fire as well as insulation material, plastic, rubber, vinyl, wood chips, pieces of paper, and other items that are combustible.

### 3.2.5 Situation of Fire Countermeasures

- (1) From 2.8 (1), it is probable that the Master did not have experience with fire drills for a fire in the Vessel's cargo holds.
- (2) From 2.5.3 and 2.8 (1), it is probable that the Master used carbon dioxide gas firefighting equipment in fire drills for fires in the Vessel's engine room and was aware that the aft cargo hold and the fore cargo hold were equipped with the same equipment based on the arrangement of pipes, etc., in the carbon dioxide gas firefighting equipment control room.
- (3) From 2.5.3 and 2.8 (2), it is probable that the Vessel had connected fire hoses to fire hydrants in response to a request from Company A but did not convey information on the carbon dioxide gas firefighting equipment that was installed on the Vessel to Company A.
- (4) From 2.8 (2) and 2.9.2, it is probable that, based on its experience of a past fire that was extinguished after around one hour of firefighting by a fire company, Company A thought that the fire of this accident could also be extinguished with water-spraying and therefore did not consider the possibility of methods other than water-spraying.
- (5) From 2.8 (2), it is probable that, although Company A had requested that fire hoses be connected to fire hydrants as a precaution against fire, it did not convey information on the cargo's characteristics to the Vessel.
- (6) From (3) and (5) above, it is probable that the Vessel and Company A did not share information concerning effective firefighting methods for times of fire and had not developed

thorough readiness to appropriately and smoothly conduct firefighting.

### 3.2.6 Circumstances Leading up to the Fire

- (1) From 2.1 and 2.7, it is probable that loading of the scrap into the aft cargo hold and compression and leveling work were conducted to around 12:00 on April 22, and that subsequently no work was done on the scrap that caught fire for approximately two days until the accident occurred.
- (2) From 2.1, 2.9.1 (1), and (1) above, it is probable that the fire started inside the scrap in the area of the port aft section of the aft cargo hold.
- (3) From 2.9.1 (1), 3.2.4, and (1) above, it is somewhat likely that a spark created by contact between metal objects, a battery, etc., in the scrap was the source of the fire, and that the source ignited insulation material, plastic, rubber, vinyl, wood chips, pieces of paper, or combustible material mixed in the scrap. However, it was not possible to determine the circumstances leading up to the fire.

### 3.2.7 Analysis of the Firefighting by the Vessel and Company A and their Effects

- (1) From 2.1 and 2.5.3, it is probable that the Vessel's crew members and Company A's workers conducted firefighting with water-spraying only, without using the carbon dioxide gas firefighting equipment, for approximately 40 minutes from the time the fire broke out until the arrival of the Fire Company.
- (2) From 2.1 and (1) above, it is probable that firefighting by water-spraying was not effective, as the fire could not be extinguished even though water-spraying was conducted continuously for approximately 15 hours.
- (3) From 2.9.1 (2), 3.2.6 (2), and (2) above, it is somewhat likely that the sprayed water was blocked by the scrap's surface layer and did not reach the fire's origin.
- (4) From 2.5.3, 2.9.1 (2), and (2) and (3) above, it is probable that closing the aft cargo hold's hatch cover and using the carbon dioxide gas firefighting equipment would have been an effective firefighting method given the characteristics of the Vessel's firefighting equipment and the scrap.
- (5) From 3.2.5 (3) and (1) above, it is probable that the Master did not think of using the carbon dioxide gas firefighting equipment at the time of the accident.
- (6) From 2.5.2 and 3.2.5 (3), it is probable that Worker A did not lower the Hydraulic Excavator's arm so that it did not obstruct the closing of the aft cargo hold's hatch cover because he did not possess information about the Vessel's carbon dioxide gas firefighting equipment or firefighting methods for times of fire.

### 3.2.8 Analysis of the Fire's Spread and Vessel's Foundering

- (1) From 2.1 and 2.6, it is probable that the insulation material and other combustible items with low specific gravity floated in a burning state even when the water level in the cargo holds rose by the continuous water-spraying and continued to burn on the water's surface.
- (2) From 2.1 and 2.5.2, it is probable that the fire spread when combustible material in the fore cargo hold caught fire because the combustion heat of the aft cargo hold passed through the bulkhead and to the fore cargo hold.
- (3) From 2.1 and 2.5.3, it is probable that the Fire Company did not know that the Vessel

was equipped with carbon dioxide gas firefighting equipment.

- (4) From 2.1, it is probable that, in a situation whereby the Fire Company could not extinguish the fire even when it conducted protein foam spraying and water-spraying into the cargo holds and sprayed cooling water onto the plating shell, the Fire Company continued water-spraying into the cargo holds while observing the circumstances of the Vessel's listing and foundering and the fire's force because it thought it could not reduce the danger that fuel oil would ignite and burn.
- (5) From 2.1 and 2.11.1 (2), it is probable that, when it became aware that the Vessel may founder, the Fire Company communicated this to Fukuoka City, which is the port management body, as information concerning oil spillage after foundering.
- (6) From 2.1 and 3.1.4, it is probable that the effect of water accumulated in the cargo holds led to the Vessel's foundering from her port bow side because no damage that could cause flooding had occurred.

### 3.2.9 Analysis of the Accident's Occurrence

From 3.2.5 (1), 3.2.5 (6), 3.2.6 (2), 3.2.6 (3), 3.2.7 (1) to 3.2.7 (5), 3.2.8 (1), 3.2.8 (2), 3.2.8 (4), and 3.2.8 (6), the situation was as follows.

- (1) It is probable that the Vessel and Company A did not share information concerning effective firefighting methods in case of fire and had not developed thorough readiness to appropriately and smoothly conduct firefighting.
- (2) It is probable that the fire started inside the scrap in the area of the port aft section of the aft cargo hold.
- (3) It is somewhat likely that a spark created by contact between metal objects, a battery, etc., in the scrap was the source of the fire, and that the source ignited insulation material, plastic, rubber, vinyl, wood chips, pieces of paper, or combustible material mixed in the scrap. However, it was not possible to determine the circumstances leading up to the fire.
- (4) It is probable that the Vessel's crew members and Company A's workers conducted firefighting with water-spraying only, without using the carbon dioxide gas firefighting equipment, for approximately 40 minutes from the time the fire broke out until the arrival of the Fire Company.
- (5) It is probable that firefighting by water-spraying was not effective, as the fire could not be extinguished even when water-spraying was conducted continuously for approximately 15 hours.
- (6) It is somewhat likely that the sprayed water was blocked by the scrap's surface layer and did not reach the fire's origin.
- (7) It is probable that closing the aft cargo hold's hatch cover and using the carbon dioxide gas firefighting equipment would have been an effective firefighting method given the characteristics of the Vessel's firefighting equipment and the scrap.
- (8) It is probable that the Master did not have experience with fire drills for a fire in the Vessel's cargo holds and did not think of using the carbon dioxide gas firefighting equipment at the time of the accident.
- (9) It is probable that the insulation material and other combustible items with low specific gravity floated in a burning state even when the water level in the cargo holds rose from the continuous water-spraying and continued to burn on the water's surface.
- (10) It is probable that the fire spread when combustible material in the fore cargo hold

caught fire because the combustion heat of the aft cargo hold passed through the bulkhead and to the fore cargo hold.

- (11) It is probable that, in a situation whereby the Fire Company could not extinguish the fire even when it conducted protein foam spraying and water-spraying into the cargo holds and sprayed cooling water onto the plating shell, the Fire Company continued water-spraying into the cargo holds while observing the circumstances of the Vessel's listing and foundering and the fire's force because it thought it could not reduce the danger that fuel oil would ignite and burn.
- (12) It is probable that the effect of water accumulated in the cargo holds led to the Vessel's foundering from her port bow side considering the fact that the vessel did not suffer damage that could cause flooding.

### 3.3 Analysis of the Environmental Impact of Oil Spillage and Control of Spillage

#### 3.3.1 Circumstances of Oil Spillage and Measures to Prevent its Spread

##### (1) Circumstances of the Oil Spill from the Vessel

From 2.5.4, 2.11.1 (1), and 3.1.1 (11), it is somewhat likely that, given that the vessel carried approximately 104.2 kl before the accident and that the estimated amount of fuel oil removed from her fuel tanks after her foundering was approximately 41.2 kl, an estimated amount of approximately 63.0 kl flowed out from the fuel tanks from the time of the foundering until the Vessel's fuel oil air vent pipe was closed approximately 12 hours and 30 minutes later.

##### (2) Circumstances of Measures to Prevent Spreading Oil

From 2.1 and 2.11.1 (2), it is probable that the situation was as follows.

- 1) Although the Master and Company B were informed by the Fire Company that the Vessel may founder at around 00:35 on April 25, they did not take measures to control oil spillage until around 15:00.
- 2) When Fukuoka City received a communication from the Fire Company stating that the Vessel could founder at around 00:35 on April 25, Fukuoka City also had information that the situation was at a stage whereby oil spillage from the Vessel was a possibility and that the danger of ignition and burning of the Vessel's fuel oil could not be discounted, and therefore Fukuoka City decided that setting up an oil fence would be difficult at that time and continued to wait.
- 3) When it received information that the Vessel had foundered, Fukuoka City asked an oil fence installation company to set up an oil fence at around 05:40 because it could not expect the Master and Company B to execute immediate control measures against oil spillage, and an oil fence encircling the Vessel's seaward side was set up at around 10:00.
- 4) Because oil was subsequently observed flowing out from the point of contact between the oil fence encircling the Vessel's seaward side and the Berth, Company B asked for the installation of an oil fence encircling the Vessel's berth side at around 15:00, and this oil fence was set up at around 17:00.

#### 3.3.2 Circumstances of the Oil's Spread, Recovery, and Damage

- (1) From 3.1.1 (11) and 3.3.1, it is probable that oil spilling from the foundered Vessel spread over during the approximately five hours that passed until the oil fence encircling the Vessel's seaward side was set up at around 10:00 on April 25.

- (2) From 2.10.2, 2.11.1 (2), and 3.3.1, it is somewhat likely that, from around 12:00, when the height of tide was lower than the height of the lower edge of the jutting out portion of the Berth (approximately 1.15 m), and around 17:00, when the oil fence encircling the berth side of the Vessel was set up, the spread of oil continued from the gap that formed between the Berth and the oil fence. (See Figure 12)

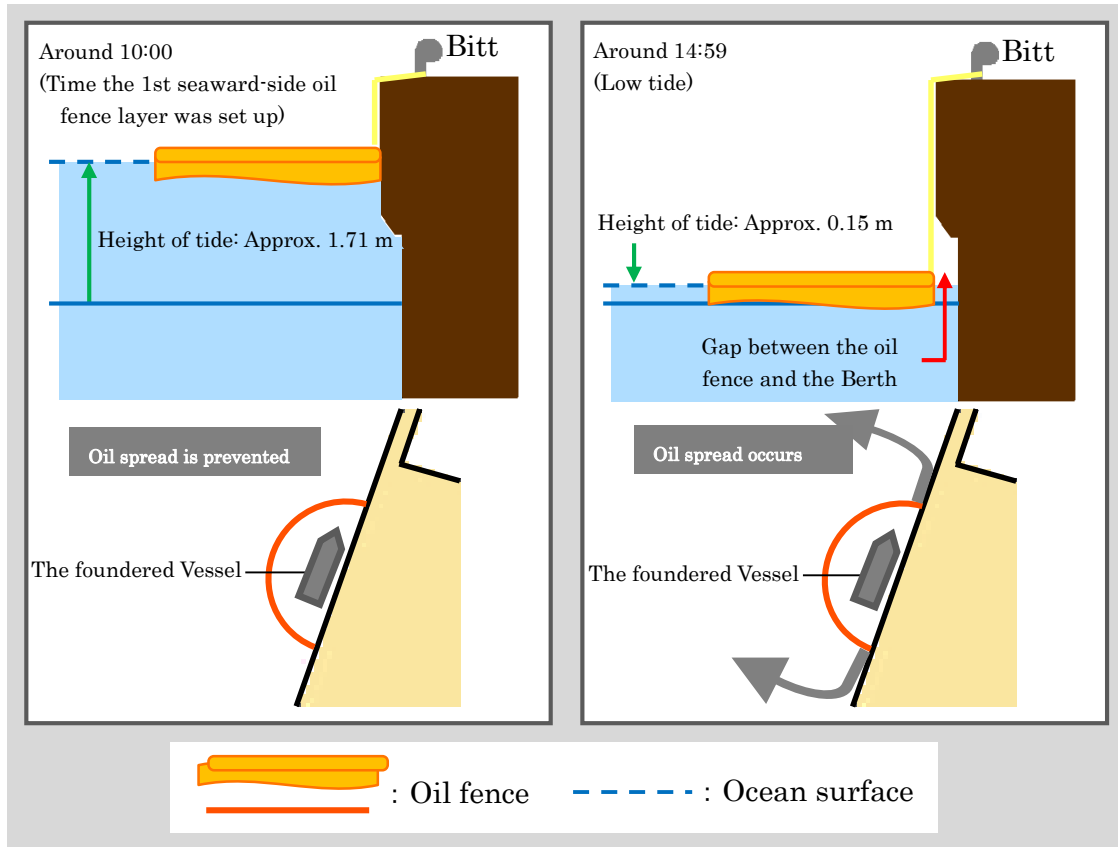


Figure 12 Conceptual Image of the Oil Fence's Setup and the Oil's Spread

- (3) From 2.11.1 (3) and 3.3.1 (1), given that the amount of oil flowing from the Vessel's fuel tanks was estimated to be approximately 63.0 kl and the amount oil recovered inside the oil fence was estimated to be approximately 39.1 kl, it is somewhat likely that an estimated amount of 23.9 kl of oil flowed outside of the oil fence.
- (4) From 2.11.3 to 2.11.5, it is probable that the oil that flowed outside of the oil fence spread over a large area that included sea areas and land areas of Hakata Bay and rivers that flow into Hakata Bay and that, although oil recovery and agitation work was conducted, harm to the fishing industry was caused by inability to conduct fishing, inability to sell catches as well as return of catches, and cancellation of fee-based shell fish gathering and fresh fish markets.

### 3.3.3 Analysis of Measures to Reduce Damage caused by Spreading Oil

From 3.3.1 and 3.3.2, it is somewhat likely that had readiness to implement measures to control oil, such as by deploying oil fences and other equipment near the Berth, at the time that the possibility the Vessel would founder emerged and oil spillage was anticipated been developed to the maximum degree possible, the amount of damage caused by spreading oil could have been reduced.

## 4 PROBABLE CAUSES

It is probable that the accident occurred when, as the Vessel was moored for the purpose of cargo-handling at Hakata Port, a fire that broke out within the scrap loaded into the aft cargo hold spread because firefighting by water-spraying was ineffective and appropriate firefighting methods using the Vessel's carbon dioxide gas firefighting equipment were not employed.

It is probable that effective firefighting methods using the carbon dioxide gas firefighting equipment were not employed because the Master did not think of using the carbon dioxide gas firefighting equipment.

It is probable that the Master did not think of using the carbon dioxide gas firefighting equipment because he did not have experience with fire drills for a fire in the Vessel's cargo holds and because the Vessel and Company A did not share information on effective firefighting methods for times of fire.

It is somewhat likely that firefighting by water-spraying was not effective because the sprayed water was blocked by the scrap's surface layer and did not reach the fire's origin.

Regarding the fire that broke out inside the scrap, it is somewhat likely that a spark created by contact between metal objects, a battery, etc., was the source of the fire, and that the source ignited combustible material. However, it was not possible to determine the circumstances leading up to the fire.

## 5 SAFETY ACTIONS

It is probable that the accident occurred when a fire that broke out within the scrap loaded into the aft cargo hold spread because firefighting by water-spraying was ineffective and appropriate firefighting methods using the Vessel's carbon dioxide gas firefighting equipment were not employed.

It is probable that effective firefighting methods using the carbon dioxide gas firefighting equipment were not employed because the Master did not think of using the carbon dioxide gas firefighting equipment because the Master did not have experience with fire drills for a fire in the Vessel's cargo holds and because the Vessel and Company A did not share information on effective firefighting methods for times of fire.

Accordingly, implementation of the following measures is necessary to prevent occurrence of a similar accident.

- (1) Masters shall build a thorough system for appropriate and smooth firefighting in case of fire with the loading business by considering and determining appropriate firefighting methods in accordance with the cargo's characteristics beforehand and conveying this information to the loading business.
- (2) Masters shall pay full attention to the following points regarding firefighting methods for fires within piled scrap:
  - 1) Firefighting by water-spraying may not be effective because the sprayed water can be blocked by the scrap's surface layer and not reach the fire's origin.
  - 2) Insulation material and other combustible items with low specific gravity may float in a burning state even when the water level in the cargo holds rises from continuous water-spraying and continue to burn on the water's surface.

- 3) Firefighting using carbon dioxide gas firefighting equipment is effective.
- 4) When a vessel has multiple cargo holds, measures such as immediately closing and sealing the hatch covers of cargo holds other than the cargo hold with the fire shall be taken to prevent a fire's spread.
- (3) Masters shall reliably provide information on firefighting equipment aboard their vessel to the firefighting organization.
- (4) Shipowners shall provide thorough instruction to masters of their vessels to unfailingly execute the measures described in (1) to (3) above and shall also implement training in accordance with said measures.
- (5) Company A shall fully understand cargo characteristics and communicate information on those characteristics to vessels scheduled for cargo-handling. Company A shall also shall build a thorough system for appropriate and smooth firefighting in case of fire with vessels by checking the firefighting equipment on those vessels and comprehending the appropriate firefighting methods.
- (6) Firefighting organizations shall study more effective firefighting by taking into account the specific nature of fires on scrap-carrying vessels.

Additionally, it is probable that, as a result of the accident, oil flowing from the foundered Vessel spread over a large area of Hakata Port and caused harm to the fishing industry.

Accordingly, implementation of the following measures is required to reduce harm caused by oil spillages.

- (1) Masters and shipowners shall implement measures as soon as possible to control oil, such as closing air vents and setting up oil fences, whenever the danger of an oil spill from a vessel arises.
- (2) Whenever the danger of an oil spill from a vessel exists, the port management body shall consider the circumstances of measures to control the oil taken by the master and owner of the vessel and, as necessary, implement measures to control the oil, such as setting up an oil fence, as soon as possible.

## 5.1 Safety Actions Taken

### 5.1.1 Safety Actions Taken by Fukuoka City

In the interest of preventing fires and the spread of fires at port facilities, Fukuoka City revised the "guidelines for fire prevention, etc., at port facilities", which establishes items necessary to promote the proper use of port facilities, by adding the following items (1) to (4) as usage standards for compliance by port facility users.

Additionally, in January 2018, Fukuoka City conducted an on-site survey of port facility users and confirmed that all users were in conformity with standards.

- (1) Conduct inspections at each stage of receiving, storage, loading onto a vessel, and carrying out, and thoroughly separate cargo that can be a source of fire and combustible substances.
- (2) Do not receive, store, load onto a vessel, or carry out the following cargoes.
  - 1) Used electrical machinery and equipment (including items that are missing pieces or have been roughly crushed)
  - 2) Cargo onto which oil or other ignitable liquid is adhered or into which such liquid is mixed
- (3) Do not jar or stress cargo with cargo-handling equipment during gathering or loading.
- (4) When gathering recycling materials for export, abide by the following:

- 1) Keep cargo organized by classification and material type.
- 2) Prepare fire extinguishers and other equipment when gathering and loading cargo.

#### 5.1.2 Measures Taken by the Fukuoka City Fire Prevention Bureau

The Fukuoka City Fire Prevention Bureau newly formulated a “firefighting plan for fires on vessels carrying metal scrap” in its Higashi Fire Station, whose service area covers Hakozaki Wharf’s Berths No. 15 and No. 16, and began employing the plan in April 2018.

As part of the aforementioned plan, the Fukuoka City Fire Prevention Bureau put firefighting tactics specifically intended for fires on vessels carrying metal scrap that are moored at Hakozaki Wharf’s Berths No. 15 and 16 (e.g., use of vehicles equipped with a compressed air foam system [CAFS]; arrangement of fire vehicles at the berth; and sharing of information from fire companies on fire spread conditions, smoke flow, etc.) into a concrete and detailed manual.

The Fukuoka City Fire Prevention Bureau decided to include training to be based on verification of the aforementioned plan in regularly scheduled practical training.

### 5.2 Measures Implemented to Reduce Damage

#### 5.2.1 Measures Taken by the Fukuoka City

- (1) Fukuoka City revised its “manual for control of spilled oil” to make it possible to implement oil control measures as required when there is the “risk of oil spillage” in addition to “when oil spillage occurs” as a response to oil spillages within the Hakata Port area.

Fukuoka City decided to add to its equipment for controlling oil and to conduct periodic training on oil fence setup.

- (2) Fukuoka City entered into an agreement with persons associated with Fukuoka City’s fishing industry concerning requests for cooperation in the following operations so as to permit prompt and smooth execution of emergency measures to prevent the spread of damage when an oil spill occurs or may occur within the Hakata Port area as a result of a vessel accident.

- 1) Work of recovering oil by oil absorbing mats, etc.
- 2) Maintenance and management of materials procured by Fukuoka City (oil absorbing mats, etc.)
- 3) Other items deemed to be necessary by Fukuoka City

- (3) Fukuoka city has concluded the agreement of the following operations with the Port Construction Association of the Fukuoka City, to protect the necessary activities of the port service operations, life, health and property of the citizen against oil spill accident, which has established the cooperative system for implementing the disaster prevention activities promptly and properly when occurring disaster or possibility of it.

- 1) Spillage oil diffusion measure
- 2) Spillage oil absorbent measure
- 3) Action of providing necessary human resource, apparatus, etc. for practicing the above mentioned 1) and 2)



## 6 SAFETY RECOMMENDATIONS

### 6.1 Safety recommendations to Tai Yuan (Hong Kong) International Shipping Co., Ltd.

It is probable that the accident occurred when a fire that broke out within the scrap loaded into the aft cargo hold spread because firefighting by water-spraying was ineffective and appropriate firefighting methods using TAI YUAN's carbon dioxide gas firefighting equipment were not employed.

It is probable that effective firefighting methods using the carbon dioxide gas firefighting equipment were not employed because the Master did not think of using the carbon dioxide gas firefighting equipment because the Master did not have experience with fire drills for a fire in TAI YUAN's cargo holds and because TAI YUAN and Miki Shouji Co., Ltd. did not share information on effective firefighting methods for times of fire.

Additionally, it is probable that, as a result of the accident, oil that spilled from the foundered TAI YUAN spread through a large area of Hakata Bay and caused harm to the fishing industry.

In view of the result of this accident investigation, the Japan Transport Safety Board recommends that Tai Yuan (Hong Kong) International Shipping Co., Ltd., which is the owner of TAI YUAN, take the following measures for the purpose of preventing the occurrence of a similar accident and reducing damage:

Tai Yuan (Hong Kong) International Shipping Co., Ltd. shall provide thorough instruction to masters of its vessels to unfailingly execute the following measures and shall also implement training in accordance with said measures:

- (1) Build a thorough system for appropriate and smooth firefighting in case of fire with the loading business by considering and determining effective firefighting methods in accordance with the cargo's characteristics beforehand and conveying this information to the loading business.
- (2) Pay full attention to the following points regarding firefighting methods for fires within piled scrap:
  - 1) Firefighting by water-spraying may not be effective because the sprayed water can be blocked by the scrap's surface layer and not reach the fire's origin.
  - 2) Insulation material and other combustible items with low specific gravity may float in a burning state even when the water level in the cargo holds rises from continuous water-spraying and continue to burn on the water's surface.
  - 3) Firefighting using carbon dioxide gas firefighting equipment is effective.
  - 4) When a vessel has multiple cargo holds, measures such as immediately closing and sealing the hatch covers of cargo holds other than the cargo hold with the fire shall be taken to prevent a fire's spread.
- (3) Reliably provide information on firefighting equipment aboard the vessel to the firefighting organization.
- (4) Implement measures as soon as possible to control oil, such as closing air vents and setting up oil fences, whenever the danger of an oil spill from a vessel arises.

Annex Figure 1 Outline Map of the Location of the Accident

