JAPAN P&I CLUB Vol.52 November 2021

P&I Loss Prevention Bulletin

The Japan Ship Owners' Mutual Protection & Indemnity Association Loss Prevention and Ship Inspection Department

Response to Oil Spills

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§1 Introduction

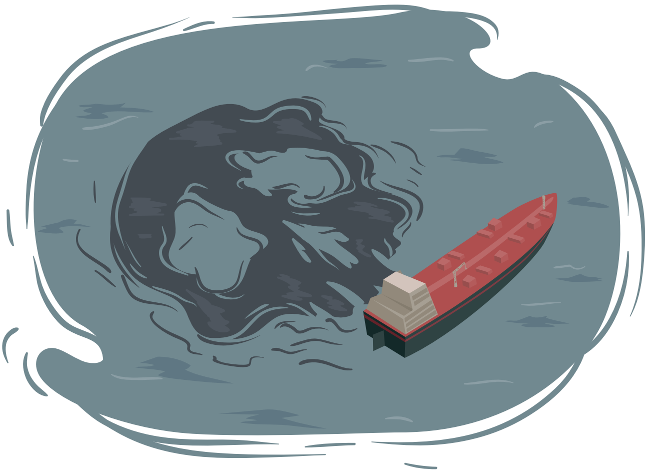


Image 1 : Imange of Oil Spill Accident

When it comes to oil spills, certain readers may remember the M/V Exxon Valdez incident which occurred in Alaska. On 23 March 1989, the M/V Exxon Valdez grounded in Alaska, North America, spilling 10.8 million gallons (approximately 41,000 KL) of crude oil. It is considered to be one of the largest human-induced environmental incidents to have ever occurred at sea.

Since then, tankers have been regulated with dedicated ballast tanks and double bottoms, and the number of spills of loaded oil have been greatly reduced. However, we receive reports of oil spills every year, and the number of oil spillage accidents show no sign of significant decline. In this guide we will discuss the prevention of oil spills and how to deal with them appropriately.

§2 Countermeasures for Maritime Accidents

2-1 Countermeasures for Maritime Accidents (For Each Maritime Accident Including Those Between Ship and Shore)

The following is a summary of the common responses to all maritime accidents and not just oil spills. It goes without saying that it is important to do everything possible to prevent maritime accidents from occurring. However, in the unfortunate event of a maritime accident, the following two factors can have a significant impact on the safety of the crew, cargo and the hull of the vessel, as well as the expenses involved in dealing with the accident.

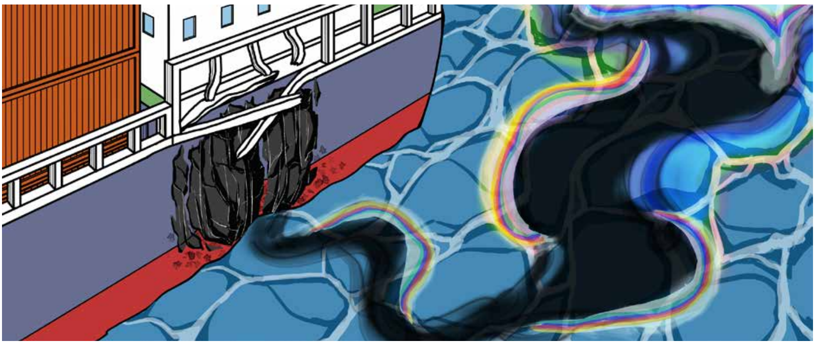


Image 2: Oil Spill Due to Collision

- **Suitability of initial measures**
- **Skilful handling of the accident afterwards**

The main difference between a maritime accident and a road traffic accident or a fire accident on land is that on land, the relevant people can arrive on the site immediately, whereas with a maritime accident, the Vessel (Master) has to take care of the situation and avoid any detriment to the shipowner from the moment of the accident until the assistance of the company's Land Support Team, the Japan Coast Guard (JCG) and private organisations have been arranged.

However, in the event of a major accident, such as a collision, fire or oil spillage accident, the Vessel may be in a state of confusion, and most probably very busy dealing with the immediate aftermath of the accident. In such cases, it is often difficult for the Vessel to keep a record of the situation and the details that need to be ascertained in order to ensure the smooth processing of the accident.

In addition, with today's communication methods such as email and Inmarsat, communication between ship and shore is much faster than in the past. However, if the Supporting Team on Land (department) has to contact the Vessel repeatedly in order to obtain information on the situation, this may not only result in inaccurate information, but may also cause further confusion between the Vessel and the department on land.

In the immediate aftermath of a maritime accident, the Master, Chief Engineer (C/E), Navigation Officer, Engineer and Supporting Team on Land are all in a state of turmoil. The initial response is of the utmost importance in order to minimise the damage and facilitate the subsequent smooth processing of the accident. In order to achieve this, the Vessel conducts regular drills on board to simulate various accidents, and an emergency support response team is also formed on shore for joint training between ship and shore.

However, as mentioned above, when a lot of information is exchanged between ship and shore via Inmarsat, there are often cases that information does not get conveyed accurately due to mutual misunderstandings and assumptions.

In order to avoid this, each company has its own ISM code and SMS manual (Safety Management System), which specify how to deal with each type of maritime accident.
It is essential that these trainings and the procedure manuals that have been so carefully created get to be utilized in accordance with the procedures. In other words, in order to avoid wasting time when checking the situation between ship and shore, it is necessary to establish in advance an efficient way of dealing with accidents, for example by using checklists and other forms such as reports. This is a good opportunity to review the relevant parts of the Safety Management System. Key points to be reviewed are as follows:

① Review of check list and reports

In order to eliminate redundant work and to communicate with an accurate and efficient exchange of information, it will be recommended to set up a report form based system between ship and shore by each type of accident. Using checklists and other documents as reports can be an option.

② The following should be noted when reporting to government authorities

- Report all actual facts concisely.
- Do not report unconfirmed, speculative or extraneous information, or declare that the information is inaccurate.
- If you have to report about something uncertain, use flexible vocabulary such as "approximately" or "about" (this makes it easier to correct the report if you get more accurate information later).
- It can be easy to make changes to your report while bearing government authorities in mind, however, even if you do not intend to do so, you are not allowed to report on anything that deliberately distorts or underestimates the

facts. It is important to remember that misrepresentation of the facts "brings nothing but harm".

③ Paperwork to be done later

When an accident occurs, a number of document exchanges between ship and shore take place. Also, in the event of reviewing the original paper by picking it out from the accumulated papers to check with the contents of a previously sent document, as a result, the order of the documents is often lost or confused at a later date. In order to avoid this situation, the following are recommendable.

- Be sure to add the date and time on all incoming and outgoing documents (preferably with a reference number).
- The original documents are to be accumulated in separate received/outgoing document boxes and sorted later.

  In the case that you need a document that has already been sent for any reason, make a photocopy of it on the spot and return it immediately to its original place. Do not add notes to the original document as an afterthought. In the case that additionally revised documents are to be added to accumulated docs, a new revised date and time and reference number are to be added for them to be accumulated in the original document box.

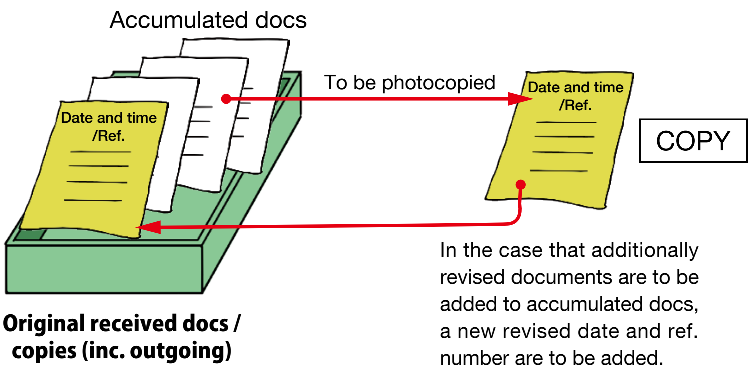


Figure 1: Document Storage Box

2-2 Immediate Launch of Land Support Team

Once you have received "contact regarding the occurrence of an accident, in the first instance", you need to launch an emergency support response team (the Land Support Team) promptly. Records (time, actions, who did it, etc.) will also start from that point.

The launching of the Land Support Team will have been developed in accordance with the Safety Management System of each company. In the case of launching the Land Support Team, the main points to be considered are as follows:

① Notification to coastal nation authorities

- When receiving contact in the first instance, it is to be confirmed as to whether the report originates from the Vessel or from the supporting team on land. If the Vessel has already reported the accident, confirm the details of the report (to whom, when and by what means).
- According to the above, in the event of a report being made by the Vessel, the Land Support Team should instruct the Vessel as to the "nature of the report, to whom it is being reported, and by what method, etc.". It will be better to avoid using VHF radio communications, if possible.

② Notifying the insurance company（Hull & Machinery Insurance and P&I Insurance)

In most cases, it is a telephone call from the Vessel to the Superintendent (SI) in the first instance. Afterwards, the party on land will convene the supporting team, which may take some time to assemble if it is during a day off or at night. In the meantime, the Vessel uses an emergency checklist to begin assessing the situation and collecting information. Once the checklist is available, Hull & Machinery Insurance and P&I Insurance may be contacted.

Hull & Machinery Insurance and P&I Insurance have information on various past cases, so we believe that it is better to consult with them directly.

The items of the checklist above should cover what you are going to confirm, but make sure it includes the following points:

- Date, time and point accident occurs
- Accident type
- The status and situation of the other ship, if any
- Possibility of accident involving people

③ Nominating the Shipowner's agency

Nominating a local Shipowner's agency at the earliest possible opportunity will help to facilitate any further arrangements. If possible, it is advisable to have the charterer's agent act as the Shipowner's agent. If different agents are selected, there is a possibility of information between them being confused. In particular, depending on the type of operation, because fuel oil is the property of the charterer, close communication is desirable.

Also, as soon as possible, two representatives from the shipowner or ship management company should be sent to the Vessel: one should be stationed at the ship's agent to act as a liaison officer, while the other attend the ship.

④ Arrangement of various surveyors

The appointment of a third party is necessary as disputes are likely to arise at a later date over the extent of the damage, the cost of ship repairs, the extent of the damage caused by the oil spill or the burden of responsibility. It should be noted that the term "surveyor" can be used to refer to any of the following types of surveyor:

(1) Hull Damage: arrangement via Hull & Machinery Insurance
(2) Response to Cargo Damage or Oil Pollution: arrangement via P&I Insurance
(3) Classification Survey (not required if there is no problem with performance

capability): arrangement via shipowner or ship management company

(4) Under Water Inspection Survey, if necessary: arrangement via Hull & Machinery Insurance.

This is needed in case of damage below the surface of the hull.

(5) Joint Survey

In the event of a damage accident, the interests of both parties involved in the accident and the victim are represented in a joint survey arrangement as described above.

In this case, a surveyor arranged by both parties may attend the site and mutually check the extent of the damage (width and depth).

Hull & Machinery Insurance and P&I Insurance are familiar with this type of survey arrangement. If in any doubt utilize the insurance companies to make the arrangements.

⑤ Notify Vessel of arrangement status

Following an accident, a number of interested parties and the media visit the Vessel. In some cases, the personnel on duty at the time of the accident, including the Master, may be interviewed in the offices of the authorities.

It is necessary to inform the vessel of the progress of the arrangements, the list of visitors and know how to deal with them in order to not be at a disadvantage in the aftermath.

The Vessel will verify the identity of the visitor and the purpose for which he or she has come on board, and will decide if the candidate is to be allowed to get on board to investigate the damage and answer questions. However, there is a limit to what the Master can do on his own, so as mentioned above, it is advisable to have a member of the Supporting Team on Land (e.g. SI) on board as soon as possible.

In addition, the Master needs to inform the crew members that the Master (or SI) is the only person who can respond to them, and that the rest of the crew members should not tell anyone what is going on. A brief summary of these is shown in Figure 2.

Figure 2: Managing Visitors on Board

Particularly, the following must be thoroughly taken into account:

① Response to government authorities

Respond immediately. Crew members other than the Master will also be interviewed, the findings of which are to be reported to the Supporting Team on Land.

② Response to Vessel's related parties

To be fully cooperative with any investigation by the Vessel's officials, including the Attorney, Surveyor and P&I and Hull Insurance representatives.

③ Response to other parties related to the Vessel

If there is a request for disclosure of records, consult with the company or insurer to decide how to respond, rather than relying on the captain's judgment. If forced to do so (permission granted), only show the situation. Do not give any comments or opinions (especially disapproving ones).

④ Letter of Guarantee or Letter of Undertaking

If there is a need for a submission, prepare in consultation with the insurance company.

⑤ Preparation of a sea [marine] protest and confirmation and instructions to be included in the Log Book

- The sea [marine] protest and the Log Book are understood to be irrevocable oaths. It must be carefully prepared and completed, fully recognising the importance of documentary evidence.
- The contents of the Chief Engineer's Log Book, Bell Book and checklists should be consistent. Only main points should be recorded in the Log Book.
  Naturally, false statements are strictly prohibited. This may have irreversible consequences. It is also recommendable to have a lawyer prepare a draft via the insurance company.

§3 Oil Spill Response

In Chapter 2, "2-1 Countermeasures for Maritime Accidents", it was explained that an accurate record be kept of the "situation and the details that need to be ascertained" and that "the initial response is of the utmost importance". In particular, in the event of an oil spillage accident occurring, the following issues should be considered when assessing the situation.

① **Type and property of oil spill**

② **The location of the spill (e.g. from a hull hole rupture or deck overflow) and the condition of the spilt site (e.g. the surrounding environment, particularly in fishing facilities where the impact of marine contamination is significant)**

③ **Oil spill spread**

④ **Amount of oil spill spread**

By assessing the situation and conditions as quickly as possible, a response is decided upon and removal measures implemented on site. In particular, some types of oil spill can produce toxic gases which can be harmful to residents of a coastal area. In the event of such types of oil spill, it may be necessary to give priority to oil removal measures, including the evacuation of the area, if necessary, in order to control the oil spill.

When an oil spill occurs at sea, it is almost impossible to take measures to control it using only the removal and recovery materials equipped on a vessel. Therefore, in order to prevent spreading, it is also advisable to request the assistance of an organisation specialising in removal operations which will help minimise damage and loss. This chapter describes the four situations that need to be identified.

3-1 Oil Spill Progression Timeline

Most spilled oil will naturally dissipate either through evaporation, dissolution or dispersion. However, some oils will evaporate within a few hours like gasolene, whereas others like light and medium crude oil can take 2-10 days to dissipate from the surface of the sea. Although other oils like the C-type heavy oil used as fuel for ships or crude oils with a high wax content can remain on the sea surface for many hours, they also naturally dissipate after some time.

= Natural Processes =

Figure 15 illustrates natural processes. Any oil type can be reduced to its natural form over time by natural processes.

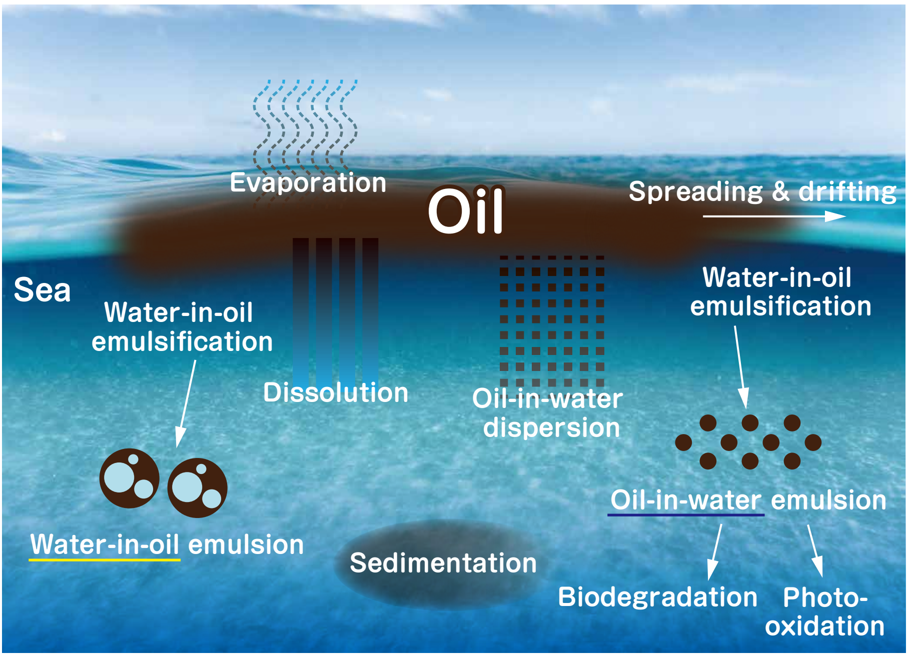


Figure 3: Oil Spill Progression Timeline
"Umi" & "Nagisa" Foundation

① Spreading

From the outset of any spill, it is vital to fully understand the spreading process. The driving force for this initial flow is the weight of the oil. A large volume of oil spilling instantaneously will spread much more rapidly than a slow spill.
In the initial stage, oil spreads in one large flow, however the speed of that flow depends on the viscosity of the oil. High viscosity oils will spread slowly, whereas an oil spill which is below pour point temperature (Note 1) will hardly spread at all. However, the initial flow will begin to break up after a few hours and start to form narrow bands according to the forces of the wind and tide.
Note 1: Pour point:
The pouring point of oil is measured in ℃. Pour point represents the temperature below which oil ceases to flow, rather it takes on the fundamental properties of a solid.

② Evaporation

The rate of evaporation and the speed at which it occurs depend upon the volatility of the oil. Oils with a low boiling point such as gasolene or kerosene will evaporate quickly and will have often entirely evaporated after only a few hours. On the other hand, oils with a high boiling point such as heavy crude oil or C-type heavy oil evaporate very little if at all.
As the surface area of the slick increases, the light compounds of the oil will rapidly evaporate. The rate and size of initial spreading directly effect the amount of evaporation.
Furthermore, when highly volatile oils like gasolene (boiling point 35～180℃, flash point -40℃) spread in an enclosed sea area, there is a risk of fire/explosion when the evaporated oil mixes with the air.
It is often possible to ignite large oil flows which have just begun to spread. However, once the volatile compounds of the oil have evaporated the remaining slick is thin and together with the cooling effect of the sea water, it becomes increasingly difficult to maintain any kind of combustion, even with the use of wicker material.

③ Oil-in-water dispersion

Waves and turbulence at the sea surface can cause some or all of a slick to break up into fragments and droplets of varying sizes. Some of the smaller droplets of oil will remain suspended (like solid particles floating in a liquid) in the sea water while the larger ones will tend to rise back to the surface and reform with any droplets which remained at the surface. This reformed slick will then spread out to form a very thin film. The smaller suspended droplets encourage other natural processes such as biodegradation (the breaking down of chemical compounds into inorganic compounds through the actions of bacteria, fungi and other life forms).

It is interesting to note that given enough time microplastics may also biodegrade, but the process is extremely slow and they remain undegraded for a very long time causing a marine pollution problem which has recently come under much scrutiny.

④ Water-in-oil emulsification

The term “emulsion” refers to a state in which two liquids, which normally don't mix (like oil and water), become combined. For example, oil and vinegar, which normally don't mix, can be temporarily combined after vigorous shaking. This state is referred to as “emulsion”.

As the oil slick spreads over the sea, the film transforms from thick to thin and during this time the various distilled fractions of petroleum gas and petrol (gasolene) evaporate. Finally, only the non-volatile compounds remain and these are buffeted by waves to form an “emulsion”. This emulsion consists of the following two types.

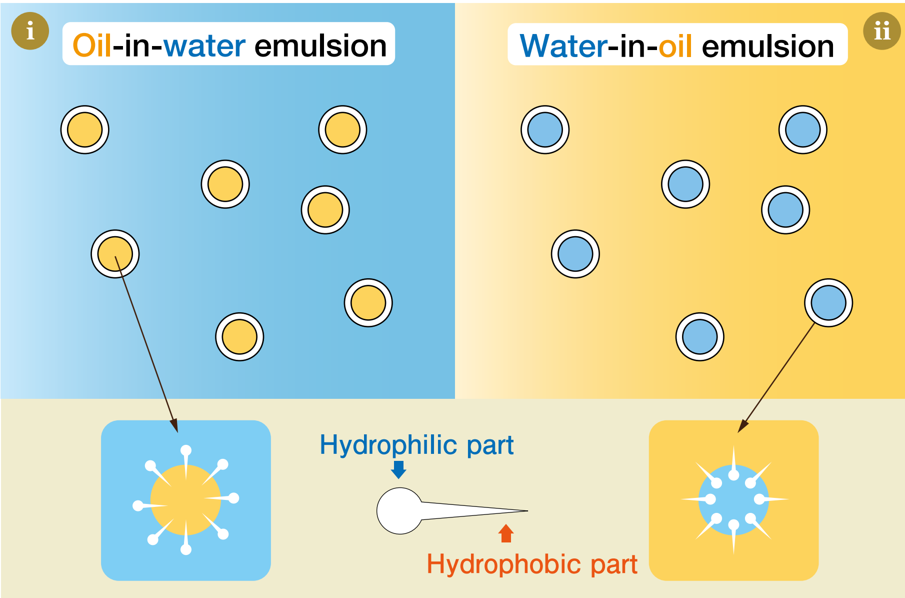


Figure 4: Emulsion Diagram

i Oil in Water

Oil particles in water. It is reduced to seawater by digestion and oxidative decomposition by bacteria.

ii Water in Oil

This is an oil containing water (seawater). When an emulsion is formed, the volume increases by a factor of three or four times and the viscosity increases by several stages. If the asphaltene content is especially high, it can lead to "Chocolate Mousse", a stable tar-like oil mass that is extremely difficult to process, or "Tar-balls", which can take years or even decades to break down. Therefore, removal measures must be performed before the oil spill becomes an emulsion.

Photograph 1: Emulsion (Chocolate Mousse)

Photograph 2: Emulsion (Tarball)

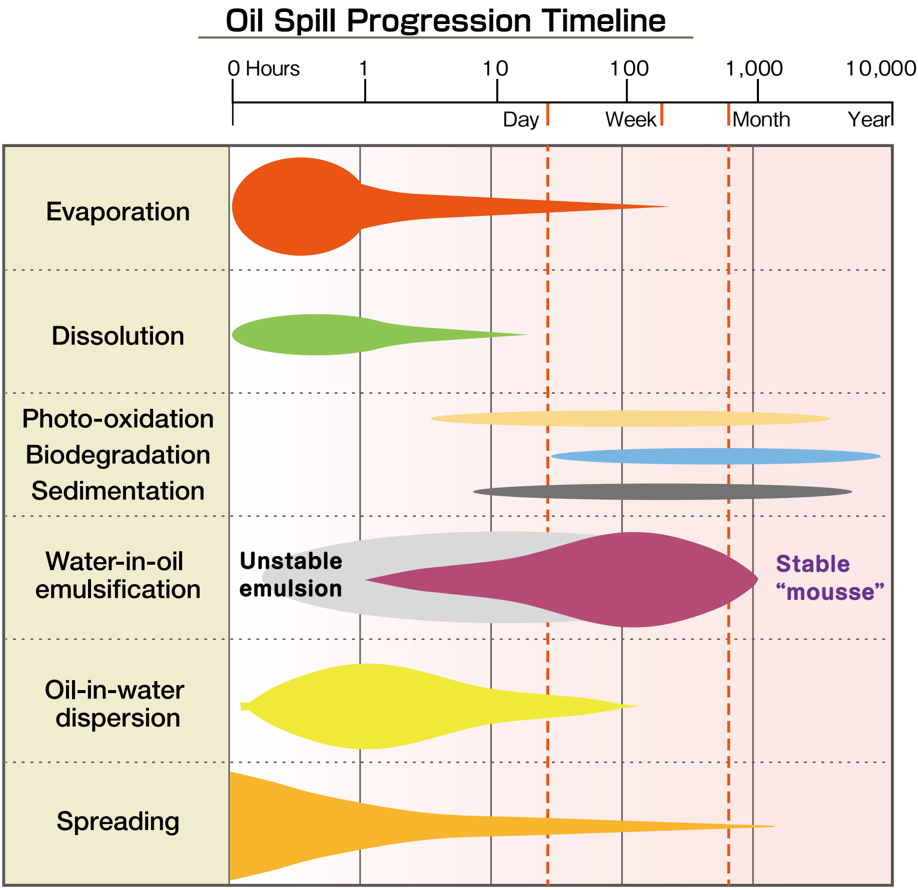


Figure 5: Oil Spill Progression Timeline (modified with data from the ITOPF)

3-2 Oil Spill Spreading Factor

Spilt oil is spread by gravity (the weight of the oil) acting on the oil in the initial stage and then by the surface tension of the oil. These spreads are short in duration and limited in extent. In fact, however, it is affected by the following external forces, which cause it to spread intermittently, forming long, narrow strips or masses of oil in an irregular shape rather than a circle.

= External Forces: Spreading Factors =

① Wind

The floating oil spill is influenced by wind and leeway currents and is carried away by weathering at a speed of approximately 3% of the wind speed.

② Ocean current

The strength (speed) and direction of the ocean current will carry it away.

③ Tidal current

When considering ocean currents, it is also necessary to take into account tidal currents.

④ Waves and Undulations (Swells)

As for spreading, the effects of waves and undulations (swells) are difficult to calculate, but these facilitate the emulsification of oil.

= Direction of Spilled Oil Flow: Vector Calculation =

Figure 6 is a method of measuring the direction and speed of spilled oil flow by vector calculation.

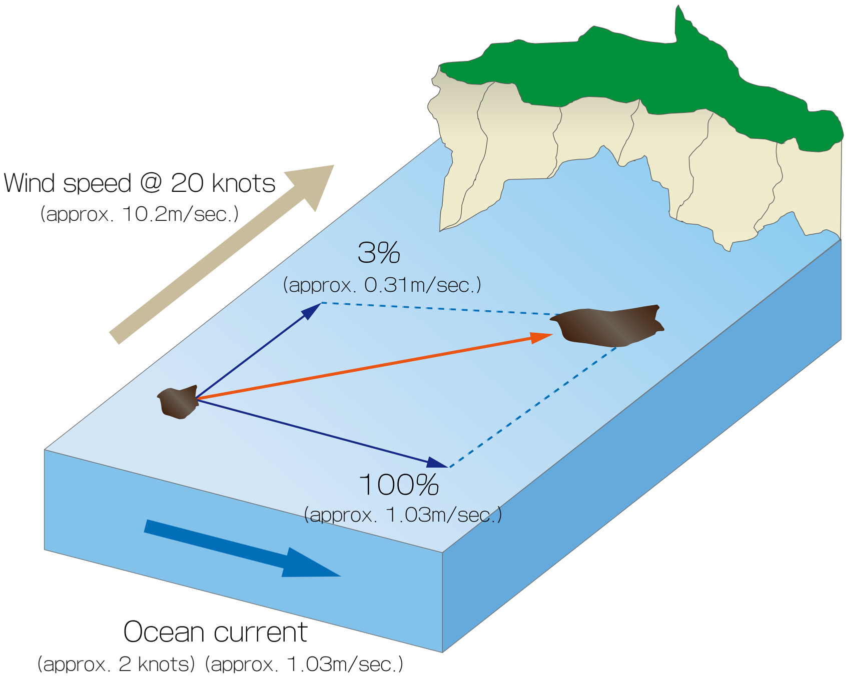
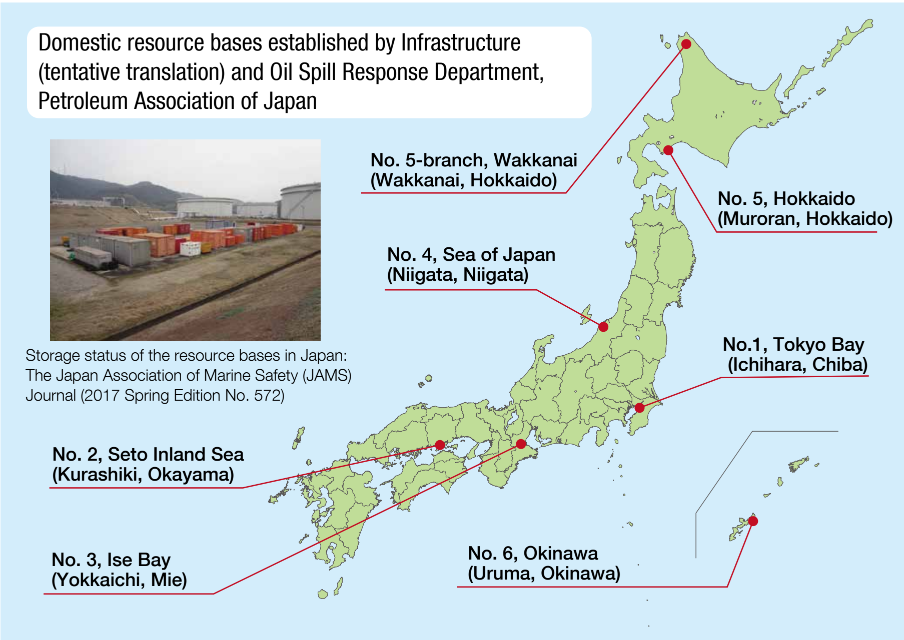


Figure 6: Direction and Speed of Spilled Oil Flow
(Document modified from the Marine Disaster Prevention Center (MDPC))

Using vectors, by calculating the data of the direction of flow of the ocean current (100%) and the wind speed of the prevailing wind (3%), the direction and speed of the oil spill can be determined.

3-3 Spreading Preventive Measures

The best way to minimise the damage caused by an oil spillage accident is to prevent the spread of the spilled oil. However, the Vessel has a limited supply of oil recovery materials, which are unlikely to be able to contain the spread of an oil spill. Therefore, the sooner oil recovery materials are made available, the less damage and loss is likely to occur. ITOPF has seven resource bases in Japan. (See Figure 7.)



Storage status of the resource bases in Japan: The Japan Association of Marine Safety (JAMS) Journal (2017 Spring Edition No. 572)

Figure 7: Bases of Petroleum Association of Japan (Partly Modified with Data from the ITOPF)

The MDPC has also set up resource bases in various parts of Japan. (See Figure 8.) The roles and activities of the MDPC are as follows: (Taken from the MDPC homepage.)

1. Purpose

In conjunction with the implementation of countermeasures to deal with the outbreak of maritime disasters and the containment of any escalation thereof (hereinafter collectively referred to as "maritime disaster prevention"), the MDPC also provides the necessary vessels, equipment and materials for such eventualities as well as the organisation of any necessary training programmes. Through international cooperation on maritime disaster prevention, the MDPC aims to contribute to the protection of human life and property.

2. Activities

(1) Implementation of measures to clean up any oil spills and recovery of any costs incurred therein, in accordance with directives from the Japan Coast Guard Commandant.

(2) Implementation of measures to clean up any oil spills, extinguish fires and/or prevent the spread of fire or any other maritime disaster, on behalf of shipowners or any other party.

(3) Ensuring that oil recovery vessels, oil recovery equipment, oil booms etc., or any other vessels or equipment deemed necessary to prevent a maritime disaster are made available to shipowners or any other party.

(4) Provision of the training required to implement maritime disaster prevention measures.

(5) Ensuring that the results of any research into the equipment, materials, and skills required for maritime disaster prevention are made available to shipowners or any other party.

(6) Gathering, collating and ensuring that any relevant information pertaining to maritime disaster prevention is made available.

(7) Provision of advice and guidance on maritime disaster prevention on behalf of shipowners or any other party.

(8) Provision of advice and guidance on maritime disaster prevention in overseas countries. Provision of maritime disaster prevention training to overseas trainees, and contribution to international cooperation on maritime disaster prevention.

(9) Manufacturing and retail of the materials and equipment necessary for maritime disaster prevention, publication and retail of printed material regarding maritime disaster prevention, and conduction of any other incidental business arising from the previously mentioned activities above.

(10) Any of the previously mentioned activities above apply in a similar fashion to rivers, lakes etc.

MDPC's Accident Response System and Base Map of Materials, Equipment and Experts for Maritime Disaster Prevention (2021 FY)

- In addition to the three bases such as the Headquarters (Yokohama), West Japan Branch (Kobe) and Kyushu Branch (Kitakyushu), five representative offices have been established in Tomakomai, Chiba, Yokkaichi, Mizushima and Iwakuni to ensure the efficient and effective implementation of standby operations during normal times, and to establish a rapid and accurate accident response system on a nationwide scale by utilizing the contractual disaster prevention system (tentative translation).

● Contractual disaster prevention measures (implemented by 166 companies)

● Base for materials, equipment and experts for maritime disaster prevention in designated areas (44 bases) (HNS (Hazardous Noxious Substance) response: 32 bases out of the above)

● Organization

- Headquarters (Yokohama)
- West Japan Branch (Kobe)
- Kyushu Branch (Kitakyushu)
- Representative offices in Tomakomai, Chiba, Yokkaichi, Mizushima and Iwakuni

● MDPC Training Department

Training Department in Yokosuka

▼ Deployment of oil recovery equipment etc.

▶ Oil prevention and degreasing materials and equipment for oil discharge

◀ HNS equipment

▲ Assignment of HNS disaster prevention experts

■ MDPC Disaster Response Depots (Kawasaki, Sakaisenboku and Kitakyushu)

■ MDSS Implementation Districts (26) (Remarks: "Keihin region" consists of Yokohama and Kawasaki, and Imabari and Matsuyama are one area)

Head office (Yokohama)
- **Training Department (Yokosuka)**
- **West Japan branch (Kobe)**
- **Kyushu branch (Kitakyushu)**

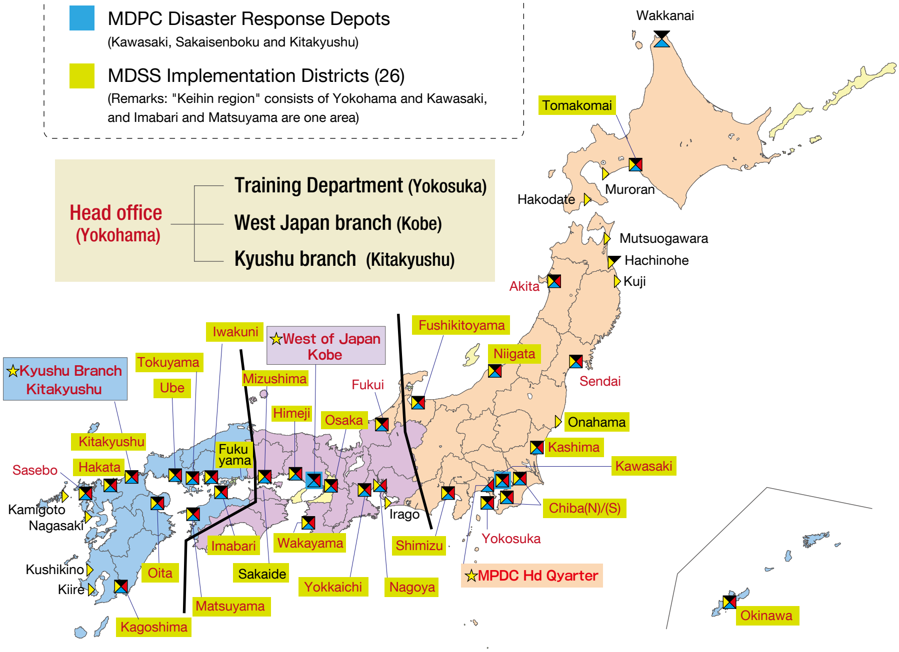


Figure 8: MDPC's Base Map (From MDPC Website)

Following an oil spill and on behalf of a Shipowner or any other party acting as the principal polluter, the Maritime Disaster Prevention Center (MDPC) will respond to any maritime accident.

Marine Pollution and Marine Disaster Prevention law requires that owners of tankers which have a gross tonnage in excess of 150 tonnes, which are navigating through applicable sea areas (*1), and are carrying specified oils such as crude oil or heavy oil, should have secured availability of specialised oil removal materials (oil booms, oil absorbents, oil dispersants etc.). The same law also requires that owners of specified oil tankers with a gross tonnage in excess of 5,000 tonnes which are navigating through specified sea areas (*2) have also secured the availability of oil recovery equipment. Furthermore, there are similar legal obligations for tankers with a gross tonnage in excess of 150 tonnes and which are carrying oil other than specified oil or hazardous and noxious substances (HNS), to similarly secure availability of oil removal equipment and personnel with the necessary expertise. On behalf of the shipowner, the MDPC issues certification (HNS Certificate and Specified Oil Certificate) to legally verify that vessels have secured availability of the proper oil removal equipment. The certification further guarantees that in the event of any oil or HNS spillage and upon request from the shipowner or ship's Master, the MDPC will provide an "Emergency Response Service" which will respond swiftly to clean up the contaminated area.
However, vessels without the proper certification or any other separate standby agreement with the MDPC, must first conclude a separate contract before any response can be made.

*1: Applicable sea area refers to specified sea areas, any port falling under the Act on Port Regulations, and Kagoshima Bay. (Pertaining to sections (6) and (9) of Article 33 of the ordinance for enforcement, and sections (3) and (4) of Article 39 of the Marine Pollution and Disaster Prevention Law.)
*2: Specified sea areas refers to Tokyo Bay, Ise Bay and the Seto Inland Sea. (Pertaining to sections (6) and (9) of Article 33 of the ordinance for enforcement, and sections (3) and (4) of Article 39 of the Marine Pollution and Disaster Prevention Law.)

Whilst there are other private oil recovery services available, there have been cases of oil spill incidents where valuable time has been lost in making the decision about which oil recovery operator to choose. Time which has led to the spreading of the spill and an escalation of the scale of the disaster. Costs are imperative in any recovery operation, and prompt decision making use of the nearest available recovery agency or operator can ultimately lead to a reduction of those costs.

3-4 Classification of Oil Spills

Oil spills from a vessel can be classified as shown in Figure 9. These are roughly categorized into two classifications: “cargo oil spills” from tankers and “fuel oil, lubricants and sludge spills” from all vessels including tankers.

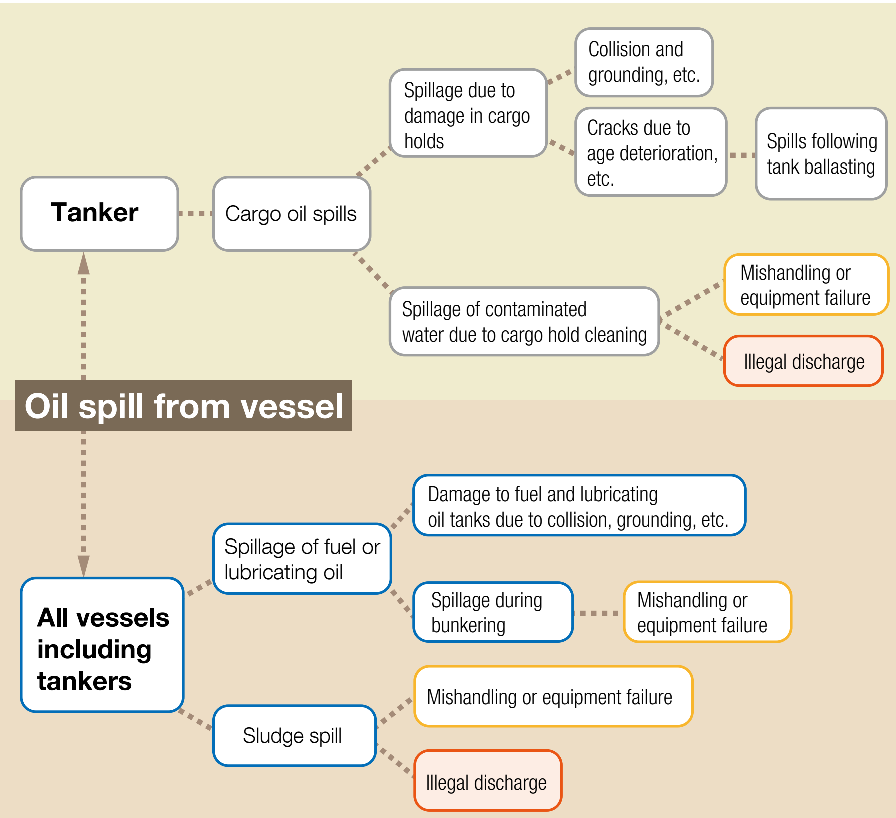


Figure 9: Classification of Oil Spills

Secondary disasters such as collisions and groundings can result in spills of fuel or cargo oil, but the majority of accidents involve spills of fuel or lubricating oil due to operational errors during bunkering.

3-5 Oil Types

Figure 10 illustrates oil types refined from crude oil.

Crude oil is divided by a method of separation and concentration of the mixture according to its components, using the difference in boiling point. Crude oil is heated and separated in a 50m high pressurised distillation column, where the lower boiling point substances (gas, naphtha etc.) are extracted from the top fraction and the higher boiling point substances (heavy oil etc.) are extracted from the bottom. It then undergoes a secondary treatment, including the removal of sulphur, to become a product.

Liquid Petroleum Gas (LP Gas) is refined first, followed by petrol and naphtha, jet fuel and paraffin, light oil, and finally residual oil, heavy oil and asphalt. (Figure 10 and Table 1.)

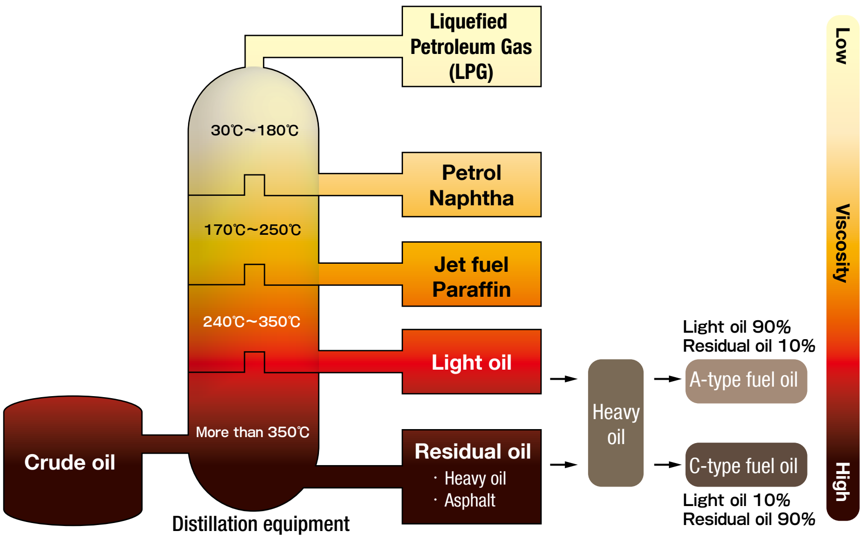


Figure 10: Oil Types
Source: Official website of Idemitsu Kosan Co., Ltd.

Oil type	Purpose	Points to note and response methods
A-type fuel oil	For vessels, factories, etc.	When a light petroleum oil is spilled at sea, it evaporates relatively quickly due to wind waves. However, in winter and/or in port, the speed of evaporation is slower and persistence is higher which requires early recovery.
Light oil	For vessels and vehicles	
Paraffin	Mainly for heating	
Lubricants	Engines, etc.	As this almost never evaporates, the basic principle is to surround it with string of flags-type oil absorbents which are then wrung to recover the oil.
Hydraulic oil	Oil hydraulic equipment	
C-type fuel oil	Large vessels, factories, thermal power plants, etc.	High viscosity index oil that hardly evaporates mixes with seawater to form an emulsion. This becomes hydrous and highly viscous, and expands to three times its volume whereby it can be physically recovered.
Petrol	For cars and sport fishing boats	Highly flammable, evacuate and escape on the leeward side.
Crude oil	Refined in an oil refinery	Carried by large tankers. Be cautious as it is flammable and toxic depending on the oil type.
	Crude oil-fired thermal power plants	

Table 1: Purpose by Oil Type
(Modified from the management manual from "Umi" & "Nagisa" Foundation)

The method of recovery in the event of a spill varies greatly depending on the oil types and the location of the spill (in port or outside of port). These recovery methods are listed in the table (Table 2). For a full list please see Attachment 1.

It is difficult to recover petrol and liquefied gas, which has a low boiling point temperature and high volatility, because it takes a long time to evaporate, also, at the same time there is the possibility of fire, explosion and toxic gases being generated which means that evacuation measures must be taken to ensure that human life is not affected.

A-type fuel oil, which is used for marine fuel, has a low viscosity and therefore spreads to form a thin oil film. Therefore, the recovery operation must be completed before the oil spreads over a large area. On the other hand, the higher viscosity C-type fuel oil spreads more slowly than A-type fuel oil, but is more highly likely to emulsify, making recovery a longer process. To prevent this, the oil must be recovered before it has a chance to spread.

Point oil spill occurs	Oil type	Preventive objective	Procedure	Necessary materials	Damage expected	Remarks
In port	A-type fuel oil	Recovery/ spreading	A, B	Oil fence boom and absorbent boom	Port closure, spoilage of water intakes, etc.	Spreads to form a thin oil film
	C-type fuel oil	Recovery	A, B, C	Oil fence boom, absorbent boom, and powerful suction trucks	Port closure, spoilage of water intakes, etc.	Use of absorbents for high viscous oils, emulsions
	Emulsion	Recovery	A, B	Oil fence boom and absorbent boom		Use of absorbents for high viscous oils, or snares (see photograph)
	Petrol	Monitoring and evacuation		Powder gelling agent	Fire, explosions and loss of life	Preventing the spread of secondary damage
	Chemicals	Investigation and confirmation	Instructions from expert	Powder gelling agent	Differ depending on type of chemical	Always consult an expert as treatment will vary depending on type
	Liquefied gas	Monitoring and evacuation			Fire, explosions and loss of life	LNG and LPG
Outside of port	A-type fuel oil	Recovery/ dispersion	A, B, D	Oil fence boom, absorbent boom, oil recovery vessels and oil treatment agents	Destruction of fisheries, tourism, and the natural environment	
	C-type fuel oil	Recovery/ dispersion	A, B, D	Oil fence boom, absorbent boom and oil treatment agents	Destruction of fisheries, tourism, and the natural environment	
	Emulsion	Recovery	A, B	Oil fence boom, absorbent boom and oil recovery system	Destruction of fisheries, tourism, and the natural environment	
	Petrol	Monitoring and evacuation			Fire, explosions and loss of life	Preventing the spread of secondary damage, natural evaporation
	Crude oil	Recovery/ dispersion	A, B, D	Oil fence boom, oil recovery vessels and oil recovery system	Destruction of fisheries, tourism, and the natural environment; fire, explosions and loss of life	Initially there is a crude gas hazard, then emulsions form
	Chemicals	Investigation and confirmation	Instructions from expert		Differ depending on type of chemical	Always consult an expert as treatment will vary depending on type
	Liquefied gas	Monitoring and evacuation			Fire, explosions and loss of life	LNG and LPG

Procedure A: In the case of large quantities, oil is to be recovered with oil fence booms and then recovered by an oil recovery vessel or powerful suction trucks, etc. Or, the oil can be absorbed using an oil absorbent. For small quantities, use oil absorbent.
B: For small quantities, the oil is to be surrounded by an absorbent boom (oil fence, string of flags-type, rolls, etc.) and then wrung and recovered by suction.
C: In the case of large quantities, oil is to be collected with oil fence booms and then recovered by powerful suction trucks.
D: Direct spraying and dispersal with oil treatment agents (for vessel and aircraft).

Table 2: Oil Recovery Procedure by Oil Type
(Modified from the management manual from "Umi" & "Nagisa" Foundation)

3-6 Oil Recovery Materials

The Ministry of Land, Infrastructure, Transport and Tourism has deployed Water Surface Cleaning and Oil Recovery Vessels etc. to Regional Development Bureaus, and some private companies and organisations also have these oil recovery vessels. However, these vessels are usually engaged in dredging operations and it is difficult for them rush to the site immediately when an oil spill occurs.

Photograph 3: Water Surface Cleaning and Oil Recovery Vessel, Beikurin (Bay-clean)
Source: website of the Chiba Port Office, Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism

Therefore, in the immediate aftermath of an oil spill, it is essential to control the spread of the spill as soon as possible and to begin recovery operations. However, this can only be done by human intervention.

Here are some of the materials that can be used for this purpose.

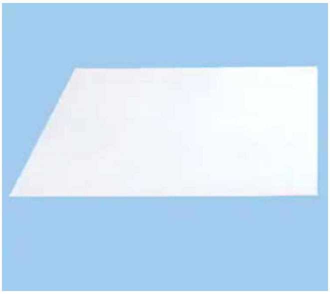
= Oil Snare =

The literal translation of Oil Snare is “Oil Trap”. The Oil Snare is an oil recovery material developed by Parker Systems in Virginia, USA specifically for high viscosity oil. Due to the unique shape of the oil adsorbent, oil gets trapped inside its thin looped tassels, which can capture the high viscosity of C-type fuel oil that cannot be recovered by other conventional oil adsorbents. For the past 25 years, it has been utilized in major tanker spills around the world and is highly regarded as an essential oil recovery material for the recovery of high-viscosity oil. An oil Snare is also used by the Japan Coast Guard in their “Oil Removal Contingency Programme”. (Tentative translation). A 15m long rope with 30 oil snares, shipped in a plastic bag, each oil snare weighs 230 grams and can trap up to 14kg of oil. It is made of polypropylene and can be incinerated after use.

Photograph 4: Oil Snare
Source: Website of Anandenki Co., Ltd.

= Oil Absorbent Pad =

In the field, it is necessary to choose the oil removal equipment appropriate for the oil spill. For less viscous oils such as A-type fuel, the use of oil absorbents such as oil absorbent pads (hereinafter referred to as mats) can be effective. These mats are manufactured from polypropylene and vegetable fibres, the performance of which is defined by type approval, but the use of materials without type approval is not an issue and the use of non-approved materials is permitted. It absorbs more oil than water.



Photograph 5: Oil Absorbent Mat

Photograph 6: Oil Absorbent Mat Usage Example
Source: Website of Mitsui Chemicals, Inc.

Photograph 7: Oil Absorbent Roll

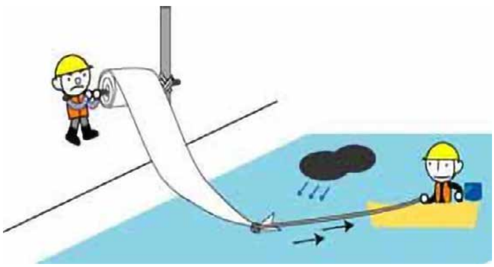
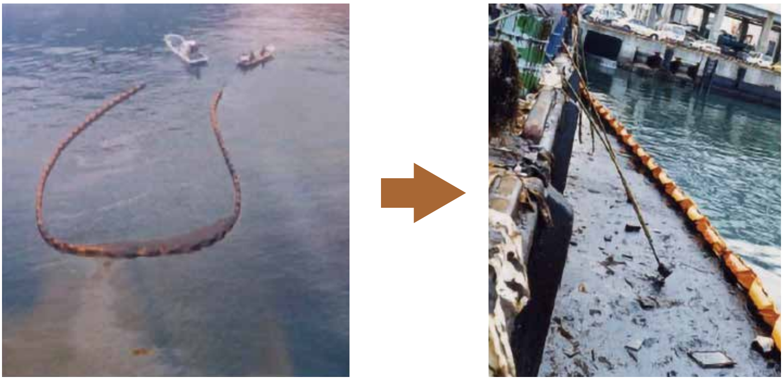


Image 3: Oil Absorbent Roll
(Modified from Documents Created by
"Umi" & "Nagisa" Foundation)

= Oil Fence Boom =

An oil fence is a floating structure, also known as a boom, which is stretched over a body of water to prevent oil from spreading in the event of a spillage. Except for special types such as "floating" oil fence booms, they are standardised so that they can be connected to oil fence booms of different manufacturers; there are two types in the Japanese standard: Type A and Type B. This material is used to control the spread of spilled oil and their main purpose is to collect, attract, enclose and prevent oil spread. It is not used as a stand-alone product, but in conjunction with materials and machinery to recover the oil. This is possible when the sea is calm, but if the wind, ocean current or waves exceed a certain limit, the oil can leak from the bottom or spill over the top and become uncontrollable.



Photograph 8: Oil Fence Boom Extension in Use
(From a Manual Created by "Umi" & "Nagisa" Foundation)

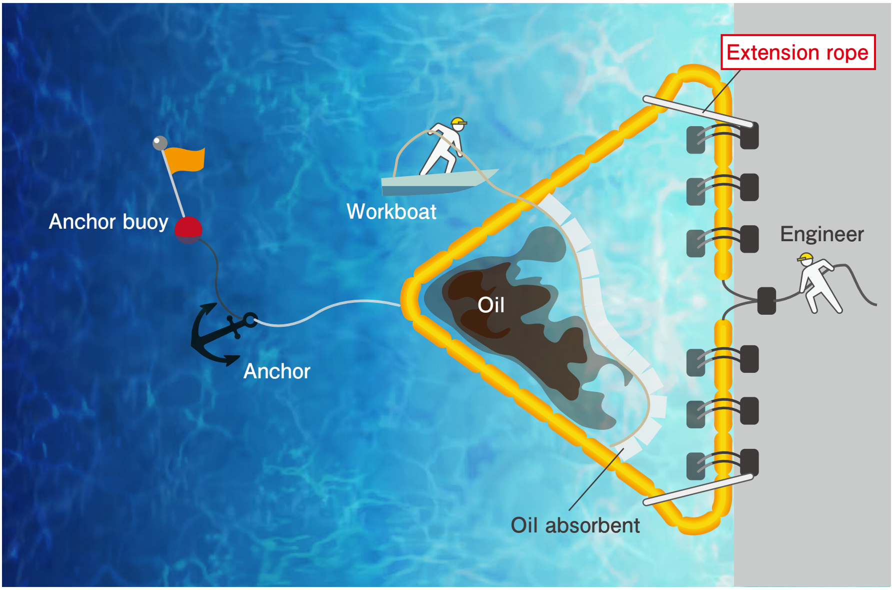


Figure 11: Oil Fence Boom Extension in Use

3-7 Oil Treatment Agents

An oil treatment agent is defined as a substance which when sprayed onto and mixed into floating oil at the sea surface, will cause the oil to rapidly emulsify and disperse into fine particles. This ultimately results in preventing the oil from sinking to the seabed, and enables the sea to naturally attenuate more easily. Furthermore, such agents also have a low toxicity towards marine life.

Previously, such agents were mistakenly referred to as “neutralizing agents” which wrongly suggested that they somehow chemically transformed the oil into a different substance.

However, as the opening definition states, oil treatment agents are rather chemical agents which atomize the oil, dispersing it over the nearby sea surface. This increases the surface area and encourages natural attenuation through the actions of microorganisms and oxygen. The effect of this atomization also means that the oil does not sink, and both the level of toxicity to which coastal and marine life is exposed and the amount of oiling damage to seabirds can be contained. (Taken from the Fire and Disaster Management Agency of the Ministry of Internal Affairs and Communications webstie.) Oil treatment agents do not make the oil disappear, nor do they neutralize and chemically transform the oil into a different substance.

= Types of Oil Treatment Agents =

The two types of solvent are shown below. These solvents are further classified according to their percentage content of surfactant. Thus, 10-15% content is referred to as low concentrate, 15-20% as medium concentrate, and 35-60% as high concentrate.

1) Hydrocarbon type

This includes both 1st and 2nd generation types. The 1st generation type is an aromatic solvent of high toxicity. The 2nd generation type (Type 1) is paraffin-based. In terms of surfactant content, the 2nd generation type ranges from a low to medium concentrate. It is this 2nd generation type which is currently in commercial use in Japan.

2) Concentrated type (concentrate)

The concentrated type (Type 2) and self-mixing type (Type 3) are known as 3rd generation oil treatment agents. They are either alcohol or glycol based. These types contain a high ratio of surfactant.

= Efficacy and Application Methods of Oil Treatment Agents =

When the viscosity of the oil slick is high, oil treatment agents have little effect since they slip off the surface of the oil before the solvents can disperse within. As a general rule, the agents remain effective on oils with a relative viscosity of less than 2,000cSt. However, this effectiveness drastically reduces when that viscosity is exceeded, and within viscosity levels of 5,000 - 10,000cSt all efficacy is lost. In short, oil treatment agents are not suitable for use with high viscosity emulsion oils or those oils with a pouring point in excess of the ambient temperature. Furthermore, it may at first seem that the oil can be dispersed at the outset of the spill, however the volatile compounds quickly begin to evaporate and due to the effects of natural weathering, viscosity increases making any dispersion impossible within a short period of time.

Therefore, whilst the efficacy of any oil treatment agent also depends on the prevailing weather and sea conditions, wherever possible it is best to apply these agents one or two days before viscosity becomes high. The main methods of application are by a workboat or aerial spraying by plane.

= Toxicity =

Compared to the 1st generation oil treatment agents, the toxicity of recent agents has decreased. However, there still remains much debate as to their method of use. Furthermore, there is variation in local and national attitudes towards the use of oil treatment agents. In particular, the use of oil treatment agents runs the risk of introducing new marine pollutants into the sea, leading to an increase of localised hydrocarbon concentrations. The effect of this on marine life is a cause for concern. It is therefore vital that there is a consensus of opinion between local authorities, fishery officials etc., regarding the use of any oil treatment agents.

3-8 Oil Spill Response

Figure 12 is a flowchart of an oil spill response. (Please see Attached 2 for details)

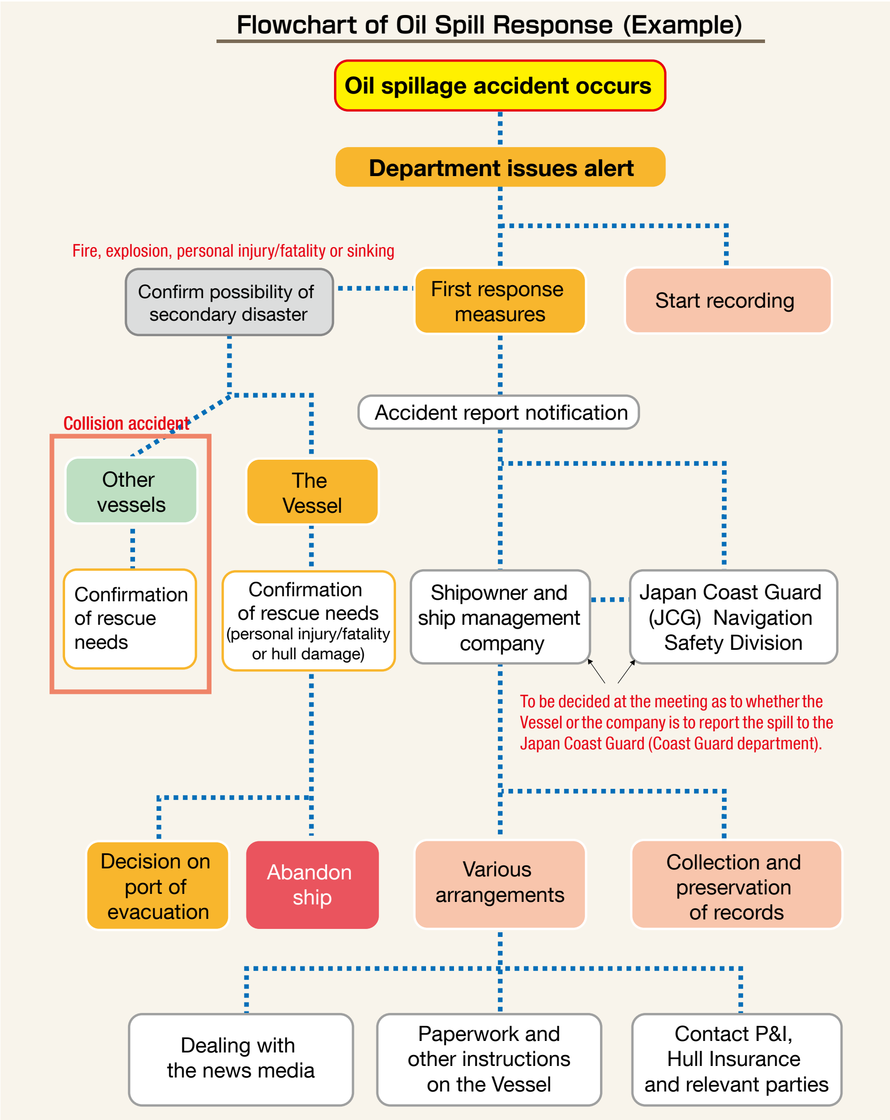


Figure 12: Flowchart of Oil Spill Response (Example)

1. In the event of an overflow during bunkering, first of all, immediately stop pumping oil from the supply vessel. Then, the Oil Removal Emergency Department issues an alert. (Tentative translation.)

2. In accordance with the sharing roles of the Emergency Department, the crew will start operation according to the Master's orders. Naturally, the first priority is to check that there has been no injury to persons.

3. Start first response measures to stop overboard discharge. Looking at the oil spill incidents reported to this Club, in some cases the scupper plugs were not set and the oil spilled overboard from there. In other cases, there was a failure to close or a loss of the spill combing plug in the vent pipe, which led to an oil spill on deck and overboard via a scupper.

= Spill Prevention, Mitigation and Leak Closure Measures =

To follow are some of the initial emergency measures which aim to prevent and reduce spills.

- **Decompression of the leaking tank and pipe**
- **Closing of the relevant valves (and in some cases those for gas biting), if necessary**
- **In case of tank damage, transfer the remaining oil in the leaking tank to another tank**
- **Maintaining ship directional control by Ballast control**

4. At the same time as the first response measures are taken, report the accident to the Shipowner (or ship management company) and confirm with the Shipowner (or ship management company) as to whether the incident is to be reported to the authorities (the Regional Coast Guard

Headquarters in Japan) by the Vessel or by the Shipowner (or ship management company). Please note that it is important to remember that the reporting of an accident is a battle with time so as to minimise the spread.

5 Moreover, the possibility of secondary disaster (fire, explosion, personal injury/fatality or sinking) is to be confirmed. In the case of a collision, after checking the status of the Vessel, the status of other ships should be checked.

6 As mentioned in section 2-1 of Chapter 2, Countermeasures for Maritime Accidents (For Each Maritime Accident Including Those Between Ship and Shore), it is important to make an appointment with the local Shipowner's agency, although the Shipowner (or ship-management company) is responsible for arranging the recovery personnel.

Figure 13 shows the response framework of major oil pollution incidents in Japan (organisation chart). (Modified with technical data from ITOPF: Please see Attached 3 for a full list.)

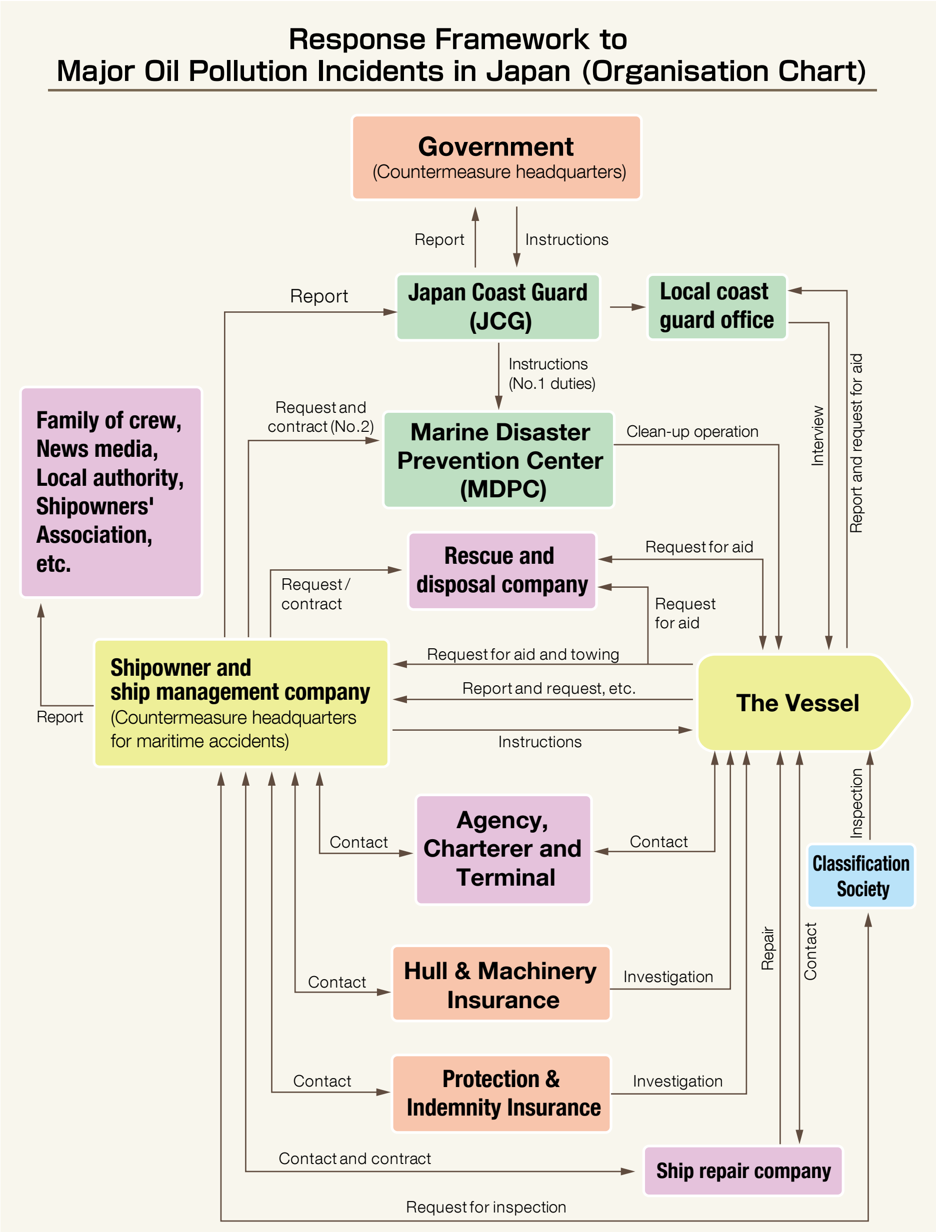


Figure 13: Response Framework to Major Oil Pollution Incidents in Japan (Chart)

3-9 Oil Spill from a Vessel with a Hole Rupture

Pop quiz !

Q In the case of a collision accident etc., as shown in Figure 14, and in the event of a hole rupture in any one part from ① to ④ , predict how much oil will be spilled. This is assuming no change in hull angle inclination, trim or draft, and no effects from currents or waves. It is also assumed that no fuel oil tank is actually connected to the double bottom and tanks in the port and starboard sides.

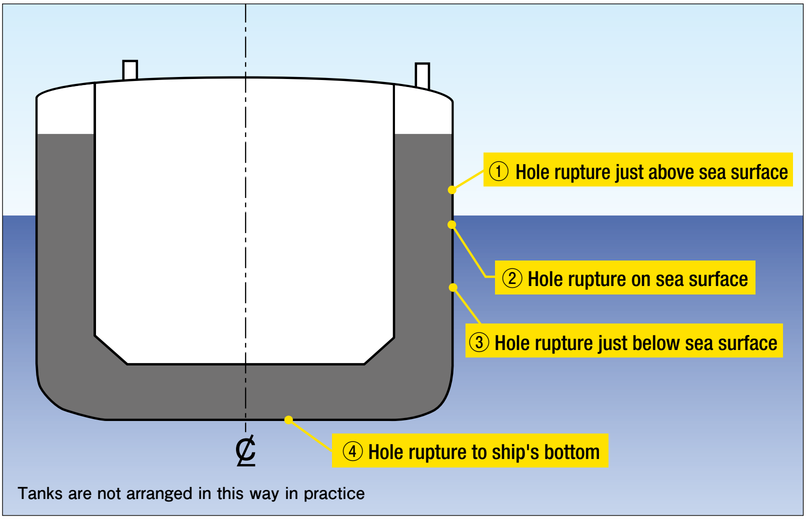


Figure 14: Oil Spillage Differs According to Hole Rupture Location

As a hint of how to approach this, it may be helpful to distinguish between "instantaneous oil spill", where the spilled oil flows out the moment the hole rupture occurs, and "continuous oil spill", where the spilled oil flows out slowly afterwards. Answer can be found on Page 75 .

§4 Case Study of Oil Spillage Accidents

Accident cases involving both oceangoing vessels and coastal vessels will be examined.

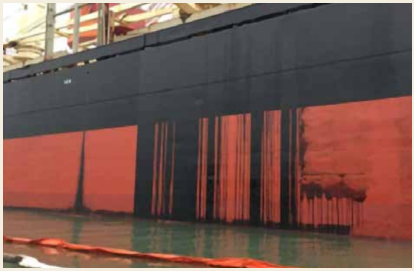
4-1 Oceangoing Vessel Case

= Date, Time and Point Accident Occurs =

Date and time accident occurs: DD/MM/20YY

Point oil spill occurs: Unspecified repair wet dock quay

Ship type: General cargo ship approx. 19,000 G/T

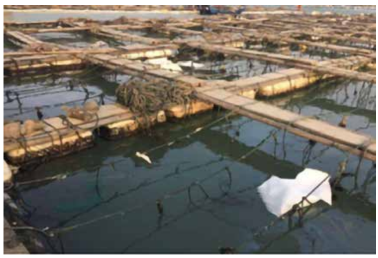


Photograph 9: Hull Spoilage of Vessel After Accident

4-1-1 Accident Overview

The Vessel was in the process of bunkering when C-type fuel oil (HFO) spewed onto the deck from the air ventilation of the Vessel's No.2 fuel tank, of which approximately 3 KL spilled into the sea. Some of the oil spilled over the oil fence extended around the Vessel and spread to the surroundings after the accident, causing damage to nearby bay and fishing facilities.

Photograph 10: Oil Slick Drifting in Coastal Areas



Photograph 11: Damage to Fishing Facilities

4-1-2 Accident Treatment Expense

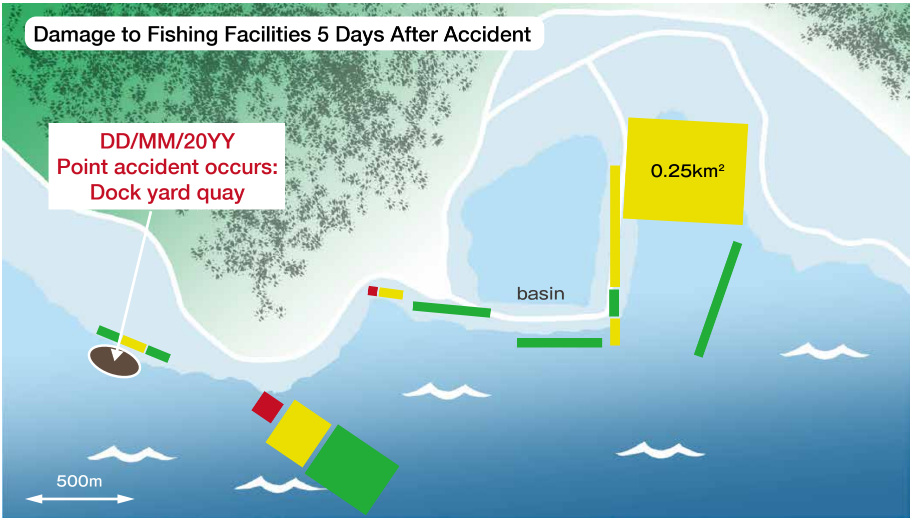
The following expenses have been incurred for accident treatment.

Oil spill recovery and clean-up expenses	Approx. 129 million yen
Compensation for fisheries	Approx. 46 million yen
Penalty (fine)	Approx. 13 million yen
Attorney fee	Approx. 20 million yen
Condition survey costs and others	Approx. 7 million yen
	Total approx. 215 million yen

Photograph 12: Fuel Oil Recovered from the Deck

Photograph 13:
Recovery via Oil Adsorbent

Photograph 14:
Recovery Work Using Oil Adsorbent



Red	Sea area shown in red (fishing facilities)	Serious damage
Yellow	Sea area shown in yellow (fishing facilities)	Moderate damage
Green	Sea area shown in green (fishing facilities)	Unknown damage

Figure 15: Damage to Fishing Facilities 5 Days After Accident

Photograph 15: Fuel Oil Spilled on the Sea

Photograph 16: Fuel Oil Washed Ashore against Seawall

4-1-3 What Caused the Accident?

The Vessel, had almost finished with dock repair work and was docked at the wet dock quay. Scheduled to depart from dock on the evening of the 01.XX.20XX (Day 1), the Vessel's bunkering plan was to receive 100 M/T of Low Sulphur Marine Gas Oil (LS-MGO) into No.5 Center DO tank and 600 M/T of 380cSt C-type fuel oil into No.3 Center and No.4 Center FO tanks as shown in Table 3.

Oil type	Amount	Receiving tank
LSMGO	100 M/T	No.5C DO Tank
HFO(380 cSt)	300 M/T	No.3C FO Tank
	300 M/T	No.4C FO Tank

Table 3: Planned Quantity for Bunkering

Table 4 illustrates the timeline of events leading up to the accident.

= Timeline of Events Leading up to the Accident =

Date	Time	Work undertaken
Day 1	19:15	Bunker vessel B came alongside the Vessel. Briefing finished.
	19:30	Connection of hose for bunkering A-type fuel oil
	20:30	Started bunkering A-type fuel oil (LSMGO: Low Sulphur Marine Gas Oil)
		Receiving tank: DO Tank No.5 C
	21:30	Completed bunkering A-type fuel oil (LSMGO: Low Sulphur Marine Gas Oil)
	21:45	Confirmed bunkered amount of A-type fuel oil
		Disconnected A-type fuel oil hose and connected C-type fuel oil hose
	22:00	C-type fuel oil (bunkering of 380 cSt started)
		Receiving tank: FO Tank No.3 C

Date	Time	Work undertaken
Day 2	01:25	Chief Engineer: Emergency stop of oil supply ordered for Bunker vessel B. Reported to Master.
	01:30	Master: Issued alert to Oil Pollution Department
	01:50	Master: Telephone called to SI, dock and agents to inform them of the oil spill
	03:00	Chief Engineer: Started transferring fuel oil from No.2C FO Tank to No. 4C FO Tank
	13:00	5 members of Marine Safety Agency (MSA) boarded to investigate
		Instructed appointment of 2 SPROs
		Then, the SPROs began recovering the spilled oil
	15:00	Chief Engineer: Finished transferring fuel oil from No.2C FO tank to No. 4C FO tank
Day 3	PM	Oil spill recovery and clean-up on deck completed

Table 4: Timeline of Events Leading up to the Accident

At approximately 19:15 on 01/MM/20YY, after a bunker barge (hereinafter referred to as "barge") came alongside the starboard side of the Vessel and a briefing with the Master of the barge and confirmation of the amount of fuel that the barge was holding was finished, at approximately 19:30, the connection of hose for bunkering was made, and from 20:30, LSMGO (Low Sulphur Marine Gas Oil) 100 M/T started to be received into No.5C DO tank. At 21:30, bunkering of LSMDO was completed. Later, at around 21:45, while the amount of LSMGO received by the Vessel was confirmed the bunker hose was replaced with one designed for 380cSt C-type fuel oil.

The original Bunkering Plan was to first bunker the No.3C FO tank with 300 M/T and then accept the remaining 300 M/T into the No.4C FO tank.
At 22:00 C-type fuel oil started being bunkered at a slow rate of transfer to begin with. After confirming that there were no leaks from the pipeline, the amount of oil transferred was increased to around 130KT/h.

At approximately 01:25 on 02/MM/20YY, 3 hours and 25 minutes after the start of bunkering, Ordinary Seaman (OS) on deck patrol reported fuel oil leaking from the Air Vent of No.2C FO Tank which was not to be bunkered.
The Chief Engineer immediately requested the barge to make an emergency stop of oil supply and reported the oil leak to the Master who was in the captain's cabin.
At approximately 01:30, the Master issued an alert to the Oil Pollution Department, and at around 01:50, telephone called the Super Intendant (SI), the person in charge of the Vessel at dock and agents to inform them of the oil spill.

After issuing an alert to the Oil Pollution Department, crew members started recovering the fuel oil spilled on the deck and, simultaneously confirmed that it had spilled overboard. Also, from approximately 03:00, because the No.2C FO tank was full, the C/E started transferring a portion of the fuel oil from No.2C FO Tank to No. 4C FO Tank.

At approximately 13:00 on the same day, 5 members of the Marine Safety Agency (MSA which is equivalent to the JCG or Ministry of Land, Infrastructure, Transport and Tourism in Japan) boarded. In addition to confirming the spill and commencing questioning of the crew, two SPROs (Ship Pollution Response Organisations) were appointed to recover the fuel oil spilled overboard and clean the seawall and fishing facilities.

On Day 3 PM, recovery and cleaning up of the fuel oil spilled on deck was completed, but it took approximately one more month for the oil that had washed ashore and onto fishing facilities to be completed.

= Estimated Amount of Overboard Discharge =

The fuel oil that spilled overboard was estimated to be approximately 3.0 KL; calculated from the amount of residual oil before the start of bunkering, that of residual oil after the stop of oil supply, that of overboard discharge recovered from the deck and the amount of oil transfer declared by the barge. Please refer to Table 5 for details.

As bunkering started at 22:00 and the emergency stop was initiated 01:25, approximately 414.00 KL of fuel oil was pumped in the last 3 hours and 25 minutes. The estimated pumping rate, calculated as a simple average without taking into account the slow pumping rate immediately after start, was 121.17 m^3/h. For the amount of spill, including the spill on the deck, calculated in Table 5 is 44.00 m^3 (column (C) of the table), divided by the oil transfer speed, we obtain: no one noticed the spill for approximately 22 minutes, after it had started through the air vent in tank No.2 C FO.

Estimation of Spillage

Unit: m^3

FOT No.	Tank Volume (AA)	Residual Oil Amount before Bunkering (BB)	Extra Space 1 - (BB)/(AA) %	Amount of Residual Oil after Pumping Stoppage (CC)		Supply Total <(CC) — (BB)>
2C	375.23	265.40	29.3%	329.37		63.97
3C	375.23	5.36	98.6%	251.02		245.66
4C	375.23	4.65	98.8%	65.02		60.37
Total	**1,125.69**	**275.41**	**75.5%**	**645.41**	**(A)**	**370.00**
Amount of oil transferred by bunker ship					(B)	414.00
Total oil outflow <(B) - (A)>					(C)	44.00
Amount of oil collected from the deck of the Vessel (approx.)					(D)	4.00
Amount of oil spilled and recovered in the Vessel's ballast tanks (approx.)					(E)	37.00
Amount of estimated overboard discharge <(C) - (D) - (E)>						3.00
Oil transfer speed (414.00 m^3 ÷ 3 hours 25 mins.)						121.17 m^3/h

Table 5: Calculation of Estimated Overboard Discharge

4-1-4 Accident Cause

= Direct Cause =

The direct cause was that the filling valve of the No.2C FO tank, which had not been scheduled to be bunkered, was not "fully closed" for some reason, but was slightly open, so that fuel from that tank entered the No.2C FO tank and overflowed through the air vent. In addition, the direct cause of the fuel oil spill overboard was, as mentioned above, according to calculations following the accident, a delay in noticing the spill from the air ventilation (no one noticed it for 22 minutes after the start of the spill) and a failure to make an emergency stop in time.

Photograph 17: No.2 C FO Tank Air Vent.

= Why Was the “Receiving Tank Main Valve (Filling Valve)” of No. 2C FO Tank Open When It Was Not to Be Refilled? =

According to the Chief Engineer of the vessel, the reason why No.2C FO Tank filling valve was open was as follows.

- **After the last refill of No.2C FO tank, the filling valve was confirmed as being closed.**
- **The fuel warm-up steam pipeline equipped above the filling valve of each fuel tank in the engine room was repaired, including the installation of insulation, as dock work.**
- **Under normal circumstances, a stepladder should be used to carry out repairs. The pipe work was carried out using a stepladder scaffolding, but the subsequent work of fitting the insulation only was simple enough for a dock worker, who was not in charge of the pipe work, who climbed over the Filling Valve of No.2 FO Tank by putting his foot on it.**
- **It is assumed that the closed valve was opened at that time.**

Photograph 18: Insulation Installation

Reconstruction by the Vessel's crew

Photograph 19: Reason Why No.2C FO Tank Filling Valve Opened

= Accident Cause from the Perspective of Human Error =

After an accident, we review it in terms of, "What would have happened had we..?" ("what if" scenarios), which is referred to as hindsight bias (the tendency to think that something was predictable after it has happened.) Acknowledging that there are prophecies recorded after the event (wise after the event) meaning that it is easy to be critical about anything after it has happened (psychological analysis), let's analyse the causes of the accident from the perspective of a chain of errors. Indirect causes include the following.

① Human error factors related to the bunkering plan, including assignment of personnel

(1) Has there been sufficient safety and environmental awareness on the part of the management (Master on the Vessel, Chief Engineer and/or the company's Opera-

tions Manager)?

It took an estimated 22 minutes from the start of the oil spill for it to be discovered. The OS (Ordinary Seaman), who were not directly involved in the bunkering work, were on deck patrol, but was every crew member on board aware of the potential significant marine pollution that could be caused by an oil leak?

(2) Had the bunkering plans and procedures been properly developed in advance? (e.g. bunker line, personnel assignment etc.)

In the analysis of the accident this time, it was not possible to examine the bunkering plan or the personnel assignment list, so we can only speculate. However, considering that it happened late at night, there was probably an insufficient number of deck officers on duty or deck patrols being conducted.

(3) Did all personnel involved in the operation have an adequate understanding of the bunkering plan in the meeting prior to carrying out the work?

- Did they understand the bunkering procedures and the condition of the bunker lines? Would **both the Master and C/O also have been present at the engine department meeting** in case of an emergency?
- **Was it predetermined** who would be in charge of which valve changeover and when?
- Due to the bunkering work being carried out at night, it is assumed that no other work was to be done, but had there been a conflict with other work that arose, **was the personnel assignment adequate?**
- **Was the deck OS on patrol briefed** on which fuel tanks were to be bunkered?

(4) Why did they start bunkering work with one valve open for No.3 C, even though No.3 C and No.4 C FO tanks were receiving tanks? (Reasons given below; see "General procedures when receiving the same type of fuel into more than two tanks."). Are there any factors in the procedure for opening or closing the relevant valves that could cause errors?

② Human error regarding status monitoring during bunkering work

The following four factors inviting human error have been introduced in several Loss Prevention Bulletins. In this guide, we will formulate an analysis applying these to the 12 Human Characteristics (Figure 16).

= Causes Which Invite Human Error =

1. **Common characteristics of highly skilled technicians**
2. **12 Human Characteristics**
3. **Four Psychological Factors**
4. **Human brain capacity and optical illusions**

Twelve human characteristics

1. Human beings sometimes make mistakes
2. Human beings are sometimes careless
3. Human beings sometimes forget
4. Human beings sometimes do not notice
5. Human beings have moments of inattention
6. Human beings sometimes are able to see or think about only one thing at a time
7. Human beings are sometimes in a hurry
8. Human beings sometimes become emotional
9. Human beings sometimes make assumptions
10. Human beings are sometimes lazy
11. Human beings sometimes panic
12. Human beings sometimes transgress when no one is looking

Figure 16: 12 Human Characteristics

(1) Did the person in charge keep checking all FO tank levels and continue to monitor tank level changes? If not, ② Human beings are sometimes careless, ③ Human beings sometimes forget and ⑩ Human beings are sometimes lazy in Figure 16 will be applicable.

(2) Had sounding measuring tape been used for level checking periodically as well as remote liquid level gauges?

④ Human beings sometimes do not notice, ⑥ Human beings are sometimes only able to see or think about one thing at a time, ⑨ Human beings sometimes make assumptions, and ⑩ Human beings are sometimes lazy are applicable.

(3) Is the indicated oil transfer rate (121 m^3 /h) adequate?

Because we have not been able to examine the diameter of the pipes in the Vessel's bunkering lines, we cannot judge whether the oil transfer speed was reasonable or not, but the author would like to know whether the person in charge was in a hurry to get the job done as quickly as possible. ⑦ Human beings are sometimes in a hurry will be applicable.

(4) Had crew on duty checked the venting of all fuel tanks for air escape? ③ Human beings sometimes forget, ④ Human beings sometimes do not notice, and ⑩ Human beings are sometimes lazy will apply.

Photograph 20: Tank Sounding

③ General procedures when receiving the same type of fuel into more than two tanks

The author surveyed the relevant procedures for receiving the same type of fuel in multiple tanks by more than two shipping companes in the form of interviews. This was summarised as follows:

(1) Check that all valves in the bunkering line are fully closed

In order to avoid such situations shown in the case this time, the FO and DO settling tanks should be filled at least one or two hours before the start of bunkering, and then, all valves in the fuel pipeline should be turned to "all closed" at once and checked.

(2) Lineup

According to the bunkering plan, Almost all companies used the "Line Up Form", opening the valves required for the receiving operation. The last valve to be opened should be the gate valve which is connected to the bunker hose.

(3) Topping off procedures

After the start of bunkering work, the valve opening angle and the oil transfer rate from the barge are decreased as each tank level is reached, and the valves of the tanks which have reached their levels are closed. A reasonable procedure for the order of topping off is to start with the FO tanks farthest from the manifold in turn. On the contrary, we received many comments that opening and closing the valves in the middle of the process can be dangerous.

(4) Inflow check

Immediately after the start of bunkering, all FO/DO tanks should be sounded, and not just the receiving tanks.

Also, check the air flow from all FO/DO tank air ventilations.

Sounding intervals were approximately 50/50, with some companies setting the standard and others leaving it to the Vessel. In general, most companies assigned a full engine department crew to each tank immediately after the start of sounding, and took frequent soundings, then once the amount of oil to be pumped reached a steady state, shifted from a full crew to a watchkeeping arrangement. Also, some companies ask the O/S on duty to check the air flow from the air ventilations.

4-1-5 Recurrence Preventive Measures

① Recurrence Preventive Measures submitted by Ship Management Company

Once the oil spill on deck had been recovered, the ship management company for the Vessel developed the following preventive measures.

- **Periodical sounding during bunkering**
- **Reinforcement of additional deck inspections**
- **Periodical verification of FO Filling Valve**
- **Verification of FO Filling Valve every time prior to bunkering**
- **Conduct drills against oil spills periodically**

Since then, the author heard that more specific recurrence preventive measures have been developed and not only incorporated into the SMS manuals, but that the accident summary has also been shared with other ships concerned.

② Preventive measures considered from the perspective of technological factors and human error

In addition to the above-mentioned preventive measures taken by ship management companies, we have also considered preventive measures from the perspective of technological factors and human error.

(a) Design of appropriate bunkering plan

- Planning that allows for sufficient capacity of the receiving tank and appropriate flow rate (m^3/h)
- The maximum capacity of each fuel tank was generally between 85% and 90%, with a maximum of 93%, although each shipping company had different standards. The amount of oil to be pumped per hour was basically at the ship's discretion, because the diameter of the fuel pipes on each vessel was different.

- Responsibility for bunkering operations (line changeover, work content and layout), and other specific details such as who will do what and when (timing) are to be included in the bunkering plan.
- In principle, the bunkering plan should be developed in such a way that the tank valves are not switched. If it is unavoidable, another operator (preferably an engineer) should double-check the plan.

(b) Briefing prior to carrying out of work

- Confirmation of the target liquid level of the receiving tank and the operation of the pipelines, valves, etc.
- Checking of work assignments (not only of the operator but also that of the manager).

(c) Thorough lineup

Regardless of whether multiple tanks are bunkered or not, basically, it is important to check that all relevant valves are "fully closed" before bunkering, and then to ensure thorough lineup work such as opening the necessary valves which would prevent accidental inflow into a tank that was not intended.

(d) Periodic tank level checks using sounding measuring tape

Do not rely solely on the display of the liquid level gauge, even if a console has been installed. As explained in the previous section, soundings of all fuel tanks should also be periodically carried out to ensure that there is no inflow into tanks that are not planned for bunkering.

(e) Appropriate response to irregularities and crew training

- Not only the responsible operator for the bunkering operation (Chief Engineer), but also should the operator who was previously assigned and following the plan be changed at short notice for any reason, the manager must ensure that both the operators concerned and all other personnel be re-made aware of the change of operators and the work to be carried out. If this requires a change in work procedure, it is necessary to consider stopping the bunkering at once.

- It is also necessary to educate and train the engineers and engine department crew by holding workshops on the daily work procedure manuals. In particular, in the event of crew change, a study session should be held.

(f) Aspects that the deck department should be aware of during bunkering

There is a tendency to regard bunkering work as the Engine Department's work, with only the Master and Chief Officer (C/O) taking part in the briefing, with deck crew and the Duty Officer who will actually be patrolling on deck being left in the dark. The deck officers and the deck crew should also be briefed on the bunkering work and given clear instructions. For example, the engine department may be overwhelmed with sounding work, so it is necessary to have the patrolling deck crew check the air flow from the air vent on a regular basis and report to the Chief Engineer via the duty officer. It is also necessary to establish an information sharing system.

4-2 Coastal Vessel Case

= Date, Time and Point Accident Occurs =

Date and time accident occurs:
01/MM/20YY
Point accident occurs:
Unspecified port in Japan
Ship type:
General cargo ship of 499 G/T

Photograph 21: Similar Kind of Vessel
(Not Related to the Actual Accident)

4-2-1 Accident Overview

During bunkering operations on board the Vessel, C-type fuel oil spilled from the common air vent of the Vessel's fuel oil tanks onto the deck, of which approximately 300 litres spilled into the sea. Some of the oil spilled over the oil fence boom extended around the Vessel after the accident. It was washed ashore on a nearby quay. No damage was caused to the fishing facilities.

Photograph 22: Seawall Spoilage by Oil Washed Ashore

4-2-2 Accident Treatment Expense

The following expenses have been incurred for accident treatment.

Oil spill recovery expenses	Approx. 9.3 million yen
Clean-up expenses for the seawall etc.	Approx. 9.4 million yen
Condition survey costs and others	Approx. 3.4 million yen
	Total approx. 22.1 million yen

Photograph 23: Seawall Scupper Spoilage Caused by Oil Leakage

Photograph 24: Recovery Work Using Oil Adsorbent

4-2-3 Extent of Damage

Most of the spilled oil was recovered by the evening of the day of the accident, but some was spread by the current. Later, the oil reached a seawall and the inside of a quay apron within a radius of approx. 3 km. It took 16 days to spread the oil and clean up the damaged seawall, resulting in a loss of almost the same amount as that of the first day's recovery service fee. Fortunately, fishing facilities were not damaged.

Photograph 25: Agitation Process

Photograph 26: Spilled Oil on Sea Surface

Photograph 27: Quay Wall Spoilage

4-2-4 What Caused the Accident?

At approximately 07:00 on 01/MM/20YY, the Vessel was docked at a public quay in an unspecified port of Japan on the port side for discharging. Then at approximately 09:00 the barge came alongside the starboard side of the Vessel and started bunkering work with 55 KL of C-type fuel oil at 09:10. Later, at approximately 09:50, the starboard No.1 FO (on the starboard side) tank overflowed and the spilled oil flowed into the "overflow tank (capacity 500 L)", which was also full. Eventually, 2,450 L of fuel oil spilled on deck via common air ventilation.

Later on, when calculating the oil transfer speed, it showed that there was a continuous spill from the air ventilation onto the deck for approximately 2 minutes and 40 seconds. Because the deck scuppers were inadequately set, approximately 300 litres of the oil spilled overboard.

= Planned Quantity for Bunkering =

The planned amount for bunkering is shown in Table 6: a total of 55 KL of C-type fuel oil. The planned quantity for bunkering in No.1 FO Tank (on the port side) was 27 KL of C-type fuel oil first, followed by the remaining 28 KL in No.1 FO Tank (on the starboard side). After the bunkering of C-type fuel oil was completed, the tank was to receive 15 KL of A-type fuel oil.

Planned Quantity for Bunkering

<table>
<tr><th>Oil type</th><th>Amount</th><th>Receiving tank</th><th>Remarks</th></tr>
<tr><td rowspan="2">A-type fuel oil</td><td rowspan="2">15 KL</td><td>No.2 DO Tank(P)</td><td rowspan="2">Amount to be received for each tank is unknown</td></tr>
<tr><td>No.2 DO Tank(S)</td></tr>
<tr><td rowspan="2">C-type fuel oil</td><td>27 KL</td><td>No.1 FO Tank(P)</td><td></td></tr>
<tr><td>28 KL</td><td>No.1 FO Tank(S)</td><td></td></tr>
</table>

Table 6: Planned Quantity for Bunkering

Table 7 shows the timeline of events leading up to the accident.

＝Timeline of Events Leading up to the Accident＝

Date	Time	Work undertaken
Day 1	09:00	The bunker barge came alongside the starboard side of the Vessel.
	09:10	Started pumping FO (C-type fuel oil). Started receiving into No.1 FO Tank (P).
	09:30	Received a message from bunker barge that pumping of 27 KL of oil was complete. It was planned that 27 KL be received in No.1 FO Tank (P), but approximately 8 KL of FO flowed into No.1 FO Tank (S) as the filling valve was slightly open. Closed filling valve No.1 FO Tank (P) and opened filling valve No.1 FO Tank (S). At this point, as No.1 FO Tank (S) contained 19 KL of FO, there was only 26 KL of extra space remaining. A further 28 KL was added to that, so a total of 2 KL overflowed.
	09:50	Received a message from bunker barge that pumping of 55 KL of FO (C-type fuel oil) was complete. Received a report from the duty officer that there was a leak on deck. The department issued an alert and started recovering oil spillage on deck.
	10:10	Started pumping DO (A-type fuel oil).
	10:20	Confirmed that it had spilled overboard. And notified it to the coast guard headquarters. Started pumping DO (A-type fuel oil); received 10 KL of bunkering oil until stoppage, instead of the planned 15 KL).
	12:00	The first oil recovery workboat arrived at the site and started recovery work.
	13:00	Coast Guard officers boarded to start interviewing related parties about the spill. Workboat arranged by the Fire Department arrived at the site. Instructed by the Coast Guard to recover as much spillage as possible; to then move on to the agitation process.
	19:00	After sunset, when it was dark, recovery work was complete.
Day 2	06:00	An oil recovery vessel and a patrol boat from the Coast Guard Headquarters arrived at the site. As the oil spill was found to be 200m in circumference, the agitation process was started.　Another two workboats were added.
	19:00	Completed agitation work

Date	Time	Work undertaken
Day 3	06:00	Started clean-up of drifted oil spill left behind on surrounding quays
	19:00	Completed the above work; recovery and clean-up work was now complete.
Day 4	08:00	Following a report that drifted oil spill remained on the surrounding quays, the clean-up operation was restarted.
	17:00	Also, as a thin oil film was observed on the sea surface, the workboat agitation process was restarted.
Day 5	08:00	Continued cleaning work on the surrounding quays where the oil spill had drifted with it being left behind.
	17:00	Also, as a thin oil film was observed on the sea surface, the workboat agitation process was continued.
Day 6	08:00	Continued cleaning work on the surrounding quays where the oil spill had drifted with it being left behind.
	17:00	No more thin oil slick was found on the sea surface, and the agitation process by the workboat was complete.
Days 6 ～ 16		Continued cleaning work on the surrounding quays. Also, as the cleaning work caused an oil slick on the sea surface, agitation work was arranged by a workboat. Completed the operation on the 16th day following accident occurrence.

Table 7: Timeline of Events Leading up to the Accident

In the 40 minutes between 09:10 and 09:50, pumping of 55 KL of FO (C-type fuel oil) was complete. Then, at 09:50, the C/E received a report from the duty officer that there was a leak on deck and "Emergency Station" was issued by the Master. However, at 10:10, the C/E started pumping DO (A-type fuel oil) .

At the point when 10 KL of A-type fuel oil had been pumped, it was confirmed that C-type fuel oil had spilled overboard, and the emergency stop for bunkering had been initiated and the nearest Coast Guard Headquarters alerted. At 12:00, the first oil recovery workboat arrived at the site and started recovery work immediately.

Meanwhile, at 13:00, Coast Guard officers boarded to start investigating and interviewing related parties about the spill. They were instructed to recover as much oil as possible and to carry out agitation of any oil that had spread to the sea surface which could not be recovered.

The oil spill on the deck was recovered on the same day, but it had spread unexpectedly over a large area of the sea surface, contaminating the seawall and quay and penetrating deep into the quay apron, requiring about 16 days for cleaning and agitation processing.

= Estimated Amount of Overboard Discharge =

The total amount of fuel oil spilled overboard was estimated to be approximately 0.3 KL (300 L), calculated from the amount of residual oil before bunkering started, another amount of residual oil after bunkering stopped, the amount of overboard discharge collected from the deck and amount of oil transfer declared by the barge. (Please see Table 63 for details.)

Unit : m^3

<table>
<tr><th>FOT No.</th><th>Tank Volume (AA)</th><th>Residual Oil Amount before Bunkering (BB)</th><th>Extra Space 1 - (BB)/(AA) %</th><th>Amount of Residual Oil after Pumping Stoppage (CC)</th><th colspan="2">Supply Total ((CC) − (BB))</th></tr>
<tr><td>No.1 (P)</td><td>45.00</td><td>13.00</td><td>71.1%</td><td>32.00</td><td colspan="2">19.00</td></tr>
<tr><td>No.1 (S)</td><td>45.00</td><td>11.00</td><td>75.6%</td><td>45.00</td><td colspan="2">34.00</td></tr>
<tr><td>**Total**</td><td>**90.00**</td><td>**24.00**</td><td>**73.3%**</td><td>**76.55**</td><td>**(A)**</td><td>**53.00**</td></tr>
<tr><td colspan="5">Amount of oil transferred by bunker ship</td><td>(B)</td><td>55.00</td></tr>
<tr><td colspan="5">Total oil outflow <(B) - (A)></td><td>(C)</td><td>2.00</td></tr>
<tr><td colspan="5">Amount of residual oil in Over Flow Tank</td><td>(D)</td><td>0.50</td></tr>
<tr><td colspan="5">Total of amount of oil collected from the deck and amount of oil remaining in the oil drip tray</td><td>(E)</td><td>1.20</td></tr>
<tr><td colspan="6">Amount of estimated overboard discharge <(C)-(D)-(E)></td><td>0.30</td></tr>
<tr><td colspan="6">Oil transfer speed (55 m^3 ÷ 40 mins.)</td><td>82.50 m^3 /h</td></tr>
</table>

Table 8: Calculation of Spillage Overboard Discharge

According to the bunkering plan, the Vessel was to receive 40 KL (89% full) on her port side and 39 KL (87% full) on her starboard side in FO tanks at a volume capacity of $45m^3$ at the end of bunkering, which shows that the plan itself was reasonable.

4-2-5 Accident Cause

= Direct Cause =

The original plan was to receive 27 KL of C-type fuel oil in No.1 FO Tank (on the port side) and then switch the valve to receive the remaining 28 KL in No.1 FO Tank (on the starboard side). However, the filling valve on the starboard side was open and approximately 8 KL that was supposed to go into the port tank went into the starboard tank. Without noticing this error, when a further 28 KL was added to that (into the starboard side tank), it overflowed. Figure 17 illustrates this pipeline.

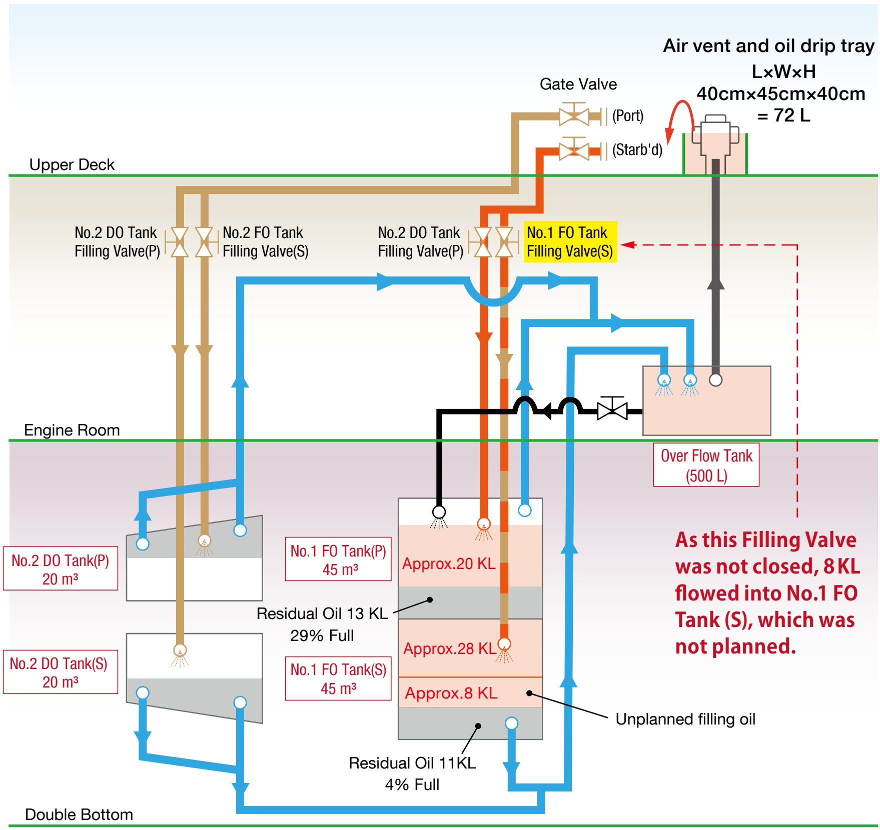


Figure 17: Pipeline for Bunkering and Arrangement of Tanks

- At 09:10, C-type fuel oil bunkering started and the No.1 FO Tank (P) with 13 KL of residual oil started receiving 27 KL as originally planned.
- However, as Filling Valve of No.1 FO Tank (P) was not fully closed, some of the pumped C-type fuel oil (7-8 KL) flowed into No.1 FO Tank (S) with residual oil at 11 KL.
- At 09:30, the Chief Engineer received a report from the barge that 27 KL had been pumped and assumed that the total amount of oil had been pumped to No.1 FO Tank (P) as scheduled. So he did not carry out confirmation sounding. After opening the filling valve of No.1 FO Tank (S) and closing the filling valve of No.1 FO Tank (P), starting to receive the remaining 28KL.

  However, at this point, No.1 FO Tank (S) contains a total of 19 KL of C-type fuel oil, and if an additional 28 KL were to be loaded into the tank (the 45m³ capacity), it would overflow by 2 KL.
- Of this overflow of 2 KL (2,000 L), 500 L remained in the overflow tank (500 L capacity), but ultimately 2,000 L spilled from the common air vent.
- The remaining 1,500 L on deck was eventually recovered, but 300 L via the scuppers spilled overboard.
- At 09:50, the bunker barge reported to the Vessel that it has finished pumping 55 KL as planned, but based on the oil transfer speed (82.5 m3/h), it takes about 1 minute and 27 seconds for 2,000 L to flow out, so we can estimate that the spill started around 09:48. For less than two minutes, it was assumed that no one noticed the leak.

= Why Was the No.1 FO Tank (S) Filling Valve, Which Was Not Planned for Bunkering, Open? =

The Vessel's crew member testified: “I thought all the filling valves were closed after the last bunkering work, so I don't know why they were slightly open.” (Tentative translation.)

It is unknown whether the closed valves were opened by vibration during navigation, or whether the crew had made sure that they were closed after the last bunkering operation. In addition, the valves were not tightened to prevent them from opening accidentally.

= Accident Cause From the Perspective of Human Error =

As in Accident Case of Oceangoing Vessel, the analysis of "...must have..." or "...should have..." is a hindsight bias assessment and therefore not an accident prevention measure. However, as a result of the lack of these measures, a chain of human errors occurred, which could not be broken, leading to an accident. Bearing this in mind, let's consider the causes of the accident by applying Figure 16: 12 Human Characteristics on page 52 to see what human errors occurred.

(1) Soundings had not been conducted

If the crew had carried out soundings of all fuel tanks, including the overflow tank, it would have been discovered that the first receiving tank did not contain the expected amount of C-type fuel oil and that the No. 1 FO Tank (S) was inadvertently filled.

The chief engineer (C/E), who was in charge of the main liquid line for bunkering work, testified that soundings had been carried out only before and after the start of bunkering in the past, and that no regular soundings had been conducted during bunkering. Therefore, the barge report was taken into account even when bunkering multiple tanks. When comparing this with the 12 Human characteristics, ③ Human beings sometimes forget, ⑨ Human beings sometimes make assumptions, and ⑩ Human beings are sometimes lazy will be applicable.

(2) Failure to take immediate action against the oil spill

At 09:50, the duty officer reported an oil leak on deck, but it was assumed that there was no overboard spill, and continued bunkering A-type fuel oil. If the emergency stop for bunkering had been initiated immediately, the spill overboard would not have occurred. Human characteristics such as ① Human beings sometimes make mistakes (i.e. emergency response procedures in this case), ② Human beings are sometimes careless, ⑦ Human beings are sometimes in a hurry, and ⑨ Human beings sometimes make assumptions will be applicable.

(3) Has there been sufficient safety and environmental awareness on the part of the management (Master on the Vessel, Chief Engineer and/or the company's Operations Manager)? Also, did the crew members follow a bunkering plan and procedure manual, or hold a briefing to confirm role assignment?

The estimated time needed to detect an oil spill is less than two minutes from the start. It was not possible to find out how many crew members were on board, but it appears that there was no clear role assignment between the duty officer and the Master during the bunkering planning and actual bunkering. Human Characteristics ③ Human beings sometimes forget, ⑥ Human beings are sometimes only able to see or think about one thing at a time, and ⑩ Human beings are sometimes lazy are applicable.

(4) Scuppers were not secured appropriately

The oil spilled overboard was via the scuppers. With 2,450 L of fuel oil spilled on deck, it may have gone over the gangway, but if the scuppers had been secured, the amount of the spilled overboard could have been much less. Human characteristics such as ④ Human beings sometimes do not notice and ⑤ Human beings have moments of inattention will be applicable.

(5) The bunkering valves were not checked to confirm if they were fully closed prior to start of bunkering and lineup work had not been completed. Also, why was it decided to top off the fuel tanks one by one?

As a basic part of bunkering work, checking that the bunkering valves are closed before starting work and subsequent lineup work had not been carried out. In the case of the Vessel, the number of fuel oil tanks is four, even including the gate valve on each side (total is 2), so that in total there are only six valves to be checked that they are fully closed and two filling valves on the No. 1 FO Tank (P/S) to be opened. Human characteristics such as ⑦ Human beings are sometimes in a hurry, and ⑩

Human beings are sometimes lazy will be applicable.

As for receiving the same type of fuel in multiple tanks, in order to achieve a time-staggered topping off procedure, the inflow rate must be regulated by adjusting the valve openings, and soundings must be carried out periodically. In order to minimize time and effort, it has become routine to rely solely on bunker barge reports regarding the amount of oil to be pumped without further soundings, and when this has not caused any accidents, it seems that this method would make life easier. Human characteristics such as ③ Human beings sometimes forget, ⑨ Human beings sometimes make assumptions, and ⑩ Human beings are sometimes lazy will be applicable.

(6) Did not a liquid level alarm of the Overflow Tank sound?

Some vessels' overflow tanks are equipped with "liquid level alarm devices" and others are not, but in general most tanks are installed with liquid level alarm devices. It was not possible to confirm whether or not the Vessel's overflow tank had this device installed, but if it did the alarm did not sound, this could be due to poor maintenance, human-caused cutting of the alarm or failure to test that the alarm was functioning properly, ② Human beings are sometimes careless, ③ Human beings sometimes forget, and ⑤ Human beings have moments of inattention will be applied.

4-2-6 Recurrence Preventive Measures

The same six measures discussed in 4-1-5 "② Recurrence Preventive Measures considered from the perspective of technical factors and human error" are listed below. For details, please refer to the same section.

(a) Development of an appropriate bunkering plan

In the case of coastal vessels, this may be seen as a regular and frequent task, but it is essential that the company's management is actively involved in the vessel's bunkering plan, rather than leaving it to the vessel.

(b) Briefing prior to carrying out of work

For this Vessel's size, even with around six or seven crew, it is important that time is allotted for all crew to have a briefing prior to the carrying out of work.

(c) Thorough lineup

The basics are to be adhered to. By eliminating assumptions (e.g. other Filling Valves should be closed), and encouraging crew to suspect they may be open, it will become necessary to carry out checks.

(d) Periodic tank level checks using sounding measuring tape

Reports from remote liquid level gauges and bunker barges are not to be overly relied upon, but thoroughly double-checked.

(e) Appropriate response to irregularities and crew training

Regarding the spillage this time, despite the fact that the duty officer had reported a leakage, the pumping of DO (A-type fuel oil) was started. It is essential to be aware that an oil spill will always lead to a marine pollution incident and that an emergency response will be necessary.

(f) Aspects that the deck department should be aware of during bunkering

There may be few crew onboard, therefore, it is crucial that the role of each crew member is checked.

= Technological Recurrence Prevention Countermeasures =

The common root cause of the spillage of both cases is that prior to bunkering, all valves in the fuel system had not been checked to find out if they had been “closed”, and that the sounding of tanks that had not been bunkered had not been carried out. Thus, to return to basics, it is necessary to check the position of the valves.

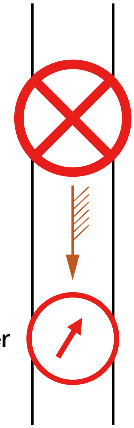


Figure 18: Technological Countermeasures (Flow Meter)

However, could it not be that where the Filling Valves of each fuel tank are lined up in the engine room, a removable flow meter can be installed to visually check as to whether fuel oil is flowing through the pipes? If it had been visible that fuel oil was flowing into an unscheduled tank, the anomaly might have been noticed at that point.

More recently, a “collapsible oil spill prevention device” (Photograph 28) has been fitted to air vents to allow air from the air vent to inflate balloons in the event of an unscheduled influx of fuel oil into the tank. These are also available on the market and can be used as necessary.

Photograph 28: Overflow Tank (Collapsible Fuel Oil Overflow Prevention Tank)
Provided by NATIONAL MARINE PLASTIC.CO,LTD.

§5 Conclusion

Just as was discussed in Chapter 1 (accident statistics for coastal and oceangoing vessels) most oil spills reported to this Club are caused during bunkering operations. If an oil spill occurs, regardless of amount spilled, be it small or large, treatment takes many man-hours and incurs a tremendous amount of expense.

As we can see in the above accident case examples, the route cause is down to a chain of human errors. To prevent this from leading to an accident, this chain must be broken. We hope that it is understood that there are a number of opportunities that we can all take advantage of.

In addition, although each company's ISM code and SMS manuals always incorporate measures and procedures to prevent recurrence as shown in the above accident examples, the failure of the crew to follow them in the accident analysis is almost always the apparent cause. However, despite the fact that crew should also be well aware of this, there are numerous examples that show that they failed to carry out their duties in accordance with the operation manual.

Some cases may state that this is easily resolved through thorough crew training, but in practice this is very difficult. However, since this must not be abandoned, repeated explanations, guidance and training will be required, which should not only be left to the Vessel's Master and Chief Engineer, but also require the active involvement of the company's administration.

In the unfortunate event that oil is spilt overboard, in order to mitigate any damage as much as is possible, keeping the area of spreading to an absolute minimum will be crucial. Also, because it is almost impossible to stop the spread of oil spills at sea with the oil treatment equipment available on board, the key is to start the recovery operation as soon as possible. Although this was not introduced above as an example, there have been a few cases where the cost of arranging a recovery service was a concern, which led to the arrangement of a more geographically remote recovery service, which delayed the start of the recovery process and resulted in the spread of the spillage over a wide area, making it more expensive than it should have been.

We believe that spills during bunkering operations are accidents that can be prevented by sticking to the basics and by raising the safety and environmental awareness of the crew. We hope that this Loss Prevention Bulletin can be of assistance in any way.

Acknowledgement of Provided References and Materials

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・The Japan Association of Marine Safety (JAMS) Journal (2017 Spring Edition No. 572)

・Idemitsu Kosan Co., Ltd.

Acknowledgement of Provided References and Materials

・Photograph 27: Oil Recovery and Water Surface Cleaning Ship, Beikurin (Bay-clean) (From the website of the Chiba Port Office, Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism)

・Mitsui Chemicals, Inc.

・ANANDENKI CO., LTD

・NATIONAL MARINE PLASTIC.CO,LTD.

P.40 Answer to Quiz

① Hole rupture just above sea surface

The oil loaded above the lower edge of the hole rupture (grey area) spills momentarily.

Thereafter, a small amount of oil may be spilled due to the ship's pitching and rolling, but this will not be a continuous spill. However, it is ideal to carry out shift and gas release of as much of the cargo oil as possible in the tanks where a hole rupture has occurred, in case of spills or repairs due to the ship's pitching and rolling or changing conditions. If other cargo tanks are fully loaded or ship-to-ship cargo transfer is not possible, as an emergency measure, shift it to other tanks in so far as oil will not breach the tank.

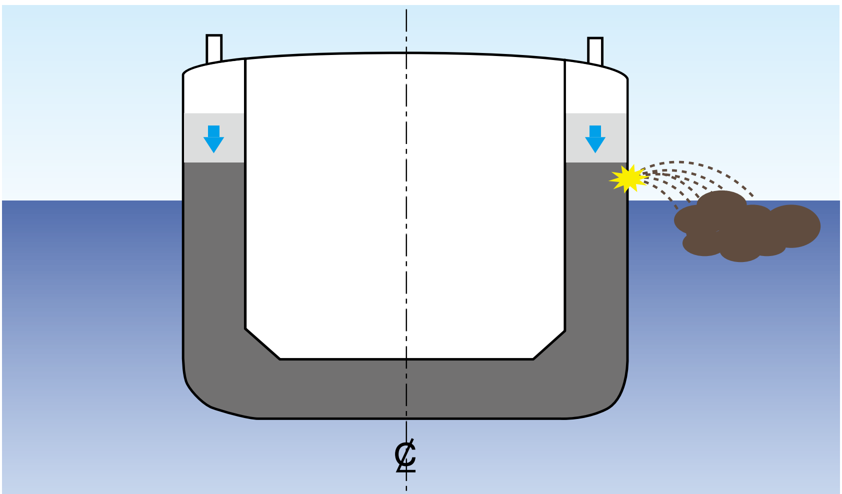

Figure 19: Hole Rupture Just above Sea Surface

② Hole rupture on sea surface

Firstly, as in ①, the oil above the surface of the water spills momentarily. Then, due to the relationship between the specific gravity of water and oil (displacement), seawater infiltrates from the hole rupture and gradually accumulates at the bottom of the tank, and the oil is pushed out because of the inflow that it continues to flow out in turn and is replaced by seawater up to the hole rupture.

In the event of grounding, the water level will be lowered by the change in tidal current or, if Deballasting is carried out to reduce the draft, the oil level will be raised above the water level by that amount. It is important to understand that this will lead to a continuous oil spill.

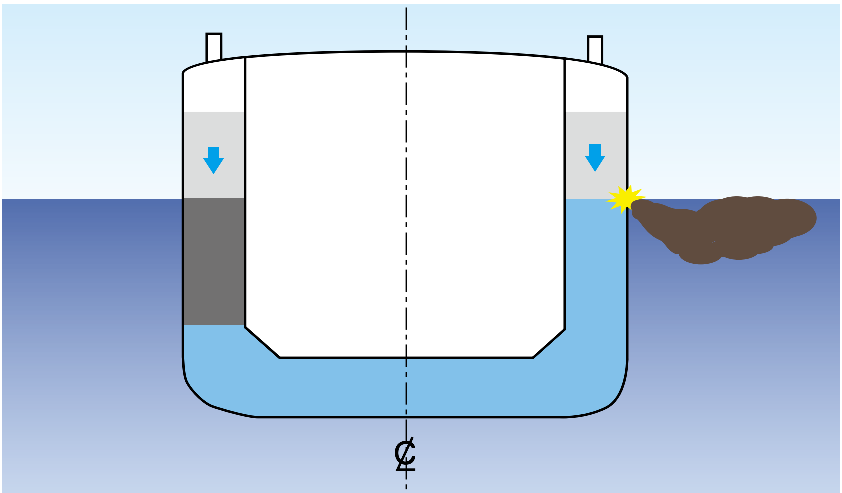

Figure 20: Hole Rupture on Sea Surface

③ Hole rupture just below sea surface

Firstly, as in ①, the oil above the surface of the water spills momentarily. Then, similar to ②, due to the relationship between the specific gravity of water and oil (displacement), seawater infiltrates from the hole rupture and gradually accumulates at the bottom of the tank, and the oil is pushed out because of the inflow that it continues to flow out in turn and is replaced by seawater up to the hole rupture.

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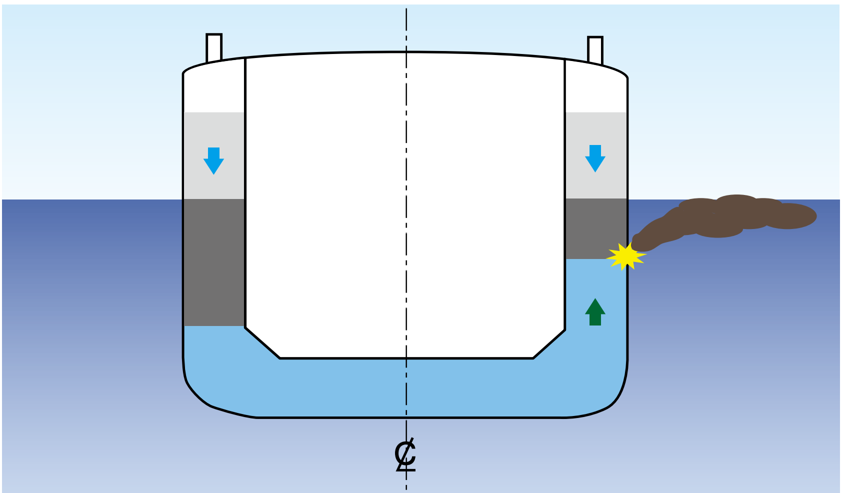


Figure 21: Hole Rupture Just below Sea Surface

④ Hole rupture to ship's bottom

Similar to ①, the oil above the surface of the water spills momentarily. Then, the spill will stop when the pressure of the oil at the bottom of the tank is equal to the pressure at the bottom of the ship. Not only because the specific gravity of oil is smaller than that of seawater, but because the pressure from the surface of the water to the bottom of the ship is lower than the water pressure at the bottom of the ship, the seawater floods into the tank through the hole rupture.
(For example, if the draft is 10m and the specific gravity of theseawater is 1.025, the water pressure is 1.025kg/cm^2. On the other hand, because the specific gravity of C-type fuel oil is about 0.998, and the pressure at the bottom of the ship iso.998 kg/cm2, seawater will enter through the hole rupture, until this pressure difference is eliminated.) Similar to ③, if the oil level rises above the surface of the water due to draft or discharging quantity adjustments, the hole rupture in the ship's bottom will cause a mixture of seawater and oil to spill. Care should be taken to avoid this.

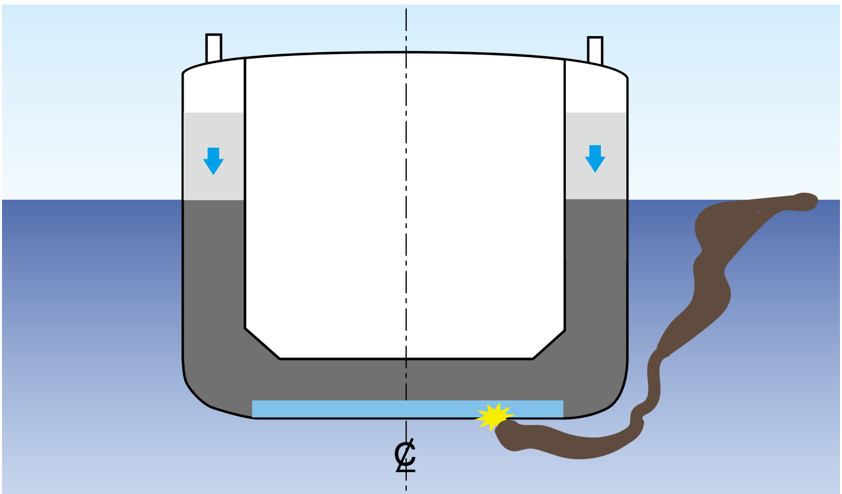


Figure 22: Hole Rupture to Ship's Bottom

⑤ Hole Rupture to ship's bottom of a common double-bottom fuel oil tank

Each company has its own ISM code, SMS manual (Safety Management System) and internal regulations which determine the maximum amount of fuel that can be accepted in a fuel oil tank, but generally in most cases, it is between 85% and 90% of the tank capacity. This means that no more up to the air ventilation can be filled with fuel. Figure: 23(1))

In the event of a hole rupture in a double bottom fuel tank, due to groundings etc., the water pressure in the bottom of the tank will push the fuel oil up to the level of the vent line, which will in turn be flooded by seawater. Figure: 71(2)) However, the fuel in the tank is unlikely to spill.

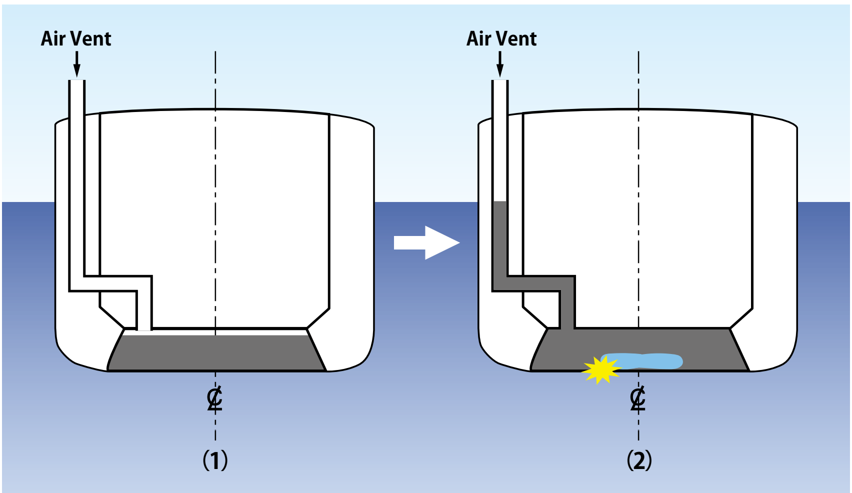


Figure 23: Hole Rupture to Ship's Bottom of a Common Double-Bottom Fuel Oil Tank

⑥ Hole rupture to ship's bottom due to internal pressure on the tank

Currently, there are no tankers with a single hull, only those with double hulls. However, suppose that a hole rupture is made in the bottom of the ship, in the case of a tanker with a single hull as shown in Figure 72, and internal pressure is applied. With a draught of 10m, the water pressure at the bottom of the ship is 1.025 kg/cm^2. In the event of a hole rupture here, depending on the specific gravity of the oil, the cargo oil will be pushed out until the pressure on the bottom of the ship is equal to the water pressure.

Except in the ① event of a hole rupture just above sea surface, the residual oil in the tank shall be shifted in order to prevent a continuous oil spill. However, even if a transfer pump is used for fuel oil, or a cargo pump for tankers, the suction is located close to the bottom of the tank. If the hole rupture is large, only flooded seawater is sucked in, which makes it difficult to shift the oil. This will be time-consuming, but requires a flexible response to the situation, such as using a portable pump to suck up the oil from near the surface and shift it.

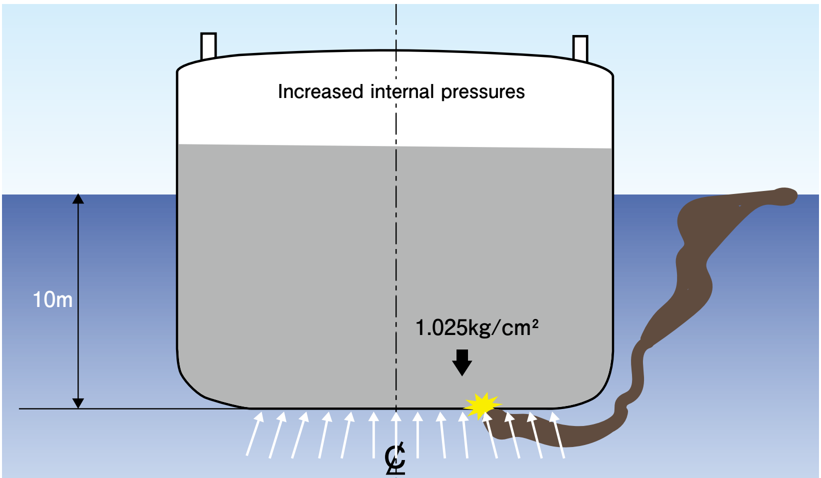


Figure 24: Hole Rupture to Ship's Bottom of a Single Hull Tanker

Depending on the location of the hole rupture, it should be understood that different measures need to be taken. It is important to assess the situation and conditions properly and take the appropriate measures in accordance based on them.

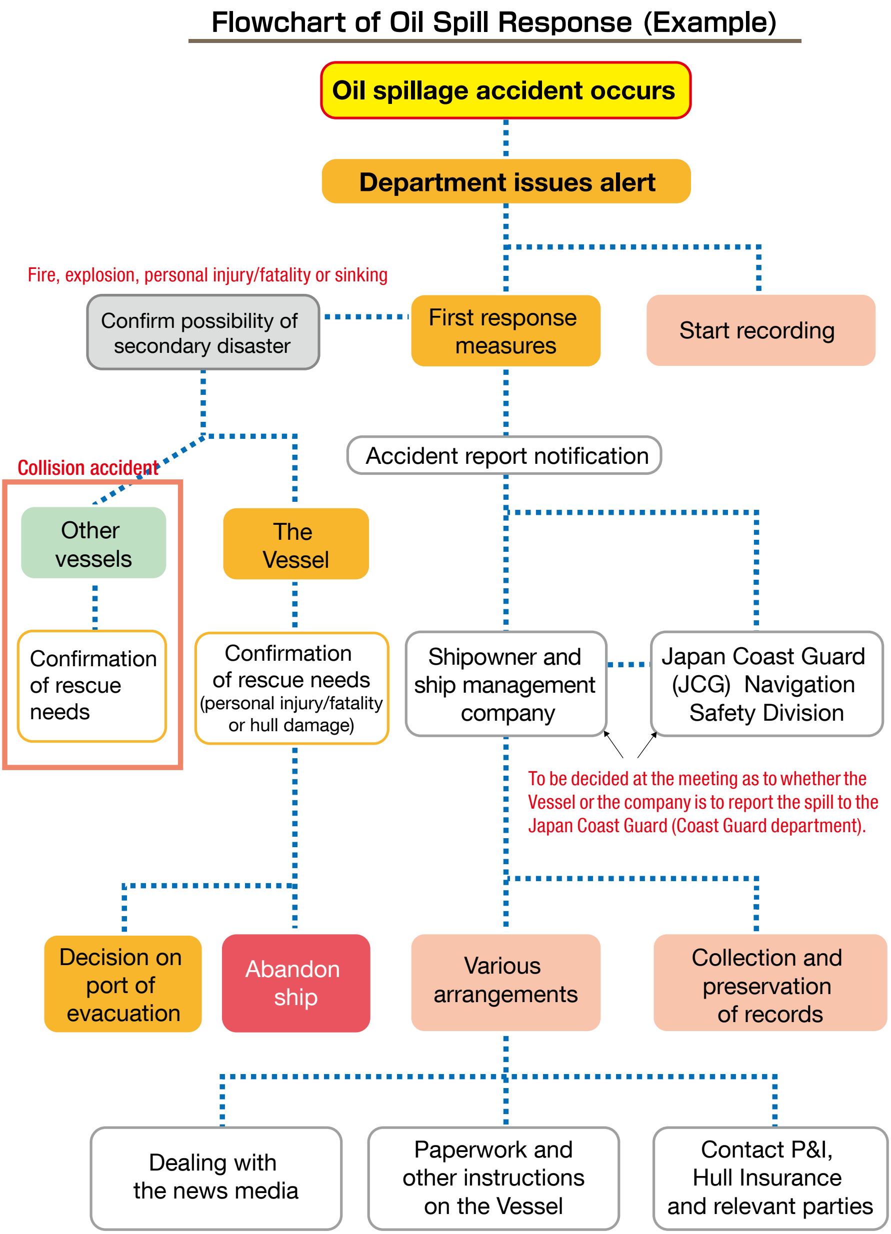
Attachment 1: Oil Recovery Procedure by Oil Type

(Modified from the management manual from "Umi" & "Nagisa" Foundation)

Point oil spill occurs	Oil type	Preventive objective	Procedure	Necessary materials	Damage expected	Remarks
In port	A-type fuel oil	Recovery/ spreading	A, B	Oil fence boom and absorbent boom	Port closure, spoilage of water intakes, etc.	Spreads to form a thin oil film
	C-type fuel oil	Recovery	A, B, C	Oil fence boom, absorbent boom, and powerful suction trucks	Port closure, spoilage of water intakes, etc.	Use of absorbents for high viscous oils, emulsions
	Emulsion	Recovery	A, B	Oil fence boom and absorbent boom		Use of absorbents for high viscous oils, or snares (see photograph)
	Petrol	Monitoring and evacuation		Powder gelling agent	Fire, explosions and loss of life	Preventing the spread of secondary damage
	Chemicals	Investigation and confirmation	Instructions from expert	Powder gelling agent	Differ depending on type of chemical	Always consult an expert as treatment will vary depending on type
	Liquefied gas	Monitoring and evacuation			Fire, explosions and loss of life	LNG and LPG
Outside of port	A-type fuel oil	Recovery/ dispersion	A, B, D	Oil fence boom, absorbent boom, oil recovery vessels and oil treatment agents	Destruction of fisheries, tourism, and the natural environment	
	C-type fuel oil	Recovery/ dispersion	A, B, D	Oil fence boom, absorbent boom and oil treatment agents	Destruction of fisheries, tourism, and the natural environment	
	Emulsion	Recovery	A, B	Oil fence boom, absorbent boom and oil recovery system	Destruction of fisheries, tourism, and the natural environment	
	Petrol	Monitoring and evacuation			Fire, explosions and loss of life	Preventing the spread of secondary damage, natural evaporation
	Crude oil	Recovery/ dispersion	A, B, D	Oil fence boom, oil recovery vessels and oil recovery system	Destruction of fisheries, tourism, and the natural environment; fire, explosions and loss of life	Initially there is a crude gas hazard, then emulsions form
	Chemicals	Investigation and confirmation	Instructions from expert		Differ depending on type of chemical	Always consult an expert as treatment will vary depending on type
	Liquefied gas	Monitoring and evacuation			Fire, explosions and loss of life	LNG and LPG

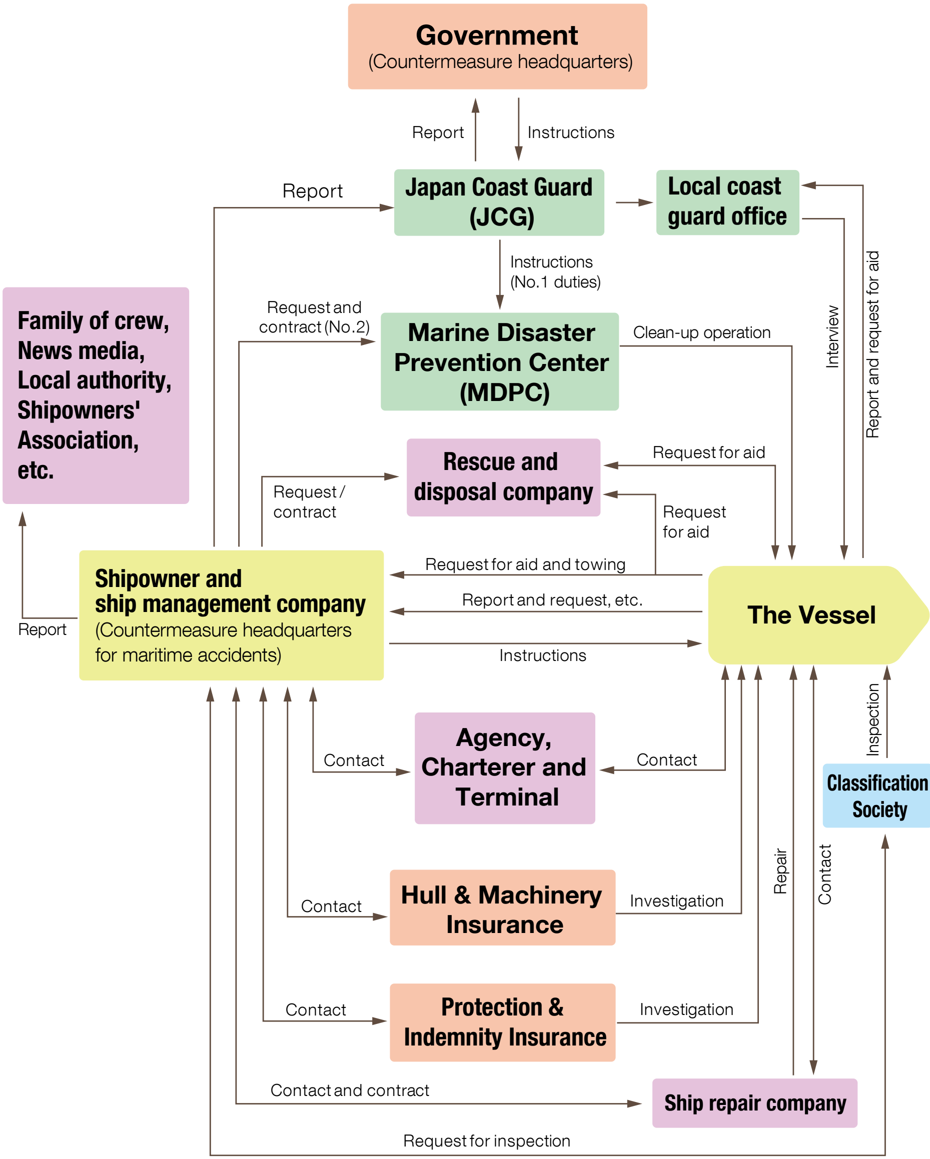
Procedure
A: In the case of large quantities, oil is to be recovered with oil fence booms and then recovered by an oil recovery vessel or powerful suction trucks, etc. Or, the oil can be absorbed using an oil absorbent. For small quantities, use oil absorbent.
B: For small quantities, the oil is to be surrounded by an absorbent boom (oil fence, string of flags-type, rolls, etc.) and then wrung and recovered by suction.
C: In the case of large quantities, oil is to be collected with oil fence booms and then recovered by powerful suction trucks.
D: Direct spraying and dispersal with oil treatment agents (for vessel and aircraft).

Attachment 2: Flowchart of Oil Spill Response (Example)



Attachment 3: Response Framework to Major Oil Pollution Incidents in Japan (Organisation Chart)

Response Framework to Major Oil Pollution Incidents in Japan (Organisation Chart)



Attachment 4: Oil Spill Report Form: Sample

Ref. No.

To

Frm	Name of Company	Title	Name	Address
	Report No.	Date and Time	JST/UTC	

Oil Spill Report Form

1	Ship's Name & Port of Register	Ship's Name			Port of Register			
2	Ship's Type & Gross Tonnage	Ship's Type			G/T			
3	Name of Owner (Person in Charge), Address	Owner's Name		Person in Charge		Address	Tel	
							E-Mail	
4	Name of Ship Management Co. (Person in Charge), Address	Ship Management Co.		Person in Charge		Address	Tel	
							E-Mail	
5	Name of Master & Chief Engineer	Master		Chief Engineer		Address	Tel	
							E-Mail	
6	Date & Time of occurrence	Date		JST/UTC		Time		
7	Place of occurrence	Port/Berth No.						
		Target Name				Bearing/Distance		
		Lat./Long.						
8	Presence or absence of imminent risk	Crew	Yes / No		Need for Rescue	Yes / No		
		Ship	Yes / No		Need for Rescue	Yes / No		
9	Ship's Draft (Before accident)	Fore Draft	m		Aft. Draft	m		
10	Port of Departure/Next Port							
11	Type of Spilled Oil (Fuel/Lub. Oil/Cargo)							
12	Cause of Oil Spill	Collision / Grounding / Over flow at Bunlering / Cargo Oil Spill / Others ( )						
13	Outflow to the Sea	Yes・No		Is "Outflow to the sea ongoing ?		Yes・No		
14	Process leading to the overflow							
15	Outflow point of the ship's hull							
16	Outflow situation (Size of hole and etc.)							
17	Quantity of estimated overflow							
18	Oil details	(1)						
		(2)						
		(3)						
19	Situation of overflow to the sea	Length		Weather & Sea Condition	Wind (Direction/Force)			
		Width			Wave height			
		Direction			Swell (Direction/Height)			
		Oil film concentration			Tidal situation (Direction/Speed)			
20	Surrounding conditions (fishing facilities, entertainment facilities, etc.)							
21	Outflow prevention measures taken							
22	Need for external assistance	Yes / No						
23	Others							

JAPAN P&I CLUB
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Website	www.piclub.or.jp/en/

Principal Office (Tokyo)	2-15-14, Nihonbashi-Ningyocho Chuo-ku, Tokyo 103-0013, Japan Phone: 81-3-3662-7272 Fax: 81-3-3662-7107
Kobe Branch	6th Floor Shosen-Mitsui Bldg. 5, Kaigandori Chuo-ku, Kobe, Hyogo 650-0024, Japan Phone: 81-78-321-6886 Fax: 81-78-332-6519
Fukuoka Branch	3rd Floor Hakata-Ekimae Center Bldg., 1-14-16 Hakata Ekimae, Hakata-ku, Fukuoka, Fukuoka 812-0011, Japan Phone: 81-92-260-8945 Fax: 81-92-482-2500
Imabari Branch	5th Floor Imabari-Kitahoraicho Building, 2-2-1 Kitahoraicho, Imabari, Ehime 794-0028, Japan Phone: 81-898-33-1117 Fax: 81-898-33-1251
Singapore Branch	80 Robinson Road #14-01 Singapore 068898 Phone: 65-6224-6451 Fax: 65-6224-1476
Japan P&I Club (UK) Services Ltd	5th Floor, 38 Lombard Street, London, U.K., EC3V 9BS Phone: 44-20-7929-3633 Fax: 44-20-7929-7557

Edited by Loss Prevention and Ship Inspection Dept. Japan P&I Club