Oil spill Port of Rotterdam
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The Hague, March 2020

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Cover photo: Rotterdam Harbour Police
The Dutch Safety Board

When accidents or disasters happen, the Dutch Safety Board investigates how it was possible for these to occur, with the aim of learning lessons for the future and, ultimately, improving safety in the Netherlands. The Safety Board is independent and is free to decide which incidents to investigate. In particular, it focuses on situations in which people’s personal safety is dependent on third parties, such as the government or companies. In certain cases the Board is under an obligation to carry out an investigation. Its investigations do not address issues of blame or liability.

Dutch Safety Board

Chairman: J.R.V.A. Dijselbloem
M.B.A. van Asselt
S. Zouridis

Secretary Director: C.A.J.F. Verheij

Visiting address: Lange Voorhout 9
2514 EA The Hague
The Netherlands

Postal address: PO Box 95404
2509 CK The Hague
The Netherlands

Telephone: +31 (0)70 333 7000

Website: safetyboard.nl
E-mail: info@safetyboard.nl

N.B. This report is published in the Dutch and English language. If there is a difference in interpretation between the Dutch report and English version, the Dutch text will prevail.
On Saturday, 23 June 2018, the chemical and oil tanker Bow Jubail collided with a jetty at the company LBC Tank Terminals, in the port of Rotterdam. As a consequence of this collision, a hole was punched in the ship's skin adjacent to the single-walled fuel tank, through which a total of 217.4 tonnes of heavy fuel oil poured into the water. Because action was taken on board the Bow Jubail immediately following the collision, to pump oil from the damaged fuel tank, the escape of around 20 tonnes of oil was prevented.

Following the collision, part of the spilled oil remained in the Petroleumhaven, while due to tidal influence, another part was transported along the river, towards the sea. As a consequence of the spill, in particular the Petroleumhaven and the Geulhaven became heavily contaminated. This also had consequences for the flora and fauna in the port, as visibly evidenced by hundreds of oiled seabirds. Preparations were made to shut down the companies in the port. This would have had considerable economic and environmental consequences, but was eventually avoided. The Dutch Safety Board observes that following the incident, the various parties involved demonstrated huge effort and commitment in managing the consequences. At the same time, it became clear that the Port of Rotterdam Authority, Rijkswaterstaat and the Rijnmond-Rotterdam Security Region were insufficiently prepared for this scenario or for a disaster on this scale.

The occurrence of the collision
The collision of the Bow Jubail was preceded by an incorrectly issued rudder command. For situations of this kind, the Bridge Resource Management (BRM) system was developed in the 1990s. The aim of BRM is to prevent accidents by training crew members in identifying the presence of latent system risks and operational hazards and irregularities (such as incorrectly issued commands). However, in this accident, BRM failed to act as a safety barrier because not all crew members had been informed of the mooring plans in advance. As a consequence, in the time remaining before the collision, the bridge team failed to recognise and put right the incorrect command.

Because the bow thruster was also forcing the front of the ship away from the jetty, the vessel collided with the jetty at an angle, stern first. In addition, the tugboat was unable to start a towing manoeuvre at the stern of the vessel in time to prevent or reduce the force of the collision. In fact, in the planning of the manoeuvre, this role had not been allocated to the tugboat. Furthermore, the type of drive system meant that the tugboat was unable to initiate a towing manoeuvre with the requisite speed after the pilot had issued this instruction, shortly before the collision occurred.

The puncturing of the fuel tank
In the collision, a combination of four factors meant that the Bow Jubail was punctured at the exact location of the single-walled fuel tank: the cargo, the water level, the angle of the collision and the shape of the vessel. The vessel was unladen and, at the moment of collision, the water level in the port was high (high tide). As a consequence, the vessel lay
higher in the water and the overhanging stern was able to swing over the jetty, where it collided with a bollard at an angle. This bollard pressed with such force that it punctured the skin, at precisely the position of the single-walled fuel tank. Because the ship’s skin also served as the outer wall of the fuel tank, the fuel tank was punctured in the collision.

The oil clean-up operation
Immediately following the reporting of the collision, the oil clean-up operation was initiated. An oil clean-up operation comprises two phases: containment (retaining) of the oil, followed by recovery. For the containment of oil in the port of Rotterdam, oil containment screens are used, drawn from what is known as the Screen Pool. The Screen Pool was activated within ten minutes of the collision. However, the screens were only able to retain part of the oil, for the following reasons:

• It was almost three hours before the screens around the Bow Jubail were fully closed. As a result, a large proportion of the oil had already spread on the outgoing current, towards the Oude Maas and the sea.
• The current meant that part of the oil floating on the surface ended up passing below the screen.
• Some of the oil sank immediately to lower water layers, where containment by screen would be completely ineffective. This oil was literally lost from view to the team responsible for the clean-up.

For the clean-up of oil, the Port of Rotterdam Authority has signed a contract with the company HEBO Maritiemservice. The first HEBO vessel started oil recovery operations almost three hours after the collision took place. HEBO eventually deployed six vessels. Rijkswaterstaat was also requested to deliver capacity for the oil clean-up operation. Eventually, two vessels were made available through a contracted party, one of which was deployed for the clean-up. Despite the deployment from the Screen Pool and the clean-up of the oil by HEBO and Rijkswaterstaat, it became clear the next morning that oil had contaminated the vessels, jetties and banks of the 3rd Petroleumhaven and the Geulhaven.

Crisis management
Following the collision involving the Bow Jubail, two separate reports were made, in short succession. In response, crisis management was activated within a few minutes. Fifteen minutes after the collision, the Duty Officer at the Rotterdam Harbour Master’s Division (DHMR) escalated the operation to GRIP-1. A further forty-five minutes later, the operation was escalated to GRIP-2, when it became clear that the spilled oil was expected to spread into the river. The participants at the Incident Location Command Centre (CoPI) that was established in response to GRIP-1, and the Regional Operational Team (ROT) established in response to GRIP-2, divided the tasks between them. The CoPI focused on the source area around the vessel while the ROT tackled the wider surroundings. The CoPI consisted of participants from the Rijnmond-Rotterdam Security Region, the Fire Brigade, Rijkswaterstaat, the Port of Rotterdam Authority, the police and the DCMR Environmental Service Rijnmond (DCMR). The ROT included representatives from the Security Region, the Port of Rotterdam Authority, DCMR and Rijkswaterstaat (RWS).
During the initial phase of the crisis management operation, essential information was clearly lacking. There was no direct contact with the vessel, and it took one and three-quarter hours before a clear picture of the scope of the spill emerged. There was also no understanding of the physical and mental condition of the persons on board the Bow Jubail. Aerial images and sound recordings were also lacking, as were accurate spread predictions. As a result, the parties were unaware of the precise rate at which the oil was spreading. Once it became clear that the oil had spread far downriver, the focus was shifted from oil clean-up to oil recovery. Although this operation was started quickly, the equipment contracted by DHMR was insufficient for an oil leak of this size. It took a great deal of time for additional recovery equipment to be provided through RWS.

Cooperation
The Rijnmond-Rotterdam Security Region, the Port Authority and Rijkswaterstaat all have statutory tasks to fulfil in the event of oil pollution on the water: Rijkswaterstaat as water quality manager, the Port Authority as nautical manager in the port and the Rijnmond-Rotterdam Security Region as the body responsible for disaster management and crisis management. The majority of operational tasks in any oil clean-up operation are the responsibility of the Port Authority. This incident revealed that the Port Authority does not have sufficient resources or knowledge to effectively deal with an oil spill on this scale. This makes cooperation with other parties essential. The urgent need for cooperation also applies to the Rotterdam-Rijnmond Security Region and Rijkswaterstaat, as they too lack the necessary resources (e.g. ships) to independently carry out a large-scale clean-up operation for oil or other pollutants in the port and the surrounding area. During the incident, the staff of the Rijnmond-Rotterdam Security Region and the Port Authority were able to cooperate successfully. Cooperation between these two organizations and Rijkswaterstaat was much less forthcoming. Cooperation between all three organisations could be reinforced by drawing up joint disaster management plans and organising joint exercises.
The Dutch Safety Board issues the following recommendations:

**With regard to preventing an (oil) spill in the port of Rotterdam:**

*To the Minister of Infrastructure and Water Management:*
1. Place on the agenda of both the European Union and the International Maritime Organization the ambition to bring forward the date for phasing out seagoing vessels with single-walled fuel tanks. For this purpose, make use of the seat occupied by the Netherlands over the next two years on the IMO Council.

*To Odfjell Ship Management and Loodswezen Rotterdam-Rijnmond (Pilotage Service):*
2. Ensure that it is clear to all parties how a manoeuvre is to be undertaken and exactly what is expected of them during that manoeuvre. In the framework of Bridge Resource Management (BRM), actively make this information available to all crew members and check regularly that the BRM system is applied.

*To the Port of Rotterdam Authority, DHMR and Odfjell Ship Management:*
3. For all seagoing vessels visiting the port, ensure that before they enter the port area, the port authorities know whether the vessels are equipped with single-walled fuel tanks.
4. Draw up an inventory of the key safety risks involving seagoing vessels with single-walled fuel tanks for (the area surrounding) the port and take measures to mitigate these risks. These must include but not be restricted to:
   - identifying and creating (guidelines for) appropriate moorings;
   - manoeuvring support by (specific types of) tugboats;
   - the timing of mooring operations in relation to water levels and the shape and cargo of the vessel.

*To the Port of Rotterdam Authority and DHMR:*
5. Together with national and international ports, draw up additional safety requirements on seagoing vessels with single-walled fuel tanks.

**With regard to oil recovery:**

*The Port of Rotterdam Authority, DHMR and Rijkswaterstaat:*
6. Invest in knowledge and innovation in relation to oil clean-up and restricting the spillage of oil. Make use of the knowledge available abroad.
7. Develop scenarios about oil spillages or spillages of other substances in which factors such as tide, current, and type and volume of the substance play a role, and use these scenarios in the operational choices and preparations for disasters.
8. In the event of a disaster, ensure that aerial support is immediately available and ensure that information and images can be rapidly exchanged and used.
With regard to the organisation of crisis management:

To the Minister of Infrastructure and Water Management:
9. Ensure that Rijkswaterstaat actually fulfils its responsibility for the quality of the surface water in the port of Rotterdam. This calls for cooperation agreements with the other stakeholders at tactical, operational and strategic level. Check whether these matters are also well-organised at other locations in the country.

To the Port of Rotterdam Authority, DHMR, the Rijnmond-Rotterdam Security Region and Rijkswaterstaat:
10. Improve preparations for large-scale oil spills at tactical, operational and strategic level, by drawing up a disaster management plan and organising joint exercises.

ir. J.R.V.A. Dijsselbloem         mr. C.A.J.F. Verheij
Chairman Dutch Safety Board       Secretary Director
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>BRM</td>
<td>Bridge Resource Management</td>
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<tr>
<td>CIN</td>
<td>Central Incident Number</td>
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<td>CoPI</td>
<td>Incident Location Command Centre</td>
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<td>DHMR</td>
<td>Rotterdam Harbour Master’s Division</td>
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<td>DCMR</td>
<td>DCMR Environmental Service Rijnmond</td>
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<td>GB</td>
<td>Combined Fire Brigades</td>
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<td>GRIP</td>
<td>Coordinated Regional Incident Management Procedure</td>
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<td>HCC</td>
<td>Port Coordination Centre</td>
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<tr>
<td>IMO</td>
<td>International Maritime Organization</td>
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<tr>
<td>ISM code</td>
<td>International Safety Management Code</td>
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<tr>
<td>KRVE</td>
<td>Koninklijke Roeiers Vereeniging Eendracht (boatmen)</td>
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<td>LCM</td>
<td>National Coordinating Committee Environmental Water Pollution</td>
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<td>LCMS</td>
<td>National Crisis Management System</td>
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<td>NLBV</td>
<td>Netherlands Pilotage Service</td>
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<td>NLC</td>
<td>Netherlands Pilotage Cooperative</td>
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<td>OvD</td>
<td>Duty Officer</td>
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<td>RCT</td>
<td>Regional Crisis Team</td>
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<td>ROT</td>
<td>Regional Operational Team</td>
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<td>RWS</td>
<td>Rijkswaterstaat</td>
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<td>SAM</td>
<td>Cooperative Procedure for Handling Spills</td>
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<td>SEB</td>
<td>Safety Evaluation Board</td>
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<td>SRH</td>
<td>Screen Pool Rotterdam Port Area</td>
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<td>VDR</td>
<td>Voyage Data Recorder</td>
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<td>VMS</td>
<td>Safety Management System</td>
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<td>VRR</td>
<td>Rijnmond-Rotterdam Security Region</td>
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<td>WMCN</td>
<td>Water Management Centre Netherlands</td>
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1 INTRODUCTION

1.1 Objectives

1.1.1 Background

The Dutch Safety Board has carried out an investigation into the allision of a Norwegian chemical and oil tanker sailing under Norwegian flag, with a jetty, and the subsequent large-scale oil spill in the port of Rotterdam on Saturday 23 June 2018.

On that day, at 13.27 hours, the chemical and oil tanker Bow Jubail entered the 3e Petroleumhaven at Rotterdam Botlek and allided with a jetty of the company LBC Tank Terminals. As a consequence of this allision, a hole was punched in the ship’s skin on the starboard side, adjacent to the front of the accommodation section\(^1\), measuring approximately 35 by 20 centimetres (see Figure 1). Immediately behind the ship’s skin there was a fuel tank containing around 385 tonnes of heavy fuel oil. This tank was punctured as a result of the allision and 217.4 tonnes of fuel oil poured into the water, at a rate of approximately 80 litres per second.

Figure 1: The oil spill from the Bow Jubail following the allision. (Source: Rotterdam Harbour Police)

\(^{1}\) Accommodation: structure on the vessel housing the crew quarters and bridge.
1.1.2 Why an investigation by the Dutch Safety Board?
The mission of the Dutch Safety Board is to improve safety in particular in situations in which personal safety is dependent on other parties such as the government, companies or institutions. The investigations of the Board do not address issues of blame or liability. The aim of the investigation is to learn lessons that reduce the risk of a similar incident occurring in the future, or limit the consequences of such incidents.

As a consequence of the damage to the vessel, the accident was classified as ‘serious’\(^2\) on the basis of the criteria laid down in the IMO Casualty Investigation Code\(^3\) and the European Regulation 2009/18/EC derived from that code. The environmental consequences of the spill of fuel oil meant that on the basis of that same legislation, the accident was classified as ‘very serious’\(^4\). As a result, the Dutch Safety Board was under the obligation to investigate the causes of the allision. An investigation of this kind is important from the point of view of prevention. There was also considerable social unrest as a result of damage to flora and fauna due to the spill. Because Bow Jubail was sailing under the Norwegian flag, the investigation was carried out in collaboration with the Accident Investigation Board Norway (AIBN). The Dutch Safety Board acts as primary investigator.

The Dutch Safety Board decided to include an investigation into the way crisis management was organised, because various parties were involved. Each party had their own tasks, responsibilities and authorities, which moreover overlapped in this case.

This resulted in the formulation of two central questions of investigation:

Which factors led to the puncturing of the fuel tank of Bow Jubail, leading to the spill of a large quantity of fuel oil?

To what extent does this incident in the port of Rotterdam provide grounds for improving or adapting the approach employed, both from a technical and administrative point of view?

1.2 Demarcation

Whenever pollution of surface water occurs as the result of an incident, the polluter is initially required to take all measures necessary to halt the pollution and as far as possible

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2 Serious shipping accident: An event such as a allision which results in serious consequences, such as damage to the structure of a vessel that negatively affects its seaworthiness.

3 Code of International Standards and Recommended Practices for a Safety Investigation into a Marine Casualty or Marine Incident (Casualty Investigation Code).

4 Very serious shipping accident: Events such as a allision which result in very serious consequences, such as serious harm to the environment, caused by damage to one or more vessels, which result from or relate to the functioning of a vessel.
to mitigate the consequences. In the event of large-scale pollution such as the one caused by Bow Jubail, it cannot be expected that a vessel or its owner will have all the resources necessary to fully satisfy that obligation. In such cases, the responsibility also lies with the manager of water quality and the organisation responsible for crisis management.

The Dutch Safety Board investigated the allision and the subsequent oil clean-up operation. They decided to investigate the period from the moment of allision on 23 June 2018 to the ending of the crisis situation on the afternoon of Sunday 24 June 2018. The subsequent removal of the oil from the surface water and the cleaning of the vessels and port infrastructure are beyond the scope of this report. The same applies to the clean-up operation of the swans that were contaminated with the oil.

1.3 Other investigations

In addition to the Dutch Safety Board, the following parties also carried out an investigation into the incident: Odfjell Management AS, Rijnmond-Rotterdam Security Region, Rijkswaterstaat, the Harbour Master on behalf of Port of Rotterdam Authority. The Safety Board was able to examine the findings of these investigations (see also Appendix A - Investigation accountability).

1.4 Investigation approach

The Dutch Safety Board examined how the incident involving Bow Jubail took place, and how the oil clean-up operation was undertaken. As part of its investigation, the Safety Board made use of the technical information from the shipping operator, the Rijnmond-Rotterdam Security Region, LBC Tank Terminals and the Port of Rotterdam Authority. Information was obtained among others from the Voyage Data Recorder (VDR) and other logged information from Bow Jubail, tape recordings and transcriptions of emergency control rooms, reports from the combined control room system, the National Crisis Management System (LCMS), eye witness reports, interviews with those involved and picture recordings made during the accident and the subsequent clean-up operation.

1.5 Parties directly involved

1.5.1 Odfjell Management AS and the crew of Bow Jubail
As the persons responsible for operations on board, the crew members on board the vessel are subject to the responsibility of the vessel’s owner. On board the vessel, the Master bears final responsibility at all times.

In international legislation and regulations, it is clearly specified that the owner of a vessel must formally appoint a ‘ship manager’ who is responsible for safe operations on board and for preventing pollution. On 23 June 2018, Odfjell Management AS, based in Bergen, Norway, and part of the Odfjell Group, was ship manager of Bow Jubail.
1.5.2 Port of Rotterdam Authority
The Port of Rotterdam Authority is an originally municipal organisation that was part of the municipality of Rotterdam. The Authority was established in 1932 as the Port Authority of the Municipality of Rotterdam, a name that was altered in 1980 to Rotterdam Municipal Port Authority. On 1 January 2004, the Rotterdam Municipal Port Authority was privatised and converted into a non-stock exchange-quoted public limited company, and is 70% owned by the Municipality of Rotterdam and 30% is owned by the Kingdom of the Netherlands. The Port of Rotterdam Authority is responsible for nautical and commercial management of the port and industrial area of Rotterdam. The Harbour Master of Rotterdam, employed by Port of Rotterdam Authority N.V., is responsible for a smooth, clean, safe, and secure completion of shipping in the port of Rotterdam. On behalf of the government of the Netherlands as well as the Municipality of Rotterdam, the Harbour Master of Rotterdam executes a number of nautical public duties. Although the Harbour Master is employed by the Port of Rotterdam Authority N.V., the Municipality of Rotterdam, Port of Rotterdam N.V., and the Harbour Master made an agreement in the so-called Harbour Master Covenant. This covenant states that the Harbour Master will not report to the board of Port of Rotterdam N.V. on his execution of his public law duties, but will instead report directly to the administrative body that assigned tasks to the Harbour Master. These public tasks are carried out by the Port Coordination Centre (HCC) and the Traffic Control Centres Botlek and Hoek van Holland, and are part of the Harbour Master's Division Rotterdam (DHMR) under command of the Harbour Master.

1.5.3 Rijkswaterstaat
On behalf of the Minister of Infrastructure and Water Management, Rijkswaterstaat is the executive service responsible for the development, management and maintenance of national roads, main navigable waterways and the main water system. Rijkswaterstaat manages what is known as the main water management system: the large rivers and canals and the North Sea. The Minister of Infrastructure and Water Management bears (final) responsibility for nautical management and water quality of all navigable waterways, whereby Rijkswaterstaat operates as competent authority to manage water quality. Rijkswaterstaat is made up of national and regional departments: a central organisation, seven regional services and seven national organisation elements. Each organisation element of Rijkswaterstaat is managed by a chief engineer director (HID). The RWS Sea & Delta department is responsible for the North Sea and access to the ports of Amsterdam and Rotterdam, among others. RWS West Nederland Zuid is responsible for the Province of Zuid-Holland, but waterway management and nautical management in the ports of Rotterdam are under the authority of the Harbour Master Rotterdam. Nautical management of the main waterways de Nieuwe Waterweg and de Oude Maas are under authority of the Minister of Infrastructure and Water Management, and mandated to the Harbour Master. Nautical management of the harbour basins is also mandated to the Harbour Master by the Municipality of Rotterdam.

In South-Holland, water quality management of the main navigable waterways and in the docks is controlled by Rijkswaterstaat WNZ. The Water Management Centre Netherlands (WMCN) is part of the national department of Rijkswaterstaat in which all Dutch water managers work together. The WMCN is active in crisis consultancy and is able to produce simulations of the spread of pollution on surface water. Part of the WMCN is the National
Coordinating Committee Environmental Water Pollution (LCM). Following the allision of Bow Jubail, the LCM was involved in incident management.

Rijkswaterstaat itself has no duties in respect of the rapid and safe handling of shipping traffic on the navigable waterways and docks in the port of Rotterdam. This authority and the resultant duties and responsibilities have been awarded to the Harbour Master Rotterdam, via a series of laws and regulations\(^5\). The Harbour Master was mandated by the Dutch government to manage the national waters, and by the Municipality of Rotterdam to manage the regional municipal waters. However, RWS (Rijkswaterstaat) is responsible in the port of Rotterdam for the quality of the surface water.

### 1.5.4 Rijnmond-Rotterdam Security Region

The regional organisation for disaster management and crisis management in the Netherlands is regulated in the Security Regions Act and in associated regulations. The security regions organise and facilitate the harmonisation between stakeholders, both inside the region and beyond. This coordinating role is also laid down in the Security Regions Act.

Within the 25 Dutch security regions, various services and administrative bodies work together in implementing the tasks relating to the fire service, medical emergency services, public order and security.

The port of Rotterdam is part of the Rijnmond-Rotterdam Security Region (VRR). This security region is made up of 15 municipalities under the chairmanship of the Mayor of Rotterdam. The security region not only regulates cooperation between the 15 municipalities but also with the Police, Water Authorities, the Harbour Master on behalf of Port of Rotterdam Authority, DCMR Environmental Service Rijnmond and the Public Prosecution Service.

### 1.5.5 LBC Tank Terminals

LBC Tank Terminals offers temporary storage capacity all over the world for liquid chemicals, oil products and refinery products. The company LBC Tank Terminals has a total global storage capacity of 2.4 million m\(^3\), in Europe (Antwerp and Rotterdam), North America (Houston, Freeport and Baton Rouge) and Asia (Shanghai). The location in Rotterdam is located in the Botlek area\(^6\) and has a storage capacity of 110,000 m\(^3\), divided across 69 tanks, ranging from 235 m\(^3\) to 5,000 m\(^3\).

### 1.5.6 The Dutch Pilotage Service

The Dutch Pilotage Service is an independent organisation consisting of two components: the Nederlandse Loodsen Corporatie (NLC) and Nederlands Loodswezen BV (NLBV). Seagoing vessels entering or departing Dutch seaports are in principle required to be advised by a pilot. The same applies to sailing into and from Flemish ports, if this requires passing through Dutch waters. The Pilotage Act states that pilotage services may only be provided by authorised and registered pilots.

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5. Article 1a of the Appointment of authorised body traffic information and traffic instructions (shipping traffic) Decree.
6. Oude Maasweg 4, Rotterdam.
1.5.7 HEBO Maritiemservice (HEBO)
HEBO is a privately owned maritime service provider that specialises in special transport by water, salvage work and oil clean-up. By contract, HEBO also carries out maintenance on navigable waterways and quaysides. For its oil clean-up operations, HEBO operates a fleet of nine vessels, varying in size. HEBO has entered into an agreement\(^7\) with the Port of Rotterdam Authority, including the removal of oil and cleaning operations on the outside of contaminated vessels and port infrastructure elements in the Rotterdam port area.

1.6 Frame of reference

For each investigation, the Dutch Safety Board draws up an assessment framework which indicates the aspects that were included in their considerations. The framework is founded on the principle that all relevant actors bear (social) responsibilities to manage safety risks in the investigated system as systematically and as effectively as reasonably possible. The responsibilities that the Board identified are outlined in the assessment framework. By considering non-conformities in relation to the assessment framework, the Safety Board is able to identify areas where they believe safety improvements can be achieved.

The assessment framework in the current investigation\(^8\) consists of the following elements:
- Safety management;
- Nautical safety;
- Crisis management and incident management.

1.7 Reading this document

The report is structured as follows. Chapter 2 provides a reconstruction and analysis of the circumstances that resulted in the allision between Bow Jubail and the jetty at LBC Terminals. Chapter 3 describes the course of events in the oil clean-up process. In Chapter 4, the organisation of the crisis management structure is considered in further detail. Chapter 5 lists the conclusions, followed in Chapter 6 by a number of recommendations.

\(^7\) Spillage Incidents Agreement, 13 Dec 2016.
\(^8\) See Appendix C.
2 THE ALLISION AND PUNCTURING OF FUEL TANK

2.1 Course of events

This chapter first describes the course of events and then the causes of the accident. A distinction is made between the allision with the jetty and the oil spill through the hole in the ship’s skin.

The investigation considered ‘Which factors led to the puncturing of the fuel tank of Bow Jubail, leading to the escape of a large quantity of fuel oil into the dock?’

2.1.1 The transfer from the Waalhaven to the 3e Petroleumhaven

In the days prior to the allision, Bow Jubail was moored for repair and maintenance at the company Westerstuw in Rotterdam’s Waalhaven. The vessel departed in the morning without cargo but having taken on fuel from the Waalhaven, for a transfer to another mooring in Rotterdam, the Botlek, in order to take on cargo at LBC Tank Terminals (see Figure 3). For this transfer, the Master was required to make use of the services of a pilot, who came on board shortly prior to departure. The Master also called in the assistance of a tugboat. He was allocated Fairplay 21 by the tugboat operator.
Upon departure from the Waalhaven, the tugboat was fastened to the centre of the stern of Bow Jubail. In this way, the vessel could be towed out of the narrow Waalhaven harbour basin in reverse. Throughout the journey from the Waalhaven to the Botlek, Fairplay 21 remained made fast to the vessel. Bow Jubail could have completed this section of the journey independently, but the tugboat stayed attached because the vessel required further assistance in reversing towards the jetty at LBC Tank Terminals in the Botlek.

Figure 3: The journey from the Waalhaven to the Botlek.

On schedule, as shown in Figure 4, the vessel was placed in position in the entrance to the Botlek and manoeuvred in reverse to the jetty of LBC Tank Terminals, where it was brought to a standstill parallel to and at some distance from the jetty.

Figure 4: The manoeuvre towards the jetty at LBC Tank Terminals.
2.1.2 The planned mooring manoeuvre

As usual, the mooring manoeuvre was verbally agreed upon between pilot and Master and started at the moment that the vessel was (approximately) parallel to the jetty. During this manoeuvre, the vessel was assisted by the tugboat.

The planned mooring manoeuvre consisted of three phases:
1. First the instructions would be issued from Bow Jubail to the tugboat to push the vessel towards the jetty. If necessary, the fore part of the vessel could be moved towards the jetty, using the bow thruster;
2. The vessel would then be kept as parallel as possible to the jetty, making use of the rudder, the propeller and the bow thruster;
3. Finally, the sideways movement towards the jetty would have to be slowed down to such an extent that the vessel would come to a standstill immediately alongside the jetty. In a configuration with one tugboat at the stern, there are three options:
   a. Slowing down the fore part with the bow thruster;
   b. Holding back the stern part by turning the rudder full starboard and briefly applying forward power to the propeller. As a result, the stern part is pushed to port or, as in this case, the movement to starboard is slowed down;
   c. If necessary, calling upon the tugboat to pull on the stern part. This is known as ‘taking up the slack’ by the tugboat.

2.1.3 The mooring manoeuvre as carried out

The push by the tugboat
At 2 minutes and 7 seconds before the allision, the tugboat received the instruction to push the ship towards the jetty. This push lasted 44 seconds. At that moment, Bow Jubail was attached to shore by four mooring lines: two lines running from the fore part backwards to the quayside (the ‘fore spring’) and two lines running from the stern part forward to the quayside (the ‘aft spring’), see Figure 5. These hawsers were connected on board to large winches. At the same time as the tugboat carried out the push manoeuvre, these hawsers were wound in by the winches. This was carried out at high power and high speed. Because the ship was unladen and therefore relatively light, in the first part of the manoeuvre, this influenced the speed with which the vessel moved towards the jetty. The speed of drawing in the lines was quickly moderated at the command of the Master.
**Figure 5:** Phase 1 of the mooring manoeuvre, with the position of the tugboat marked in yellow. The red dot marks the leak.

*Holding parallel to the jetty, and slowing down the movement towards the jetty.*

As planned, for the parallel manoeuvring of Bow Jubail, use was made of the rudder, the bow thruster and the propeller at the stern of the vessel. The Master and the pilot were outside on the bridge wing during the manoeuvre, on the extreme starboard side of the vessel. From that position, the Master operated the propeller and the bow thruster. The rudder was operated inside, on the bridge, by a helmsman, and the instructions from the Master and the pilot were relayed verbally to the helmsman, by the duty officer. For that purpose, the duty officer had taken up a position in the opening of the bridge door. The Master and the pilot were able to observe the rudder position throughout the manoeuvre from their position on the bridge wing, via two separate helm angle indicators.

From the conversations recorded on the Voyage Data Recorder (VDR), it can be concluded that just a few seconds after the tugboat stopped pushing, the pilot and the Master jointly decided to slow down the speed of the stern part towards the jetty, by briefly applying power to the propeller (‘kick ahead’) in combination with a starboard rudder. Based on the tape recording, this agreement never reached the duty officer. Subsequently, at 1 minute and 7 seconds before the allision, the command ‘Full to port’ was issued from the bridge wing. This order was passed on to the helmsman, by the duty officer. The helmsman complied with the instruction and relayed the order via the duty officer.

In the time it took for the rudder to reach the required position, the pilot, at 54 seconds before the allision with the jetty, advised the Master to turn the bow thruster full to port. This advice was immediately followed by the Master. The result was the situation reproduced in Figure 6.
A few seconds later, the Master briefly applied power to the propeller. He did this almost simultaneously with the corresponding advice ‘kick ahead’ from the pilot. This ‘kick ahead’ in combination with the setting of the rudder and bow thruster to port caused the rotating speed to port to increase, as a result of which the speed at which the stern part was moving towards the jetty increased, rather than decreasing.

The contact with the jetty
Both the pilot and the Master observed that the speed of the stern part towards the jetty was not decreasing. At 33 seconds before the vessel allided with the jetty, the pilot ordered the tugboat to slow down the stern part by ‘taking up the slack’.

The pilot also advised the Master to repeat a ‘kick ahead’ an instruction which was complied with by the Master. As a result the speed at which the stern part was travelling towards the jetty increased. Shortly afterwards the pilot asked the Master why he was ‘not doing anything with the main engine’. The Master indicated that he was operating the main engine by carrying out the requested ‘kicks ahead’. At the same time, he once again applied power and from 8 seconds before the allision until after the allision, applied additional power to the propeller. As a result, the speed of the stern part further accelerated towards the jetty, because the rudder was still turned full to port. Because the bow thruster was also turned full to port, and remained in that position, the fore part in fact turned away from the jetty. The stern part then allided with the jetty (see Figure 7).
A few seconds before the allision, the duty officer reported to the Master and the pilot that the rudder was turned to port. In response, the pilot immediately issued the command ‘Full starboard’ which instruction was followed by the helmsman. Although the rudder did then start to move, the allision had already taken place. The tugboat also only managed to ‘take up the slack’ following the allision.

The allision caused a hole in the ship’s skin, at the position of one of the fuel tanks, through which eventually 217 tonnes of fuel oil escaped, over a period of 46 minutes.

2.2 The allision - direct cause

No technical defects were found on the vessel, which influenced the occurrence or course of the allision. Wind and current played no significant role in this allision. Moreover, all members of the bridge team had the required training and experience, and according to their statements at the time of the allision, were all in good health. The allision between Bow Jubail and the jetty was primarily a consequence of the fact that the bridge team on board was too late in recognizing and correcting an unintended port rudder position. This unintended rudder position arose following the command ‘full to port’ from the bridge wing, at 1.07 minutes before the allision.

In the run-up to the allision, both the Master and the pilot became increasingly aware that the mooring manoeuvre carried out did not result in the intended slowing down of the athwartships movement of the stern part towards the jetty. Indeed, this movement was in fact amplified by the repeated application of power to the propeller, and the fact that the bow thruster was kept running continuously. The investigation was unable to provide an answer to the question why the Master and the pilot themselves did not
notice that the rudder was turned to port. It also remained unclear why neither the Master nor the pilot instructed the bow thruster to be switched off.

The allision between Bow Jubail and the jetty at LBC Tank Terminals took place because the Master issued the command ‘Full to port’ instead of the command ‘Hard to starboard’, during the slowing down of the movement of the stern part towards the jetty, at 1.07 minutes before the allision.

This incorrect command was not recognised or corrected in time by the bridge team in the remaining time before the allision took place. Because the bow thruster was also forcing the fore part away from the jetty, the vessel allided with the jetty at an angle, with the stern part first.

2.3 The allision - contributing factors

2.3.1 Failing Bridge Resource Management

To prevent people sticking too long to an incorrect assessment of the situation, the Bridge Resource Management (BRM) system was developed as a safety barrier for crew members on board ships. BRM is an effective management system that uses all human and technical resources available to the team on the bridge of a vessel and that can be deployed to assist the crew in the safe completion of each journey. BRM training is an international requirement for officers that form part of a bridge team.

Bridge Resource Management is based on its aviation counterpart Cockpit Resource Management, and was developed in the early 1990s in collaboration between shipping operators, shipping associations, maritime authorities and insurers. The primary aim of BRM is to prevent accidents by training crew members to recognise the latent presence of system risks and operational hazards and irregularities (incorrectly issued commands, for example).

The principles of BRM were present on board Bow Jubail. The duty officer, for example, was expected to maintain the clearest and most accurate picture of the situation during navigation and manoeuvring and, if in any doubt about the safety of the ship, to immediately inform the Master. The fact that seconds prior to the allision the duty officer informed the Master and pilot that the rudder was turned to port confirms for the Safety Board that the duty officer did not feel restricted at that moment in sharing his analysis of the problem, but that he too recognised the situation at a late stage.

To ensure that the BRM delivers maximum effectiveness as a security barrier, in this case, all members of the bridge team should have been informed of the plans and agreements and the resultant actions. As a result, it could have been concluded that the process was not functioning or was threatening not to function as intended. In that respect, the BRM failed to serve as a safety barrier in this allision. The duty officer was not informed of the agreement to slow down the vessel by means of rudder and propeller, and from his position in the door opening had no full view of the actions of the Master in respect of
the propeller and the bow thruster. In fact, he was only aware of the rudder positions and had no knowledge of the planned manoeuvre, and the issued rudder command ‘Full to port’ sounded no alarm bells. In the initial period following this command, therefore, there was no necessity for the duty officer to draw the attention of the Master and the pilot of the port rudder position.

The Bridge Resource Management on board Bow Jubail failed to function successfully as a safety barrier because not all the members of the bridge team were informed of the plans, agreements and actions.

2.3.2 The role of the tugboat

In the planned manoeuvre to slow down the stern part by means of propeller and rudder, Fairplay 21 had no role to play. The tugboat was only to be deployed in pushing the stern part of Bow Jubail towards the jetty. This pushing action was supposed to take place at a position approximately forty metres towards the fore part of Bow Jubail, as measured from the stern part. Returning from that position to a point from which it was possible to pull in an uninterrupted straight line using the towing line took more than 33 seconds from the moment that the pilot issued the instruction to Fairplay 21 to pull on the stern part. Eventually, the tugboat achieved the situation in which the slack was taken up 15 seconds after the allision.

The analysis revealed that the type of propulsion of the tugboat influenced the time the boat needed in order to take up the slack at the stern part. Fairplay 21 was what is known as an ASD tug, whereby ASD stands for Azimuth Stern Drive. In other words, the tugboat is equipped for propulsion and steering with two rudder propellers installed at the stern. If the rudder propellers are installed at the stern, a tugboat is only able to move in an athwartships direction at a lower rate of speed. As a result, Fairplay 21 was forced to first turn, to sail towards the stern part of Bow Jubail and then once again make a turn to be able to pull on the line. Moreover, the line had to be free and in a straight line with the attachment point in the middle of the stern of Bow Jubail, because otherwise there was a risk that the towing line would break.

The tugboat was unable to start pulling on the stern part quickly enough to avoid the allision or to reduce the force of the allision, because this task was not assigned to the tugboat during the planning of the manoeuvre. When the pilot decided that assistance was needed, the tugboat was unable to start pulling quickly because of its propulsion system.
2.4 The puncturing of the fuel tank, the direct causes

2.4.1 The construction of the jetty
The hole in the ship’s skin of Bow Jubail was caused by an overhanging section of the stern part coming into contact with a bollard that formed part of the jetty structure (Figure 8). The section of the jetty that was forced to absorb the allision was more than fifty years old. Prior to the allusion, the jetty was due for replacement by a jetty with more capacity. Following the incident with the old jetty, the new jetty was brought into use more quickly.

Figure 8: Jetty LBC Tank Terminals, a few weeks following the allision.

Figure 9 provides a diagrammatic representation of the section of the jetty relevant in the framework of this investigation.

Figure 9: Diagrammatic representation of the jetty (not to scale).
In the construction of the jetty, the following components can be distinguished:

- The top deck of the jetty, with an upstanding edge.
- Three ladders.
- The fenders (marked in green), timber posts installed vertically and not connected to the jetty itself, are intended to protect both the jetty and the vessel in the event of an allision, for example by bending with the movement. The ladders and fenders were attached together using horizontal steel beams, in sections between the hawser posts.
- Three hawser posts with bollards, numbered 1 through 3.

Hawser post 2 and all fender posts except for those near the ladders were lower than the section of the jetty deck that overhung the water. Hawser post 1 was higher than the jetty deck, but thanks to a recess in the deck was able to bend in the event of an allision, without coming into contact with the jetty. Hawser posts, ladders and all timber fenders were not connected to the structure of the jetty itself. In other words, an allision with the fender system did not automatically result in an allision with the jetty.

The allision involving Bow Jubail mainly caused damage to hawser post and bollard 2, and to the jetty platform above hawser post 2. Figure 10 shows the damaged hawser post. Hawser posts 1 and 3, the fenders and the ladders marked in yellow suffered relatively little damage.

![Figure 10: The damaged hawser post 2. (Source: Odfjell Shipmanagement AS)](image)

The ladder attached to the fender post next to hawser post 2 and the two fender posts on each side of that hawser post also suffered relatively little damage. From this, it can be concluded that the fender posts were able to bend unhindered with the impact of the allision, but this applied only partly to the hawser post. The upstanding concrete edge of
the overhanging jetty deck was forced against the jetty itself over a length of approximately ten metres (see Figure 11).

Figure 11: Damage to the edge of the overhanging jetty deck. (Source: Rotterdam Harbour Police)

Video images of the allision, made by cameras mounted permanently on the jetty, show that the damage to the concrete edge caused by the allision was not instantaneous. The vessel forced the edge further and further inwards, from the position of the hawser post to approximately ten metres further, in the direction of the fore part of the vessel. This leads to the conclusion that the vessel first made contact with the jetty at hawser post 2. The images show that hawser posts 1 and 2 and the ladder marked on the left in Figure 9 moved towards the jetty at the moment they were hit. Before the movement halted, the jetty was hit with such force that the entire structure shook. It can be concluded from this fact that the vessel allided with the jetty before the fender posts alongside the ladder and hawser post 1 came into contact with the jetty. Immediately afterwards, Bow Jubail rose slightly and then sank back into the water, away from the jetty. The upstanding concrete edge of the jetty deck had already been seriously damaged by this point. Eventually, the jetty halted the sideways movement of the vessel.

The pipelines traveling along the jetty also suffered damage, probably because during the allision, the jetty ‘kinked’ over its length. The damage to the pipelines led LBC Tank Terminals to decide to immediately fully decommission the jetty. The ‘kinking’ of the jetty confirms the image that the jetty was hit heavily, over a relatively short surface area.

Hawser post 2 also initially moved in line with the movement of the vessel towards the jetty. Imprints in the ship’s skin below and next to the hole from the fender posts attached to the hawser post suggest that initial contact with hawser post 2 was absorbed by the fenders. However, the force of the allision was so considerable that the fenders broke off and the platform was buckled. The bollard, which had reached the end of its travel, also pressed so hard on a relatively small area of the vessel that it penetrated the ship’s skin. The investigation was unable to reach a conclusion on precisely how this happened. In
any case, the hawser post was not capable of absorbing the impact. The conclusion of the Safety Board is that the force with which the allision occurred was so considerable that the construction of hawser posts and fender work alongside the jetty were unable to prevent Bow Jubail coming into contact with the jetty.

**Jetties and quay walls in Rotterdam**

The port of Rotterdam is built on land owned by the Municipality of Rotterdam and issued to the Port Authority on long-term lease. In many cases, this land is let out or subleased to businesses. This construction offers the municipality and by extension the Port Authority the possibility of imposing requirements aimed at improving the safety of the port.

There is no European legislation for the new building or renovation of quay walls, jetties and fixed mooring facilities. The Port of Rotterdam Authority has drawn up its own guidelines that are based on past experience and developments in the past, and on internationally employed standards (not requirements). These guidelines have been continuously adjusted and improved over the years.

2.4.2 Single-walled fuel tank

Bow Jubail was equipped with single-walled fuel tanks. In principle, any penetration of the ship’s hull at the location of the tank below the level of the fuel present in the tank would have resulted in a spill.

When the vessel was delivered in 1996, there was as yet no obligation to fit double-walled fuel tanks. However, since 2010, new seagoing vessels are subject to a requirement\(^9\) to have double-walled fuel tanks. Vessels with single-walled tanks that date from before 1 August 2010 may remain in operation until they are scrapped or converted in such a way that they effectively become a new vessel\(^10\).

The hole in the ship’s skin of Bow Jubail following the allision was approximately 35 cm wide and 20 cm high. Given the dimensions of the bollard that penetrated the ship’s skin, it can be concluded that the bollard penetrated the vessel by a maximum of 20 centimetres. The current requirements assume a minimum separation of 1 metre between ship’s skin and fuel tank. This reveals that there would not have been a spill if the fuel tank on Bow Jubail had been double-walled, in line with current requirements.

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\(^9\) Seagoing vessels, therefore including tankers, delivered since 1 August 2010 and with a total fuel tank capacity of more than 600 m\(^3\) as a rule no longer have single-walled fuel tanks unless individual tanks have a capacity of less than 30 m\(^3\). This rule is part of the International Convention for the Prevention of Pollution from Ships (Marpol 73/78). If the total capacity of all fuel tanks on board is less than 600 m\(^3\), single-walled fuel tanks are still permitted. Generally speaking, these are smaller vessels with a number of smaller fuel tanks.

\(^10\) Whenever a vessel is converted to such an extent that it effectively becomes a new vessel, following the conversion, that vessel must satisfy all regulations that applied for new vessels at the moment the conversion started. In English, the term ‘major conversion’ is used for this type of operation.
The vessel allided with the bollard at the position of the fuel tank. This tank was single-walled so that it was punctured at the moment the bollard penetrated the ship's skin.

Vessels with single-walled tanks that date from before 1 August 2010 may remain in service until they are scrapped or converted to such an extent that they effectively become a new vessel.

2.5 The puncturing of the fuel tank - contributing factors

2.5.1 Vessel shape

Figure 12 shows horizontal cross-sections of Bow Jubail at two different heights. These show that the stern part is narrower and shorter at the underside than at the topside. The topside of the stern part as it were overhangs: in nautical terms this is referred to as ‘swept’ stern part.

Figure 13 shows horizontal cross sections at two positions on the vessel. The stern part is narrower at the rear, and draws less deeply. This figure also shows that the stern part is ‘swept’. In the drawing on the right, the overhanging section is shown in hatching. The hole in the hull occurred just outside the hatched area, in other words in the overhang section of the stern part.
Cross section C = cross section at the height of the cargo zone
Cross section D = cross section at the height of the hole in the hull
Cross section E = cross section at the height of the stern of the ship

Figure 13: Vertical cross sections at three positions on the vessel.

2.5.2 Angle of allision
In addition to the shape of Bow Jubail, the angle of the allision is a contributing factor. Figure 14 shows two different situations. If the vessel is parallel to the quayside at the moment of allision, puncturing of the fuel tank is practically impossible. After all, the overhanging section of the stern part is unable to swing over the quayside, and therefore is unable to come into contact with obstacles on the quayside, such as a bollard. On the other hand, the vessel is able to swing over the quayside if it does not come into contact with the jetty ‘in line’ but at an angle, whereby the stern part contacts the jetty.

Figure 14: Angle of allision with jetty. Left: parallel; Right: at an angle.
2.5.3 Loading condition and water level
The combination of the shape of the vessel and the angle of allision explain how the stern part was able to swing over the jetty. The loading condition and the water level at the time of the allision also play a role.

The port of Rotterdam is a tidal port. The water level is subject to the influence of the tide, with high and low tides occurring twice a day. Figure 15 is a diagrammatic indication of three possible combinations of loading and water level. The left-hand illustration shows Bow Jubail in fully laden condition. As a result of the loading, the vessel lies so deep in the water that even at high water the entire hull is lower than the quayside. The overhanging section of the stern part is therefore unable to swing over the jetty. If the vessel is unladen, at low water, as shown in the middle illustration in Figure 15, the hull of the vessel is still lower than the jetty. In this situation, too, the swept stern part cannot swing over the quayside.

The right-hand illustration in Figure 15 shows the situation at the moment of the allision. This took place approximately half an hour after high water. Given this high water level and in unladen condition, the hull of Bow Jubail was higher than the quayside. As a result, when the vessel allided with the quayside at an angle, the overhanging stern part was able to swing over the jetty and collide with the vertically positioned bollard.

Figure 15: Three combinations of loading and water level. Left: ship fully laden, high water; Middle: ship unladen, low water; Right: ship unladen, high water.

Nautical risks in the port of Rotterdam
The Harbour Master’s Division Rotterdam (DHMR) makes use of a nautical risk assessment developed in house. Past incidents and risks that are recognised as different are mapped out by allocating a risk factor. The findings are passed on to the Safety Evaluation Board (SEB), which consists of the Rotterdam Harbour Master as well as representatives of such partners as the pilotage service, the inland shipping industry, the boatmen and the tugboat services. All these parties are also involved in designing and implementing management measures for identified risks. The puncturing of a fuel tank as a consequence of an allision with a jetty had not emerged in the Nautical Risk Assessment and had not been evaluated by the SEB, prior to the accident with Bow Jubail.
The shape of the vessel, the angle of allision, the level of loading and the water level all contributed to the puncturing of the vessel.

### 2.6 Conclusions from the allision and puncturing of the fuel tank

#### The allision
The allision of Bow Jubail with the jetty at LBC Tank Terminals was preceded by an incorrectly issued rudder command. Subsequently, in the time remaining before the allision, the bridge team failed to recognise and correct this error in time. Because the bow thruster was also forcing the fore part away from the jetty, the vessel allided with the jetty at an angle, with the stern part first.

Not all members of the bridge team were informed of the berthing plans, the berthing agreements and the resultant actions. As a consequence, Bridge Resource Management was unable to function ideally as a safety barrier.

In the planning of the manoeuvre, no role had been allocated to the tugboat for slowing down the movement of the stern part towards the jetty. The type of drive system meant that the tugboat was also unable to quickly start a towing manoeuvre after the pilot had issued this instruction shortly before the allision occurred.

#### The puncturing of the fuel tank
The vessel was unladen and at the moment of the allision, the water level in the port was high (high tide). Bow Jubail allided with the jetty at an angle. The overhanging stern part was therefore able to swing over the jetty, and allided with a bollard. This bollard pressed with such force against the ship’s hull, that it penetrated the skin. A single-walled fuel tank was present at the location of the penetration, and as a result was punctured.
3 THE COURSE OF THE OIL CLEANUP

3.1 The spread of the oil

3.1.1 Outflow of the oil
The allision involving Bow Jubail took place at 13.27 hours. Together with the ship's duty officer, the Master immediately started taking the necessary actions on board to limit the outflow of oil and its consequences, as quickly as possible. The chief engineer was instructed to immediately start pumping the oil from the damaged fuel tank. This adequate response prevented the escape of approximately 20 tonnes of oil.

At 14.14 hours, the outflow of oil from Bow Jubail was halted because the level of the oil in the fuel tank came into line with the lower edge of the hole caused to the hull. Later that afternoon, the chief engineer calculated that 217.4 tonnes of oil were missing, from on board. His conclusion was that this oil must have ended up in the water.

3.1.2 Characteristics of the escaped fuel oil
The day before the allision, Bow Jubail had taken on board IFO380 fuel oil, which ended up in the water following the allision. As is the case for practically all liquids, the physical characteristics of this fuel oil depend on the temperature. As temperatures fall, density and viscosity increase.

What is fuel oil?
Fuel oil is a collective name for all forms of liquid fuel that are burned in an oven or boiler to generate heat, or in an engine to generate power. For the most part, fuel oil is a mixture of hydrocarbons, primarily alkanes, cycloalkanes and aromatics, that form long hydrocarbon chains. In shipping, the term fuel oil is used for the heaviest form of commercial fuel that can be obtained from crude oil, in other words heavier than petroleum and naphtha. More information about fuel oil is contained in Appendix E.

Heavy fuel oil is used as fuel on practically every seagoing vessel. This oil is present in large volumes on board vessels throughout the port of Rotterdam, and is transported from refineries to vessels, and pumped on board seagoing vessels. Transport is often carried out by inland shipping vessels.
3.1.3 Vertical displacement of the oil
IFO380 is pumped at temperatures in excess of 70°C because at that temperature the fuel oil becomes more ‘liquid’ and is more easily pumped. The IFO380 bunkered in Bow Jubail had a measured density of 991.5 kg/m³, at a temperature of 15°C. By means of a correction factor\textsuperscript{11} it is possible to calculate that at 70°C, the oil had an arithmetic density of 953 kg/m³. It should be also considered that fuel oil is a mixture of different types of oil, the density of which can vary in respect of one another, and which also behave differently in water. The lighter components, for example, will tend to float more to the water surface than the heavier components.

The fuel oil that escaped from Bow Jubail had a density that was almost identical to that of the water in the port. When the vessel was punctured, the oil was able to flow unimpeded through the resultant hole, and poured into the water from a height of approximately 2.5 metres. As a result of the speed with which the oil entered the water and the minimal difference in density between the oil and the seawater/brackish water, the oil, in figurative terms, ‘fell vertically through the water surface’ and in part sank to deeper levels of water, where it remained ‘suspended’. As a result, following the allision, there was not only oil present (visibly) on and just below the surface, but also out of sight, in the deeper layers.

3.1.4 Horizontal displacement of the oil
Under the influence of wind, current and movements on the water surface, the oil was displaced not only in a vertical but also in a horizontal direction. On 23 June 2018, the weather in Rotterdam was sunny, with a temperature of approximately 21°C and a wind blowing from the west/northwest at force 3 Beaufort\textsuperscript{12}. The temperature of the water was approximately 17°C. The allision took place just after high tide (12:55 hours). From the moment of the allision, as a result of the changing tide and the ebb flow, the water started flowing out of the 3e Petroleumhaven and the Botlek. At the same time, just outside the entrance, an incoming rising tide continued to flow for some time on the Nieuwe Waterweg, the Nieuwe Maas and the Oude Maas before there, too, the flow changed direction, towards the sea.

Part of the oil remained in the 3e Petroleumhaven; another part was spread by the tidal current and the whirlwinds caused by the propellers of Bow Jubail and the two tugs, along the mouth of the 3e Petroleumhaven and the mouth of the Botlek, reaching the river at around 13.30 hours. As a result of the rising tide on the river, spilled oil was carried around the tip of the Geulhaven, and from there was carried mainly onto the Oude Maas river. As the tide on the river turned, the oil was drawn towards the sea, in the falling tidal water. In the course of several hours, the oil was carried to the river and was visible on the images of the coast guard airplane past Maasluis until the Maeslantkering. The oil mainly escaped from the Botlek towards the sea via the dam on the western side of the mouth of the Botlek, past the Scheurkade quayside and via Het Scheur. It then spread along the river down to the sea.

\textsuperscript{11} The influence of temperature on the density of oil can be derived from the temperature/volume correction factor. During pumping, only the displaced volume is measurable, so that the correction factor is needed to determine how much mass of oil has been pumped.

\textsuperscript{12} Wind direction 280° and wind speed 4m/s.
The oil was only carried towards the river for a relatively short time. With the tidal cycle\textsuperscript{13} of 12 hours and 25 minutes, this period lasted around 5 hours and started precisely at the moment of the allision, until approximately 18.30 hours. From that moment, the oil was carried by the river towards the sea, but mainly swirled back into the mouth of the Botlek. This swirling action continued until around 23.00 hours. After that time, the turning tide on the river meant that the water was forced back into the Botlek, by the rising tide.

From 18.30 onwards, the oil that was swirling in the mouth of the Botlek was carried along the southern side of the Central Botlek Channel towards the Welplaathaven and, until around 01.00 hours in the morning of Sunday 24 June, was carried via the Westkop of the 3\textsuperscript{e} Petroleumhaven, deeper into the 3\textsuperscript{e} Petroleumhaven. At the same time, until around 02.00 hours in the morning, a current with a constantly changing rate ran from the mooring of Bow Jubail into the 3\textsuperscript{e} Petroleumhaven. Above all between 01.00 and 02.00 hours, the speed of this current was around 0.3 metres per second. Prior to that time, the current speed was lower.

As a consequence of the allision of Bow Jubail, 217.4 tonnes of fuel oil entered the water. The oil spread vertically and horizontally in/through the water. Part of the oil sank to deeper water layers, while another part remained floating. Part of the oil remained in 3\textsuperscript{e} Petroleumhaven, while another part was carried under the influence of the tide along the river towards the sea and then back into the dock.

\subsection{3.2 Containing the oil}

\subsubsection{3.2.1 The two phases of oil clean-up}

In the event of pollution with a considerable volume of fuel oil, it is not realistic to expect that the entire mass can be contained and cleaned up. It is not even possible to exclude in advance that the pollution will spread over and in a large area, in particular if the fuel oil starts spreading in the deeper layers, under water, out of sight of the persons responsible for clean-up. To mitigate the most serious consequences of pollution, efforts are not only focused on containment but also on recovery. Speed is of crucial importance because oil can be removed best when floating on the surface of the water, in concentrated amounts. The greater the horizontal and vertical spread of the oil, the more difficult it is to clean up, particularly in an area in which the spread of the oil is influenced by wind, current and tide.

If an oil slick is not tackled in open water, it eventually leads to pollution of banks, jetties and ships. For that reason, an effective oil clean-up operation on the water is essential, because the degree of success is determined to a large extent by how fast the operation is launched.

\textsuperscript{13} Tidal cycle: Time between successive high and low water levels. On the day of the allision, that period lasted approximately 12 hours and 25 minutes.
In general terms, oil clean-up operations consist of two phases: oil containment followed by removal. Oil containment operations in the port of Rotterdam use oil containment screens provided by the Screen Pool. These screens are launched from predetermined locations and transported to the destination location. The Port of Rotterdam Authority has signed a contract with the company HEBO with its fleet of oil recovery vessels, for oil clean-up operations.¹⁴ Rijkswaterstaat also has a number of vessels capable of oil recovery.

### 3.2.2 Activating the Screen Pool

The first Duty Officer of the Rotterdam Harbour Master’s Division was at the scene within a few minutes of the allision. His first measure in the framework of the oil clean-up operation was to activate the Screen Pool. At 13.36 hours, the on-call officer at the Combined Fire Brigade (GB) received orders to mobilise a total of 900 metres of linked oil containment screens, and to launch them from the Exxon jetty (the closest location to Bow Jubail). The screens were in the water by 15.07 hours.

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**What factors determine the effectiveness of an oil containment screen?**

In addition to the depth of the screen, the effective functioning of an oil containment screen depends on the speed of the current in relation to the (stationary) screen. If the flow speed of the water in a direction of flow perpendicular to the screen exceeds 0.3 metres per second, the oil floating on the water will pass below the screen. At even higher current speed, there is an increasing risk that the screen will fail. Wind can also have a negative influence on the functioning of the oil containment screens. At wind speeds above of 5 Beaufort, the wind blows the oil over the screen. If the waves exceed a height of one and a half metres, the screens are no longer effective. In addition, oil containment screens have no effect whatsoever on oil remains that have sunk to deeper water layers.

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After the linked oil containment screens had been launched, it took one and a half hours before the screens arrived at Bow Jubail. This time was necessary to call out, launch and sail the oil containment screens to the ship’s location, from the launching location. The screens were sailed out by DHMR employees using breathing gas. At the front end, the screen was attached to the shore (see Figure 16). Bow Jubail was held in position by two tugboats. Only after the vessel had been safely moored could these tugboats depart, and the oil containment screens be definitively closed around Bow Jubail. This took place at around 16.15 hours, two hours and 45 minutes after the allision.

To moor the vessel, boatmen from the Koninklijke Roeiers Vereeniging Eendracht (KRVE) were deployed. They carried the hawsers from the vessel to shore. However, on and around Bow Jubail, the spread of fuel oil led to an increased risk of inhaling harmful oil fumes. For that reason, the second Duty Officer DHMR only gave permission to the...
boatmen to bring the hawsers ashore and to moor the vessel once he was certain that it was safe for the boatmen.\textsuperscript{16} He was accompanied by a hazardous substances inspector who brought measuring equipment and who wore the appropriate protective clothing.

It is not possible to determine precisely how much oil was contained by the screen around Bow Jubail. It is clear that a large proportion of the oil had already spread via the Nieuwe Waterweg towards the North Sea, in the period before the screens could be definitively closed around Bow Jubail, because the oil containment screens can only be closed after mooring. In addition, the oil containment screen could only contain a limited amount of oil around Bow Jubail because of the interval between the allision and the closing of the screens. Also, the screen was unable to contain the oil that had sunk to deeper layers in the water. This oil was spread by a deeper water flow that could not be observed at the surface. Finally, the effectiveness of the oil containment screen was further reduced by the water flow. As outlined previously, between 01.00 hours and 02.00 hours, the flow rate was at or above 0.3 metres per second, as a result of which part of the oil that was present on the surface passed beneath the screen.

\textbf{3.2.3 Deployment of water cannons and additional oil screens}

At around 14.30 hours, when there was a danger of the oil flowing up the river, patrol vessels of the DHMR were called in to attempt to prevent the spread of the oil to the Geulhaven using water cannons (see Figure 17). Permission for this attempt was given by the first Duty Officer DHMR. It is possible that some of the oil floating on the surface of the water was prevented from flowing into the Geulhaven but it also caused the oil to spread further via the river. However, this operation had no effect on the oil suspended

\textsuperscript{16} Measurements had to be made on site by the Hazardous Substances Advisor of the Rijnmond-Rotterdam Security Region.
in the deeper water layers. Eventually, at a later stage, the Geulhaven itself also became heavily polluted with oil from Bow Jubail.

Figure 17: Use of water cannons from patrol boats. (Source: DHMR)

3.2.4 Inspection and re-closure of the dock
During the course of Saturday evening, during an inspection of the 3rd Petroleumhaven and the Geulhaven from a patrol boat, the second Duty Officer DHMR observed little oil in the surface water and on the banks. On the Sunday afternoon following the accident, a new inspection was carried out in the dock. It emerged that the Southern arm of the 3rd Petroleumhaven was coated with a thick layer of oil. Part of the Western arm of the 3rd Petroleumhaven was clean, upon which the Western arm was closed off by an additional oil containment screen.

The late placement of the oil containment screen around Bow Jubail meant that less oil was contained.

Part of the ‘submerged’ oil passed unseen beneath the screens.

The water flow between 01.00 hours and 02.00 hours carried a proportion of the oil from the surface beneath the screen.

On Sunday morning, the 3rd Petroleumhaven and the Geulhaven turned out to be heavily polluted.

3.3 Removing the oil

3.3.1 Actions by HEBO
The Port of Rotterdam Authority had signed a contract with the company HEBO Maritiemservice for the removal of oil on the water. The contract states that in the event of incidents involving oil spills, HEBO would act under the command of the DHMR. Among other things, this command related to prioritization of the recovery operation,
approval of the Action Plan as drawn up by HEBO, supervision of implementation of the Action Plan and guaranteeing the interests of the Port of Rotterdam Authority.

The requirements imposed on HEBO in the schedule of requirements that formed part of the contract included:

- deploying a coordinator at the incident location within 60 minutes following call-out;
- starting with the recovery operation within 60 minutes following approval of the Action Plan;
- subsequently theoretically recovering from the surface water 350 m³ of spilled product within 5 hours;
- in the subsequent period, continuing the recovery operation, the cleaning of jetties, quaysides, slopes and cleaning polluted outsides of vessels, 24/7.

Twenty minutes following the allision, at 13.45 hours, HEBO was notified by the Port Coordination Centre (HCC) and was instructed to deploy its heavy equipment to the 3e Petroleumhaven. HEBO immediately deployed its available fleet.

In the period following the accident, all six vessels of the company HEBO that were available for oil clean-up work were actually deployed. Command was delegated to a second Duty Officer DHMR, who had arrived on the scene to assist the first Duty Officer DHMR. At the start of the recovery operation, a verbal action plan was discussed between the commander from the DHMR and the coordinator at HEBO.

HEBO deployed the following vessels:

- The *HEBO-Cat 9* started recovery in the 3e Petroleumhaven at 16.10 hours. Shortly after this, this vessel interrupted its work to clean the oil from the hulls of the two tugboats that had assisted in the mooring of *Bow Jubail*;
- At the same time, the *HEBO-Cat 9* launched the far smaller *HEBO-Cat 8*, a vessel with limited oil recovery capabilities (storage capacity 2 m³);
- The *HEBO-Cat 6*, the sister ship to the *HEBO-Cat 8*, was also deployed in the 3e Petroleumhaven;
- The *HEBO-Cat 5* was sent to the Botlek from the Europoort and while sailing towards the Botlek also started oil recovery work at Rozenburg, on the Nieuwe Waterweg, at around 16.15 hours. After arriving in the Botlek, the vessel continued its cleanup work there;
- The *HEBO-Cat 7* was deployed from the 3e Merwedehaven in Dordrecht. The vessel started oil recovery at around 17.00 hours from the Botlek bridge to the mouth of the Oude Maas and then in the mouth of the Botlek.
- On Sunday 24 June, the *HEBO-Cat 13* also set sail from Moerdijk heading for the Botlek at 07.00 hours.
<table>
<thead>
<tr>
<th>Name</th>
<th>Task</th>
<th>Recovery system</th>
<th>Capacity per hour(^\text{17})</th>
<th>Storage capacity(^\text{18})</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEBO- Tender 1</td>
<td>Assistentie</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>HEBO- Cat 5</td>
<td>Recovery</td>
<td>2x 19-metre sweeping arm in combination with internal suction skimmer</td>
<td>2700 m(^3)</td>
<td>15 m(^3) liquid container, supported by bilge boat storage capacity 300 m(^3)</td>
</tr>
<tr>
<td>HEBO- Cat 7</td>
<td>Recovery</td>
<td>2x 19-metre sweeping arm, in combination with internal suction skimmer / + oil/water separator</td>
<td>2700 m(^3)</td>
<td>270 m(^3) (3x 90m(^3) tanks) supported by bilge boat storage capacity 300 m(^3)</td>
</tr>
<tr>
<td>HEBO- Cat 9</td>
<td>Recovery</td>
<td>15-metre sweeping arm, in combination with vacuum skid with suction capacity of 8100 m(^3)/h</td>
<td>250 m(^3)</td>
<td>Vacuum skid 12 m(^3)</td>
</tr>
<tr>
<td>HEBO- Cat 6</td>
<td>Recovery/ assistance</td>
<td>4-metre sweeping arm, in combination with oil transhipment pump</td>
<td>100 m(^3)</td>
<td>2.7 m(^3)</td>
</tr>
<tr>
<td>HEBO- Cat 8</td>
<td>Recovery/ assistance</td>
<td>4-metre sweeping arm in combination with oil transhipment pump</td>
<td>100 m(^3)</td>
<td>2.7 m(^3)</td>
</tr>
<tr>
<td>HEBO- Cat 13</td>
<td>Recovery</td>
<td>Vacuum pump</td>
<td>100 m(^3)</td>
<td>4 m(^3), supported by bilge boat storage capacity 300 m(^3)</td>
</tr>
</tbody>
</table>

Table 1: Overview of deployment of HEBO oil recovery vessels.

The capacity deployed by HEBO for the oil clean-up operation was more than sufficient to satisfy the theoretical standard of 350 m\(^3\) spilled product recovered from the surface water after 5 hours. Also in the period following those first 5 hours, HEBO met the requirement of continuing its recovery operation 24/7. The listed vessels continued recovery work permanently (also at night) from their initial deployment on. During the course of Sunday 24 June 2018, HEBO reported to the Incident Location Command Centre (CoPI) that around 120 tonnes of oil mixture had been recovered. By Monday morning, the total was 180 tonnes.\(^{19}\)

3.3.2 Actions by Rijkswaterstaat

Because this incident involved a major oil spill, the Port Authority also called upon the RWS-WNZ Duty Officer to supply oil recovery vessels, in addition to the vessels already deployed by HEBO. Rijkswaterstaat Zee and Delta (RWS-ZD) uses the vessel Arca for oil clean-up operations at sea, but this vessel was unavailable due to maintenance. The buoying vessel Rotterdam, that was moored on the Nieuwe Waterweg at Rozenburg, was

\(^{17}\) The stated capacities are theoretically only achievable if pure product can be recovered from the surface water. In practice, however, in most cases the recovered substance is a mixture of oil and water.

\(^{18}\) The stated capacities are theoretically only achievable if pure product can be recovered from the surface water. In practice, however, in most cases the recovered substance is a mixture of oil and water.

\(^{19}\) This included deployment of the Hein from Sunday afternoon, see section 3.3.2
also unavailable for timely deployment for oil clean-up tasks, because it first required conversion.

RWS-ZD has contracts with a contractor to allow the deployment of the dredging vessels *Hein* and *IJsseldelta* for oil recovery operations in the event of disaster incidents. Both vessels were moored in the port of Rotterdam on the day of the accident. Following an internal decision-making process within RWS, both ships were deployed.

<table>
<thead>
<tr>
<th>Name</th>
<th>Task</th>
<th>Recovery system</th>
<th>Capacity/hour</th>
<th>Storage capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hein</td>
<td>Recovery</td>
<td>Sweeping arm</td>
<td>350 m³</td>
<td>3,600 m³</td>
</tr>
<tr>
<td>IJsseldelta</td>
<td>Recovery</td>
<td>Sweeping arm</td>
<td>350 m³</td>
<td>3,500 m³</td>
</tr>
</tbody>
</table>

Table 2: overview of oil recovery vessels made available by RWS.

On Saturday, the *Hein* was deployed to recover oil on the Nieuwe Waterweg from 20.25 hours, after it had been reported that the oil in question was a very thin layer of light oil on the surface (a *sheen*). Following consultation with the RWS-WNZ Duty Officer at RWS-WNZ, the *Hein* eventually halted recovery work at 23.00 hours, because darkness had fallen and the sheen was no longer visible. Aerial images show that there was still fuel oil present immediately beneath the surface of the water, but this could not be observed by the crew of the *Hein*.

Early in the morning of Sunday 24 June, between 05.30 and 05.45 hours, the skippers of the *Hein* and the *IJsseldelta* consulted with the RWS-WNZ Duty Officer on the plan for that day. The skipper of the *Hein* reported that there was still oil on the Nieuwe Waterweg and the Oude Maas but that this was only a very thin layer which was very difficult to recover. The RWS-WNZ Duty Officer reported that the docks along the Oude Maas had remained clean, and that as a consequence of the wind direction the northern banks of the Nieuwe Waterweg had suffered relatively little pollution and that there was no more oil visible on the river. Given the falling tide, the overall expectation was that the oil would no longer reach the docks along the Oude Maas. This picture was confirmed by observations from the Coastguard aircraft that had carried out an observation flight over the area, that morning. During the course of Sunday, under contract to HEBO, the *Hein* continued to recover oil in the 3ª Petroleumhaven. In other words, at the end of the day, the only vessel to recover oil was the *Hein*. The *IJsseldelta* was kept in reserve but eventually did not participate in the recovery operation. It has not become clear from the investigation why the *IJsseldelta* was not actually deployed in the recovery operation.
The first oil recovery vessel deployed by HEBO started recovery work under the command of the DHMR, 2.5 hours following the allision. Other HEBO vessels followed thereafter.

Rijkswaterstaat was requested to provide oil clean-up capacity as well. The two vessels designated for that purpose from Rijkswaterstaat's own fleet were unavailable for deployment. Eventually, two vessels were made available via a contracted party, one of which was deployed.

Oil recovery by HEBO around Bow Jubail continued on Saturday evening and into the night.

The *Hein*, the vessel supplied by RWS, halted recovery work at 23.00 hours. On Sunday, the *Hein* continued operating under contract to HEBO, for recovery work in the 3e Petroleumhaven.

### 3.4 Conclusions concerning the course of the oil clean-up operation

After 217.4 tonnes of fuel oil ended up in the water following the allision involving Bow Jubail on Saturday afternoon 23 June 2018, the oil clean-up operation was initiated within 10 minutes. The Screen Pool was activated, aimed at containing the oil escaping from the vessel. Immediately after the allision, the chief engineer on board began taking all necessary actions to limit the escape of oil. He started by pumping oil from the damaged fuel tank. As a result, the escape of approximately 20 tonnes of oil was prevented.

In the event of pollution involving a large volume of fuel oil, it is not realistic to expect that the entire mass of spilled oil can be fully controlled. The screens were only able to hold back some of the oil, for the following reasons:

- It took nearly three hours before the ship was moored and the screens were fully closed around *Bow Jubail*. As a result, a large proportion of the oil had already spread towards the Oude Maas and the sea, with the falling tide.
- The water flow caused part of the oil that floating on the water to be drawn under the screen.
- Part of the oil had immediately sunk to deeper water layers and as a result could not be contained by the screens anyway. This oil went out of the oil recovery team’s sight.

The first vessel deployed by HEBO started oil recovery almost three hours following the allision. Eventually HEBO deployed six vessels. Two additional vessels were made available via Rijkswaterstaat, one of which was deployed for the recovery operation. Although air view images were made before the recovery, it was not possible to make use of continuing assistance from the air during the operational recovery.
Despite the deployment of the screen pool and the recovery of oil by HEBO and Rijkswaterstaat, it became clear the next morning that the oil had polluted the vessels, jetties and banks of the 3rd Petroleumhaven and the Geulhaven.

The effectiveness of any containment operation influences the required oil recovery capacity. However, this incident shows that on their own, screens are not always sufficient to effectively contain oil pollution of this kind. Even if the screens had been closed more quickly following the spill from Bow Jubail, they would not have been able to contain all of the oil as a result of the current and the composition of the oil.
4 ORGANISATION OF CRISIS MANAGEMENT

4.1 Report

From the first report of the allision, a number of different organisations were involved in the crisis management, and the situation was escalated so that the crisis could be managed jointly.

Saturday 23 June 2018

13.27
The stern of Bow Jubail allided with the jetty at LBC Tank Terminals.

13.29
First report by the representative of LBC TT to the Port Coordination Centre (HCC).

13.30
The HCC notified the first Duty Officer at the Rotterdam Harbour Master’s Division (DHMR).

13.32
Report by Fairplay 21 to the Traffic Control Centre.

13.36
The first Duty Officer DHMR visited the allision site; his first estimate was that the spill involves around 30 tonnes of oil.

13.36
The HCC issued the order to the fire brigade duty officer to activate the Screen Pool and to ensure that a second container of screens is taken. The first Duty Officer DHMR notified the Port Coordination Centre that the situation involved a major spill, decided that the Exxon location would be the launch location for the screens and that the screens must be installed close around Bow Jubail.
HCC notified the company HEBO by pager and called upon the company to deploy at the 3e Petroleumhaven with heavy equipment.

An employee of LBC Tank Terminals issued a CIN report concerning the allision between Bow Jubail and the jetty and the subsequent oil spill, indicating that deployment by the emergency services was required.

Two reports
The allision involving Bow Jubail took place on 23 June 2018 at 13.27 hours. On board the vessel, it was clear immediately after the allision that a large amount of fuel oil was flowing out of the vessel.

The first report was issued at 13.29 hours by a representative of LBC TT. The HCC then notified the first Duty Officer DHMR. The Master of Bow Jubail instructed the pilot to notify the port authorities and to act as contact person for the Dutch authorities. The pilot was informed by the Master that the punctured tank contained more than 300 tonnes of oil. The pilot then asked the Master of Fairplay-21 to report the spill to the Botlek Traffic Control Centre, and to pass on the information that around 300 tonnes of oil were involved. The Master of Fairplay 21 passed on this report to the Traffic Control Centre at 13.32 hours. Sound recordings of this call make it clear that the amount of oil is not referred to. The pilot also contacted the representative of the pilotage service by telephone, at the HCC. Within three minutes after the incident, the report of the allision reached the first Duty Officer DHMR. Because the first Duty Officer DHMR was present at the Botlek Traffic Control Centre, he arrived at the jetty where the allision had taken place within just a few more minutes.

The Port Coordination Centre (HCC) activated the Screen Pool and notified HEBO. At 13.45 hours, the LBC TT issued a CIN report to the control room at the Rijnmond-Rotterdam Security Region (VRR). This type of report involves a conference call in which various disciplines and partners of the VRR take part. In this case, the participants were police, fire brigade, DHMR, RWS Traffic Post Dordrecht and the DCMR Environmental Service Rijnmond (DCMR). During this group call, reference was made to several thousand tonnes of spilled oil.

Contact with the vessel
Despite the fact that Bow Jubail was at the heart of this crisis, there was no direct contact during the initial hours of the crisis management operation between the Duty Officer DHMR, who was in charge of the on-site incident management, or the Port Coordination Centre (HCC), and the crew on board Bow Jubail. Communication took place indirectly.

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CIN report = Central Incident Number. Within the Rijnmond-Rotterdam Security Region, incidents requiring the deployment of the emergency services are reported by means of a CIN report.
via the Master of the tugboat and the representative of the pilotage service at the HCC. At no point during the early hours of the operation did one of the Duty Officers DHMR consider placing a liaison on board Bow Jubail, on behalf of the emergency services, with whom direct communication could be established.

The wellbeing of the crew and the management of the damage on board Bow Jubail were not included in the crisis management operation on Saturday 23 June. The recommendations from the Hazardous Substances Advisor reached neither the crew of the vessel nor the pilot. Medical assistance was neither provided nor offered on the ship to anyone on board or in the vicinity of Bow Jubail. Boatmen, the pilot, tugboat crew and the crew of the vessel were only advised by the second Duty Officer DHMR to attend their GP if they experienced any health problems. On their own initiative, a number of them did subsequently call in medical assistance.

Following the allision involving Bow Jubail, two separate reports were made shortly following the incident. In response, crisis management was activated within a few minutes. In the communication relating to the incident, different amounts of spilled oil were referred to.

During the initial hours of the crisis management operation there was no direct contact between the crew of the vessel and the Duty Officers DHMR.

The wellbeing of the crew and the management of the damage on board Bow Jubail were not included in the crisis management operation on Saturday 23 June.

**4.2 Escalation**

**Saturday 23 June 2018**

13.43

The Central Control Room escalated the situation to GRIP-1 at the request of the Duty Officer at the Harbour Master’s Division.

13.52

Rijkswaterstaat Traffic Control Centre Dordrecht (RVC) reported to the Duty Officer at Rijkswaterstaat that a spill had occurred, and that it may be restricted to the port.
14.00

The Director of the Rotterdam Rijnmond Security Region was informed and notified the mayors of the affected municipalities.

14.14

No more oil escaped from Bow Jubail.

14.29

Announcement of escalation to GRIP-2 by CoPI Commander as advised by the first Duty Officer DHMR and Chief Duty Officer of the Fire Department.

14.49

The Incident Location Command Centre (CoPI) held its first meeting.

14.53

Second Duty Officer DHMR on location.

15.06

The oil continued to spread in the port and was observed in the Oude Maas

15.43

The company HEBO started the oil clean-up operation with the vessel HEBO-Cat 5 on the river at the Maeslantkering barrier.

15.45

The Regional Operational Team (ROT) met for the first time to coordinate the recovery operation between Rijkswaterstaat and the Harbour Master’s Division.

15.53

Meeting of the CoPI.

16.15

The Port Coordination Centre reported that Bow Jubail was safely moored; the oil screens around the vessel were closed.
Closure of the port and escalation to GRIP-1

It was immediately clear to the first Duty Officer DHMR that the incident involved a major spill and that multidisciplinary deployment would be required. At around 13.43 hours, he instructed the Security Region to announce the Coordinated Regional Incident Management Procedure GRIP-1 and ordered that shipping traffic into the 3e Petroleumhaven be blocked by the HCC, to prevent vessels close to the incident becoming polluted with oil.

The escalation to GRIP-1 meant that close to the accident location an Incident Location Command Centre (CoPI) was established immediately, attended by the first Duty Officer DHMR. Because by this time he was also responsible for coordinating the safe mooring of Bow Jubail and managing the pollution, from 14.53 hours onwards, he was assisted by an additional colleague who had arrived on the scene (the second Duty Officer DHMR).

Coordinated Regional Incident Management Procedure (GRIP)

The method that determines how coordination is organised between the emergency services. In this procedure, the central idea is that larger incidents need to be dealt with in a more coordinated manner.

<table>
<thead>
<tr>
<th>GRIP</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRIP 1</td>
<td>Management at source. Limited-scale incidents. Coordination required between various disciplines.</td>
</tr>
<tr>
<td>GRIP 2</td>
<td>Management at source and effect management. Incident with clear impact on the surrounding environment.</td>
</tr>
<tr>
<td>GRIP 3</td>
<td>Threat to the wellbeing of (large groups of) the population within a single municipality.</td>
</tr>
<tr>
<td>GRIP 4</td>
<td>Extending beyond the municipal boundaries and/or threat of spread and/or possible shortage of basic necessities of life, or other goods.</td>
</tr>
<tr>
<td>GRIP 5</td>
<td>This refers to a disaster or crisis that extends over more than a single security region.</td>
</tr>
<tr>
<td>GRIP National</td>
<td>If a crisis arises involving different Ministries, this can be a reason to announce GRIP National.</td>
</tr>
</tbody>
</table>

Mayors informed

On Saturday 23 June 2019 at 14.00 hours, the Director of the Rotterdam Rijnmond Security Region, in his capacity as on-call duty manager, was informed about the allision of Bow Jubail and the start of the oil clean-up operation. He immediately informed the affected mayors in the region (Rotterdam, Maassluis, Vlaardingen, Schiedam and Spijkenisse). He also contacted the Harbour Master. The Director of the Security Region did not contact the manager at Rijkswaterstaat, the Chief Engineer Director of Rijkswaterstaat WNZ (HID-RWS WNZ).

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21 GRIP National does not exist anymore at this time, but this is not yet implemented in the prevailing GRIP regulations.
Information backlog at Rijkswaterstaat
The Duty Officer at RWS is part of the CoPI. He was informed at 13.52 hours by the traffic controller at the Rijkswaterstaat traffic control centre in Dordrecht. Based on the information provided, the Duty Officer RWS-WNZ had the impression that this was an extensive spill, but that its spread had been limited to the 3ª Petroleumhaven. Because in that situation DHMR is responsible for initiating the clean-up operation, the Duty Officer initially doubted the need to visit the accident location. He nonetheless decided to do so. On the way to the first CoPI meeting, the Duty Officer RWS-WNZ was unable to obtain a clear picture of the situation because he had no direct access to the communication channels C2000 and LCMS, the systems in use within the Rotterdam Rijnmond Security Region and the Port of Rotterdam Authority. As a result, he reached the first meeting of the CoPI, which started immediately following his arrival, with an information backlog. As a consequence, he had also not had an opportunity to observe the situation on the ground, before the start of the CoPI meeting.

First CoPI meeting
In the first phase following the incident, there was uncertainty about the amount of spilled oil. An initial estimate by the first Duty Officer DHMR was that the incident involved 30 tonnes, but this had already been corrected to 100 tonnes before the first CoPI meeting. By that stage, the spill had already been halted.

The first meeting of the Incident Location Command Centre (CoPI) started at 14.49 hours. The CoPI meeting was attended by representatives of the Rotterdam Rijnmond Security Region, fire brigade, RWS-WNZ, DHMR and the police. During this first meeting, the members of the CoPI shared the following assessment of the situation:
- in total, more than 900 metres of oil screens would be deployed;
- shipping traffic in the 3ª Petroleumhaven was blocked.

The Duty Officer at RWS-VWM offered to have the Rijkswaterstaat LCM draw up models charting out the currents and oil spread. However, during the first meeting of the CoPI, he had been given the impression that the entire 3ª Petroleumhaven had been blocked with oil containment screens, whereas in fact the dock had only been closed for shipping traffic, and the screens had only been placed around Bow Jubail. As a result, the simulation was made using the wrong start parameters, and the actual outcome deviated considerably from what the participants in the CoPI meeting considered likely. As a result of this mismatch, it emerged during the various CoPI consultation sessions that the simulation by the LCM was unusable.

Second CoPI meeting
At 15.53 hours, a second meeting of the Incident Location Command Centre (CoPI) was held. During this second meeting, a uniform picture of the situation at that moment was shared:
- 200 tonnes of fuel oil had escaped from Bow Jubail.
- Bow Jubail was not yet safely moored, and was being held in position by two tugboats. The second tugboat had arrived on the scene following the allision;
- the oil containment screens were only placed around Bow Jubail and the LBC Tank Terminals jetty, but could not yet be closed;
the 3rd Petroleumhaven was not blocked with an oil containment screen, but only closed to shipping traffic;

The Police dispatched a helicopter to the incident site. The crew of the Coastguard aircraft that was still on the ground on Texel was also instructed to set course for the port of Rotterdam area;

Environmental safety
CoPI was also involved with environmental safety, until the ROT was operational and a transfer had taken place from the impact area of the CoPI Commander to the Operational Commander of ROT. Relevant information was collected relating to the hazards of the escaping fuel oil, both in respect of health and in terms of fire risk. The Rotterdam Rijnmond Security Region called in its experts on environmental matters and hazardous substances to carry out measurements. At the same time, measurements were also made via the permanent measurement points (E-noses) across the region, to determine the possible presence of harmful concentrations. The time it took to measure and evaluate the concentrations above the polluted surface water had an effect on the deployment of the boatmen, among other things. As a result, they were not initially able to be deployed for mooring Bow Jubail because it was first necessary to determine whether the situation was safe for the boatmen.

Escalation to GRIP-2
Even before the first CoPI meeting, the CoPI Commander had escalated to GRIP-2 as advised by the Duty Officer DHMR and Chief Duty Officer Fire Department. Within an hour of the allision, he received reports that oil had been observed in the mouth of the Botlek, around the Geulhaven. At that moment, he was convinced that the tide would also quickly spread the oil up the river and therefore instructed the Security Region to escalate to GRIP-2, at 14.29 hours.

Harmonisation between ROT and CoPI
As a result of the escalation to GRIP-2, the Regional Operational Team (ROT) was activated. The ROT is made up of representatives from the VRR, Police, DCMR and DHMR. Given the nature of the incident, Rijkswaterstaat was also invited to provide a liaison.

The Operational Commander ROT and the CoPI Commander agreed on the allocation of tasks. The CoPI would focus on the area where the oil had actually been spilled, the so-called source area: the LBC Tank Terminals jetty, Bow Jubail, the LBC Tank Terminals site and the end of the Oude Maasweg. The ROT was made responsible for the surrounding area, which was considered to be the effect area. The effect area was not restricted to the Oude Maas, Nieuwe Maas and the Scheur/Nieuwe Waterweg, but also included the Botlek Central Channel and the adjacent docks and the 3rd Petroleumhaven. According to the GRIP-regulations, the ROT made use of the Regional Operational Centre in the World Port Center in Rotterdam. This conference room is furnished especially for this purpose and provided with the necessary equipment.
First ROT meeting
The ROT met for the first time at 15.45 hours. During this first meeting, a plenary session was held to form an integral assessment of the situation. Subsequently, the conference participants – Rijkswaterstaat and DHMR among others – determined the priorities and appointed acting parties. The ROT contacted the drinking water company and the water board because they could also be affected by the oil spreading. This enabled these organisations to take preventive measures if necessary.

Concerns about the effectiveness of the oil containment screens
Both in the ROT and CoPI meetings, concerns about the effectiveness of the oil containment screens and the possible consequences of the spread of the oil increased. The parties in the meeting realised that the oil containment screens had only been closed around Bow Jubail by the time the oil had already spread far beyond the outer perimeter of the screens. Within the ROT, there was real doubt about whether the oil containment screens would actually be able to contain the oil, given the flow speed on the river, and the consequences of the tidal action.

Within fifteen minutes of the allision, the first Duty Officer DHMR escalated to GRIP-1. 45 minutes later, the CoPI Commander escalated to GRIP-2 as advised by the first Duty Officer DHRM and the Chief Duty Officer Fire Department, because they recognised that the spilled oil would spread along the river.

The participants in the Incident Location Command Centre (CoPI) (established following the escalation to GRIP-1) and the Regional Operational Team (ROT) (established following the GRIP-2 escalation) divided the tasks. The CoPI focused on the source area around the vessel and the ROT was made responsible for the wider surrounding area.

It took one and three quarter hours before there was a clear picture of the scope of the spill. Within both the ROT and the CoPI, concerns arose as to whether the oil containment screens would be able to effectively contain the fuel oil.

4.3 Information collection

Zaterdag 23 juni 2018

16.24
The Coastguard aircraft took aerial pictures but these could not be shared in real-time.

16.35
Rijkswaterstaat switched to Phase 2 and activated the Regional Crisis Team.
The fire brigade deployed its Drone Team.

CoPI meeting: images from the police helicopter became available, revealing the full extent of the spread.

The second Duty Officer DHMR inspected the 3e Petroleumhaven. Only small amounts of oil were observed in the surface water.

The Duty Officer at Rijkswaterstaat reported to the Incident Location Command Centre (CoPI) the closing of Rhoonse grienden, the ports in Rhoon, Spijkenisse and Oud-Beijerland, and Barendrecht Marina.

The oil recovery vessel Hein deployed by Rijkswaterstaat started clean-up operations on the Nieuwe Waterweg, starting at Hook of Holland.

HEBO informed the CoPI meeting that it expected to have cleaned up all the oil within the screens on 24 June. The Southern branch and the Western side of the 3e Petroleumhaven appeared to be clean.

In response to the inspection of the 3e Petroleumhaven, the DO-HCC indicated that in his opinion there was no need to maintain the closure. The second Duty Officer DHMR decided to cancel the closure of the 3e Petroleumhaven.

Need for aerial pictures

In the initial period following the accident, there was a considerable need for information and a clear overview within the CoPI. To obtain a clear picture it was essential to map out the scope of the affected area. At this stage, GRIP-2 escalation had been announced because the CoPI Commander – with advice from the Chief Duty Officer Fire Brigade and the Duty Officer DHMR – was convinced the oil would spread through the river.

It was recognised that there was a great need for observations from the air, and eventually three resources were deployed to obtain those:
- the police helicopter;
- the Coastguard aircraft, directed via Rijkswaterstaat Zee & Delta;
- a fire brigade drone.

No agreements or scenarios existed for the deployment of aerial observations in the Rotterdam port area, which made actual deployment more difficult. The deployment of the police helicopter had to be applied for at the control room of the Central Unit in Driebergen. Then, the Coastguard Centre in Den Helder had to be contacted for permission to deploy the Coastguard aircraft. The Combined Fire Brigade did not have a certified drone team at the time of the incident, so the parties decided to deploy the drone operated by the drone team from the Midden-Brabant West Fire Brigade. That drone first had to be transported to the port of Rotterdam and its deployment had to be coordinated with air traffic control.

Availability of aerial pictures
Between 16.00 and 17.00 hours, both the police helicopter and the Coastguard aircraft took pictures of the mouth of the Botlek, the mouth of the Oude Maas and the Nieuwe Waterweg. However, it was not possible to share these images in real time with the emergency services on the ground. The first pictures from the police helicopter were made available to the CoPI at 18.45 hours. These aerial photographs showed that the oil had spread over a far larger area than initially believed. The images from the Coastguard aircraft first had to be retrieved at Schiphol after the flight and only later that evening could they be transmitted to the RCT, ROT and CoPI by the Coastguard. Eventually, the images were made available at 20.17 hours. On the basis of the pictures from the police helicopter and the Coastguard aircraft, a series of actions were undertaken over the next few hours, including the closure of various ports along the rivers.

Information position of the Regional Crisis Team
Within the Rijkswaterstaat ROT there was a growing awareness that some of the oil might have been submerged and, as a consequence, could have spread out of sight of the units on site without being contained by the screen. For that reason, at 16.30 hours, Rijkswaterstaat carried out an internal situation escalation and established a Regional Crisis Team (RCT).

Rijkswaterstaat works with crisis teams; the crisis organisation functions at three operational escalation levels:

Phase 1: for a limited crisis with a local impact area. A crisis at this level is dealt with by the responsible Duty Officer (OvD).
Phase 2: for a more complex crisis with a regional impact area. For this type of crisis, a Regional Crisis Team (RCT) is established.
Phase 3: for the most complex crisis situations with a national impact area. For this type of crisis, a Corporate Crisis Team (CCT) is established.
The RCT faced a number of challenges. There was no direct line of communication with the ROT and digital information (LCMS) and photographic and film material were not provided as standard to the RCT, by CoPI/ROT. As a result, the RCT did not have access to sufficient information. In addition, expertise within the RCT relating to oil clean-up operations was limited.

On that same evening, the Duty Officer RWS-WNZ instructed the LCM to carry out a second simulation at the request of the ROT, but this time based on the correct parameters. The purpose of this second simulation was to determine whether the oil would be transported as far as the North Sea and could cause problems for the finish of the Volvo Ocean Race in Scheveningen on Sunday 24 June, an event that was expected to attract a large number of pleasure boats and other vessels. The result of this simulation was that it was very unlikely that any problems would arise at the finish as a consequence of the oil.

The realisation within the ROT that the fuel oil could possibly be below the surface of the water, led to several ports being enclosed by oil screens on Saturday evening. The ROT realised that they were still unable to contain floating oil. The second Duty Officer DHMR was not aware of this scenario. During the course of the evening, during an inspection of the 3º Petroleumhaven from a patrol vessel, he observed very little oil on the water surface or on the banks. At 21.28 hours he therefore cancelled the closure of the 3º Petroleumhaven. He took this decision without consulting with or obtaining permission from the ROT. He should have consulted the ROT first, because the ROT was responsible for the affected area. Nonetheless, the decision had no influence on the spread of the oil in the 3º Petroleumhaven, as was subsequently discovered on Sunday morning.
During the initial hours of the crisis management operation, there was a great need for aerial pictures. It took about three hours before these could be taken.

The pictures did not arrive at the Incident Location Command Centre (CoPI) or the Regional Operational Team (ROT) until five hours after the allision. On the basis of these pictures, it became clear that the oil had spread over a far larger area than first believed.

As the realisation grew within RWS that fuel oil could potentially spread even further, the situation was escalated and the Regional Crisis Team (RCT) activated. The RCT was hindered by a lack of access to information sources and limited expertise in the field of oil clean-up operations.

At two points in time the LCWM carried out simulations of the spread of the oil. The first turned out to be unusable. The purpose of the second simulation was to chart out possible consequences for the Volvo Ocean Race in Scheveningen.

Within the ROT there were concerns that fuel oil could also be present below the surface of the water. However, this information never reached the second Duty Officer DHMR. Following an inspection in the evening of 23 June, without consulting with the ROT, the second Duty Officer at DHMR opened the 3e Petroleumhaven for shipping. However, cancellation of the closure had no influence on the further spread of the oil through the 3e Petroleumhaven in the hours that followed.
Oil-smeared swans

On Saturday evening, it was first reported in the Regional Operational Team that swans smeared with oil were observed on the Nieuwe Waterweg. The team decided to bring the smeared swans together at the Bird Sanctuary in Maassluis. Rijkswaterstaat agreed to the request from the ROT to take responsibility for coordination. The operation was organised in collaboration with Sea-Alarm and SON-Respons. Further support from a contractor was arranged, and at a later stage assistance military assistance was provided through the intervention of the chairman of the Rotterdam-Rijnmond Security Region (VRR).

Starting on Sunday 24 June, one day after the allision of Bow Jubail, a large number of reports appeared on social media about swans smeared with oil. As a result, numerous volunteers, wishing to help catch and take care of the smeared swans reported at the bird sanctuary in Maassluis. Many people took the initiative within the port area to search for hundreds of smeared birds, sometimes from privately owned small boats. This caused life-threatening situations because these people had little to none nautical experience. The DHMR was forced impose restrictions on shipping traffic while, moreover, the recovery operation was disrupted.

During the course of Sunday afternoon, such a large amount of swans had been delivered to the bird sanctuary in Maassluis that the sanctuary was no longer able to cope with the situation. They then decided to establish a temporary bird sanctuary near the Maaslantkering. Occasionally this led to emotional outbursts among the volunteers, which in turn raised security concerns and fear of public disorder. As a result, a GRIP-1 situation was announced at local level at 16.30 hours on Sunday afternoon.

The entire operation was concluded after several weeks, at which point the majority of swans were returned to a designated area, after being cleaned and recuperated.

4.4 Reclosure and downscaling (de-escalation)

Sunday 24 June 2018

08.30

HEBO reported to the Regional Operational Team (ROT) that oil was still rising around Bow Jubail.

08.48

The first Duty Officer DHMR issued the instruction to once again close the 3e Petroleumhaven.
12.35

End of the GRIP-2 situation.

In the morning of Sunday 24 June 2018, during a briefing for the ROT, HEBO reported that during the night large quantities of oil had risen to the surface during the night in the 3e Petroleumhaven and the Geulhaven, and that according to the company, the oil was still not yet under control (see Figure 18). In response, early in the morning, the 3e Petroleumhaven was once again closed to shipping traffic by the first Duty Officer DHMR.

The Operational Commander of the ROT announced the end of the GRIP situation at 12.35 hours, followed by a full scaling down of the operation. The responsibilities of CoPI and ROT were transferred to the Policy Team at the Port of Rotterdam Authority and for the area outside the Botlek to RWS-WNZ.

Consequences of closure of the 3e Petroleumhaven

The day after the allision, the Policy Team at the Port Authority was faced with the fact that operations around the 3e Petroleumhaven could be at risk. The closure of the 3e Petroleumhaven could only be revoked once polluted seagoing and inland shipping vessels had been cleaned, and the remaining oil recovered. Until that time, the supply and delivery of products was impossible, and in particular for the refineries and the chemical industry that represented an urgent problem. Any long-term closure of the port would make supply and delivery in bulk impossible, and companies in the Botlek area, including refineries, would perhaps have to be shut down.

The closure of this type of complex production processes can cause environmental damage, as well as dangerous situations. The accelerated shutdown of installations could cause large amounts of intermediate products in shape of black clouds, to be released into the atmosphere via flares. Moreover, the shutdown of these installations and the long start-up processes that follow have major economic consequences.

The limited capacity available for cleaning vessels and fears of the need to shut down the refineries remained high on the agenda of the Policy Team at the Port Authority for the whole of the week. Exxon Mobil, Vopak, Odfjell and Biopetrol announced that they would make preparations for a shutdown for Thursday 28 June. At Aluchemie, a shutdown was being prepared for Friday 29 June. In the end it was not necessary to shut down these companies. Expansion of the vessel washing capacity and a priority system introduced under the management of the DHMR, ensured that products from the chemical companies could be shipped timely.
On Sunday morning the 3e Petroleumhaven was once again closed for shipping, because large volumes of oil had floated to the surface during the night.

On Sunday afternoon, the end of the GRIP situation was announced and responsibilities were transferred from the CoPI and ROT to the Port Authority and Rijkswaterstaat.

4.5  Cooperation

4.5.1  Tasks and responsibilities of the stakeholders
The three most involved parties - RWS, VRR and DHMR - each have their own responsibilities with regard to crisis management in the Rotterdam region.

Those responsibilities are formally laid down in various laws. In the event of surface water pollution, as occurred during the incident with Bow Jubail, an overlap emerges between the three individual responsibilities (see Figure 19). This overlap is further analysed below.
Rijkswaterstaat

Rijkswaterstaat West Nederland Zuid is the water quality manager in the event of disasters in the port of Rotterdam. In accordance with Section 5.29 of the Waters Act, there is an obligation upon the water (quality) manager to draw up a disaster plan and to ensure that exercises are held in effective operation. The disaster plan must be drawn up according to an overview of the types of disasters that can arise, including an inventory of the associated risks. In addition, the plan must provide an overview of measures to be taken, of potential partners in the management operation, of a reporting and alarm procedure, and of schedule outlining the emergency organisation of the manager. With this, the Act regulates the preparation for calamities that pose a direct risk to water quality, among other things. The Act also guarantees alignment with crisis plans and disaster management plans insofar as they are important for the water management.

Rijnmond-Rotterdam Security Region

The VRR is responsible for disaster and crisis management within the port area. On the basis of Article 10 of the Security Regions Act, the safety regions have duties and powers with regard to (the preparation and organisation of) fire brigade services, disaster management and crisis management and/or medical assistance in municipal areas.

The system that the Security Regions Act prescribes, in this respect basically corresponds to that of the Waters Act. The organisation, responsibilities, tasks and legal powers relating to measures and provisions for disaster management and crisis management must be described in a crisis plan. The crisis plan itself must be based on a risk profile, that for example includes an overview of the types of disasters and crises that can arise in the security region.

The weighing and assessment of the consequences (risks) of disasters and crises must be part of the crisis plan. Agreements reached with other parties involved in potential disasters and crises must also be described in the crisis plan.22

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22 In real terms, the crisis plan from the Rotterdam Rijnmond Security Region must be harmonised with the disaster plan from Rijkswaterstaat. Agreements between the VRR and RWS must be described in the crisis plan.
Rotterdam Harbour Master’s Division
The (National) Harbour Master is responsible for nautical management on navigable waterways and ports in Rotterdam. Nautical management of the main waterways de Nieuwe Waterweg, Het Scheur, and de Oude Maas are under authority of the Minister of Infrastructure and Water Management, and is mandated to the Harbour Master. Nautical management of the harbour basins is mandated to the Harbour Master by the Municipality of Rotterdam. The DHMR focuses among others on the following interests referred to in the Shipping Traffic Act:
• Guaranteeing the safe and rapid passage of shipping traffic;
• Maintaining navigable waterways and guaranteeing their usability;
• Preventing or mitigating pollution caused by shipping.

The DHMR fulfils a supervisory role in the deployment of the Screen Pool, of which the Port of Rotterdam Authority is a member. In addition, the Port Authority has drawn up contracts with HEBO for the removal of oil.

The incident involving Bow Jubail resulted in both a calamity as referred to in the Waters Act and a crisis as referred to in the Security Regions Act. Responsibility for careful preparation, by establishing and implementing the disaster plan (Waters Act) and the Regional Crisis Plan (Security Regions Act), lay respectively with Rotterdam Rijkswaterstaat and the Rotterdam Rijnmond Security Region. The disaster plan must be aligned with the crisis plan. Agreements between RWS and the VRR must be described in the crisis plan. Finally, the Rotterdam Harbour Master’s Division also has a task under the Shipping Traffic Act.

4.5.2 Importance of cooperation
In an area where wind, currents and tides affect the spread of liquids, it is not realistic to expect that the entire mass can be kept fully under control in the event of pollution with a large volume of fuel oil. In advance, it is not even possible to exclude the possibility that the pollution will spread over a large area, certainly if fuel oil becomes suspended in deeper layers, below the surface, out of sight of the persons responsible for the clean-up operation. This means that in order to mitigate the most serious consequences of the pollution, in addition to containment, efforts must be focused on a recovery operation and as such large amounts of recovery equipment must be deployed, spread over a large area. Speed is of crucial importance because oil can be most easily removed when floating on the surface of the water, in concentrated amounts. The further the oil has spread both horizontally and vertically, the more difficult it is to clean up.

In the deployment of clean-up equipment, capacity and speed are essential. Equally important is where that capacity should be deployed in order to ensure that the containment and recovery operation of the fuel oil are as effective as possible. The following points are of key importance:
• The availability of adequate knowledge about the product, specifically its behaviour in water;
• The availability of reliable models according to which spread and as such the potential area affected can be predicted;
• The availability of aerial observation, on the one hand to provide reliable indications of the area affected (image forming) and on the other hand to provide clear direct instructions for the recovery operations;
• A thorough clean-up plan, based on the previous three points, so that the equipment can be deployed in a targeted manner and so that priorities can be set in the clean-up methods (containment and recovery).

At the site of this incident, the exceptional situation of sweet and salty water and the behaviour of fuel oil in this water were not taken into account sufficiently. The investigation does not show that people acted from the awareness that this oil would sink. This applied to both the involved members of the CoPI and ROT and the supervisors involved from the Rotterdam Harbour Master’s Division (DHMR) in the Botlek and the 3rd Petroleumhaven, and RWS on the rivers. The extent to which there was confidence in the effectiveness of the oil-bearing screens in the first hours after the accident illustrates this. The fact that relatively quickly after the incident oil was observed outside the screen and that it was spread by the tide, was initially attributed to the fact that the screens had not yet been put in position. Due to the lack of knowledge, the professionals involved were not aware of the behaviour of fuel oil below the surface of the water.

This knowledge was available at other organisation units of RWS. RWS-Zee en Delta (RWS-ZD) is primarily responsible for oil clean-up operations in the North Sea. The experience gained in large-scale investigations and incidents, has over the past few decades not only resulted in specific expertise, but in combination with international obligations, has also led to the structurally organised availability of large-scale clean-up capacity. This capacity relates not only to vessels but also to the rapid availability of aerial observations (people and equipment) on the basis of operational agreements with the Coastguard. Moreover, with the LCM, RWS has access to an organisation that throughout the country is capable of generating locally reliable predictions of the spread of oil.

In this oil clean-up operation, the crisis management organisation at the VRR did request large-scale clean-up capacity, aerial observation and oil spread models from the LCWM, via RWS. For those reasons involvement by RWS-WNZ in the CoPI and the ROT was needed.
Reliable predictions of the spread of the oil, aerial observation, specialist knowledge of the product and expertise of effective methods of containment and recovery of fuel oil must be immediately available if the clean-up operation is to be effective.

The necessary resources in the port of Rotterdam at the time of the accident were provided on the one hand by parties operating subject to the crisis management of the VRR, and on the other hand by RWS.

To ensure that these resources are immediately made available during clean-up operations, cooperation was needed in the lead-up to the crisis management.

4.5.3 Agreements between the parties

The Security Regions Act is the underlying framework for crisis management in incidents on the water. This Act makes no distinction between incident management on the water or on land. In practice, it often emerges that working on water requires a fundamentally different approach and that additional agreements are needed, since for working on water there are generally speaking other crisis partners and other circumstances. This can also be derived to the fact that as suggested earlier, there is an overlap in the responsibilities in respect of surface water pollution.

The existing agreements provided for the necessary harmonization in those situations involving shared responsibility. The guidelines on which these agreements are based are reproduced below. In diagrammatic form, an indication is given of the shared responsibilities to which these agreements relate.

**RWS – VRR Covenant**

The idea of harmonizing disaster plans and crisis plans, based on statutory obligations, led in 2012 to a Covenant for cooperative agreements between the Rotterdam Rijnmond Security Region and Rijkswaterstaat Zuid Holland. This Covenant was still in force at the moment of the accident, and deals with the shared responsibility between RWS and VRR, as reproduced in simplified form in Figure 20.

![Figure 20: Shared responsibility RWS and VRR.](image-url)

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23 In 2012, the Rotterdam-Rijnmond region was the responsibility of the RWS Zuid-Holland region. Today, Rotterdam-Rijnmond reports to the RWS West-Nederland-Zuid region.
The aim of the Covenant is to ensure optimum cooperation in the field of risk management and (preparations for) crisis management. The objective was to make as much use as possible of one another’s expertise, and to organise joint exercises.

The explanatory notes added as an appendix to the Covenant between RWS and the VRR record in Article 8 that it is essential to work in a uniform approach and within nationally developed frameworks as far as possible. One example is ‘The Incident Management on Water Manual’ (‘Het Handboek Incidentbestrijding op het water’).

We already stated in section 4.5.1 that the crisis plan of the VRR must be based on a risk profile. In the Regional Risk Profile drawn up by the VRR for the period 2017-2020, a scenario is included for large-scale pollution of the surface water with (more than) 500 tonnes of fuel oil from a ship. This scenario assumes the spread of the oil by currents and pollution of a large area. It was noted that in this scenario, RWS is not identified as a partner within the complex multidisciplinary preparations for crisis management and disaster management, whereas the water authorities in the security region are mentioned, for example. The Dutch Safety Board considers this a remarkable observation. Not only because it is not in line with the Covenant, but also given the formal responsibility of RWS for, among other things, the water (quality) management in a large proportion of the area covered by the security region.

**Manual for incident management on the water**

In 2009, the Incident management on the water Manual was drawn up for the first time. Major changes in the security domain and the need to keep the Manual up to date resulted in 2015 in a new version of the manual, at the request of the Safety Council. This new version was published by the Institute for Safety (IFV) in 2015, by a project group made up of representatives of the Security Regions as well as representatives from Rijkswaterstaat and the Port of Rotterdam Authority.

The Manual is not formally embedded in legislation and regulations. It has the status of a ‘guideline’ but in and of itself is recognised by the Safety Council and partners in the security domain as a directive guideline.

**Incident management plan for incidents on the water**

The Incident management on the water Manual suggests that specifically in the event of incident management, it is often unclear who is responsible for a process and who is involved in its implementation. For that reason, the Manual assumes Incident Management Plans (IBP) in which agreements are reached on the coordination within the so-called integrated risk water system and the operational elaboration of the scenarios. The Rijnmond-Rotterdam Security Region has also drawn up an IBP for incidents on the water, for the integrated risk water system.

In the Incident Management Plan (IBP) for incidents on the water, a description is given of how disaster management and crisis management take form in the Rijnmond-Rotterdam Security Region and how the crisis partners involved prepare for specific incidents. The
plan relates to fulfilling the overlapping responsibilities between RWS, VRR and DHMR (see Figure 21).

![Diagram showing overlap of responsibilities between RWS, VRR, and DHMR]

**Figure 21: Elaboration of overlap in responsibilities.**

In the IBP, the emphasis is on the following aspects:

- tasks and responsibilities of the various partners;
- scenarios that can arise;
- specific points for attention.

In total, there are seven generic scenarios in the plan for water incidents, one of which relates specifically to pollution of the surface water.

The incident involving Bow Jubail shows that the behaviour of fuel oil in water can have an important influence on the spread of that oil. Above all, the characteristic that fuel oil can partially be present at the surface and at the same time at different depths is vital for the oil clean-up. As a result, the clean-up of fuel oil spread rapidly by current and tidal action must focus as quickly as possible not only on containment but also on recovery. The IBP presented to the Dutch Safety Board within this investigation identifies two sub scenarios within the scenario ‘Surface water pollution’. The first sub scenario relates to floating liquids, such as oil. The second scenario relates to soluble or dispersing substances. The IBP does not describe a sub scenario for pollutants such as fuel oil which do not remain floating on the surface of the water but which (temporarily) remain suspended in deeper layers, which may or may not be out of the sight of the persons responsible for the oil clean-up.

**Agreement between the Security Region and the Rotterdam Harbour Master’s Division**

As well as managing shipping traffic, the Rotterdam Harbour Master’s Division also has a fire fighting task and a task relating to disaster management and crisis management. In the Regional Crisis Plan of the VRR, that role is in fact formally allocated and recorded. In respect of those tasks, DHMR has reached agreements with the Rijnmond-Rotterdam Security Region in the operational agreement between the Rijnmond-Rotterdam Security Region, the Havenbedrijf Rotterdam N.V. and the (National) Rotterdam-Rijnmond Harbour Master. These agreements satisfy the shared responsibility reproduced in diagrammatic form in Figure 22.
This agreement specifies that the DHMR is responsible for ensuring that the necessary people and resources are available to operate as a professional emergency response organisation. The formulated tasks include receiving and passing on incident reports and containment of pollution in the water.

Cooperation arrangement between Rijkswaterstaat and the Rotterdam Harbour Master’s Division

The responsibility of Rijkswaterstaat for the quality of the water in the port of Rotterdam also includes oil clean-up following an oil spill, such as that which occurred following the allision involving Bow Jubail. For part of its task in this area, Rijkswaterstaat makes use of the oil clean-up capacity available to the Rotterdam Harbour Master’s Division (DHMR) (see Figure 23).

This cooperation is laid down in the Cooperation arrangement between the Harbour Master’s Division of the Havenbedrijf Rotterdam NV and Rijkswaterstaat West-Nederland-Zuid. The VRR refers to this Cooperation arrangement in both the ‘IBP incidents on the water’ and in the Regional Crisis Plan.
On the basis of statutory obligations, there was a Covenant for cooperative agreements between the Rotterdam Rijnmond Security Region and Rijkswaterstaat Zuid Holland. Among others, this provided for cooperation in drawing up the Regional Risk Profile by the VRR and encouraging joint planning in respect of water-related scenarios. RWS was only minimally involved in drawing up the Regional Risk Profile. The Risk Profile does include a scenario that relates to the release of more than 500 tonnes of fuel oil into the surface waters.

The Covenant referred to the Incident management on the water Manual as an important example of a nationally developed framework for tackling incidents in the water.

The Rotterdam Rijnmond Security Region, in collaboration with RWS, drew up a joint plan for tackling incidents on the water. This was the Incident Management Plan (IBP) incidents on the water, of the VRR.

Unlike the Incident management on the water Manual, the IBP did not include a scenario in which substances that (partially) sink or continue to be suspended in deeper layers underwater, enter the water. This type of fuel oil is one such substance.

4.6 Conclusions about the organisation of crisis management

The Safety Board concludes that following the allision, the escalation took place rapidly and adequately. On the basis of incomplete information, immediately following the allision an estimate was made that this was indeed a major oil spill, which could spread along the river. For that reason, after slightly more than one hour, the situation was escalated to GRIP-2 and just twenty minutes later the first meeting of the CoPI was held. It is notable that at this stage there was insufficient attention for potential health risks for the crew.

Obtaining and sharing information was less smoothly organised. It took a long time before it was clear precisely how much oil had been spilled. This information was also insufficiently passed on or requested in the two separate reporting channels following the allision. Following the allision, it took more than five hours before aerial images were available that revealed the scale and spread of the pollution. In addition, Rijkswaterstaat proved not always adequately tuned in to a part of the information flows that were available to other participants.

The 3e Petroleumhaven was released on Saturday evening by the second Duty Officer at DHMR on the basis of an inspection of the surface water. This lifting of the closure took place without consultation with the ROT, despite the fact that ROT members were still concerned about the possible presence of oil suspended below the surface which could not be observed in an inspection at surface water level. The lifting of the closure did not influence the spread of the oil in the 3e Petroleumhaven in the hours that followed.
The various parties felt that Rijkswaterstaat primarily had a support role in the event of an oil spill in the port of Rotterdam. A similar asymmetry was also reflected in the cooperation: the staff of the Rijnmond-Rotterdam Security Region and the Rotterdam Harbour Master’s Division were in excellent contact. This was far less the case between these two organisations and Rijkswaterstaat. Nonetheless, VRR, DHMR and Rijkswaterstaat all have a statutory task in relation to oil pollution in the water. Moreover, individually, none of the parties have sufficient resources (e.g. vessels) to independently carry out a major clean-up operation for oil or other pollution in the entire port and the surrounding area. That makes cooperation on the basis of equality not only important on paper, but also an operational necessity.

**Learning from incidents**

The objective of an investigation by the Dutch Safety Board is to learn from incidents with a view to subsequently improving safety. Experience has shown that an investigation by the Dutch Safety Board is in itself an intervention, and that during this process, the parties involved themselves identify initial points for learning and improvement. This type of first order learning was visibly present during the investigation into the oil spill in the port of Rotterdam. The incident left a clear impression on the parties involved and the environmental damage was highly visible. The ship operator involved has already improved its preparations for the port infrastructure at ports where vessels of this type are moored, by drawing up an overview of port conditions. On behalf of the Rotterdam Harbour Master’s Division (DHMR), Crisislab undertook a learning evaluation into the deployment of DHMR. The Rotterdam-Rijnmond Security Region called in the Institute for Safety (IFV) to evaluate the role of the security region following this incident. During administrative discussions with the various parties involved, the Dutch Safety Board observed that the outcomes from these evaluations and self-evaluations are receiving all due consideration, along with the points relating to cooperation between the parties involved. With this report and its recommendations, the Dutch Safety Board aims to take the lessons already being learned from this incident one step further, so that the maximum improvement in safety can be achieved.

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On 23 June 2018, Bow Jubail allided with a jetty in the port of Rotterdam. As a result of the allision, a hole was punched in the ship’s skin adjacent to the fuel tank, causing 217.4 tonnes of fuel oil to pour out of the vessel. The Dutch Safety Board investigated the allision between Bow Jubail and the jetty, the puncturing of the fuel tank, the oil clean-up operation and the organisation of the crisis management that was launched in response to the puncturing of the tank. On the basis of the investigation, the Dutch Safety Board has drawn the following conclusions.

**Allision and accident factors**

The allision of Bow Jubail with the jetty was a direct consequence of the incorrect assessment of the rudder position following an incorrect steering command from the Master. The combination of a number of underlying factors also played a role in the puncturing of the vessel: the tide, the shape of the vessel, the shape of the quayside, the selected manoeuvre and the preparations for that manoeuvre. The risk that a similar incident with precisely this combination of factors could recur is relatively small. An allision of a vessel with a single-walled fuel tank can however in other circumstances also result in a considerable oil spill. This incident shows that the consequences of such a spill can be far-reaching. This illustrates the necessity for maximum focus on prevention.

The point where the vessel was hit was vulnerable because the fuel tank was produced with a single wall. Equipping a vessel with a double-walled fuel tank is the most effective means of preventing an oil spill following an allision of this kind. This has been a legal requirement since 2010 for new vessels, but given the relatively long service life of seagoing vessels, vessels with single-walled fuel tanks are expected to continue to be used for several decades.

**The course of the oil clean-up operation and the organisation of the crisis management**

Following the allision, some of the fuel oil from the vessel became submerged, and as a result became lost from view by the persons responsible for carrying out the oil clean-up. Their focus was on a rapid response in accordance with practised scenarios. This meant that the oil clean-up operation was aimed at a situation in which all oil remains floating on the water, that must then be contained using oil containment screens. This strategy proved partly effective in this case because the screens were unable to prevent the spread of the oil that was suspended below the surface of the water. There was no scenario for oil that mixes with the harbour water, and as a result the persons responsible for the clean-up operation were not prepared for this situation.

In the first phase of the crisis management there was a lack of essential information. There was no direct contact with the vessel and it remained unclear to the emergency services for quite some time how much oil had escaped. There was also no information about the physical and mental condition of the persons on board Bow Jubail.
Also missing were aerial images and accurate spread calculations, so the parties were unaware of the rate at which the oil was spreading. Once it became clear that the oil had spread a long distance down the river, the focus of the oil clean-up operation was shifted to oil recovery. This operation was rapidly initiated but the equipment that was contracted for this task proved insufficient for an oil spill of this size. It took a great deal longer to obtain this additional clean-up capacity.

The Safety Board notes that following the allision, the parties involved did tackle the oil clean-up operation with considerable dedication and effort. However, the investigation has revealed that the agreements and harmonization between the three parties involved proved insufficient. The VRR, the DHMR and Rijkswaterstaat all have a legal task with regard to oil pollution in water. The Rotterdam Harbour Master’s Division of the Port Authority bears the greatest operational responsibility for oil clean-up. However, the Port Authority does not have the resources or knowledge to ensure that an oil spill of this size is tackled as effectively as possible. This makes cooperation with other parties vital. This necessity for cooperation also applies for VRR and Rijkswaterstaat, because they too do not have the resources (e.g. vessels) to independently carry out a major clean-up operation for oil or other forms of pollution in the entire port and the surrounding area. To make this possible, both formal agreements and joint preparation for major disasters must be improved.
The Dutch Safety Board issues the following recommendations:

**With regard to preventing an (oil) spill in the port of Rotterdam:**

*To the Minister of Infrastructure and Water Management:*
1. Place on the agenda of both the European Union and the International Maritime Organization the ambition to bring forward the date for phasing out seagoing vessels with single-walled fuel tanks. For this purpose, make use of the seat occupied by the Netherlands over the next two years on the IMO Council.

*To Odfjell Ship Management and Loodswezen Rotterdam-Rijnmond (Pilotage Service):*
2. Ensure that it is clear to all parties how a manoeuvre is to be undertaken and exactly what is expected of them during that manoeuvre. In the framework of Bridge Resource Management (BRM), actively make this information available to all crew members and check regularly that the BRM system is applied.

*To the Port of Rotterdam Authority, DHMR and Odfjell Ship Management:*
3. For all seagoing vessels visiting the port, ensure that before they enter the port area, the port authorities know whether the vessels are equipped with single-walled fuel tanks.
4. Draw up an inventory of the key safety risks involving seagoing vessels with single-walled fuel tanks for (the area surrounding) the port and take measures to mitigate these risks. These must include but not be restricted to:
   - identifying and creating (guidelines for) appropriate moorings;
   - manoeuvring support by (specific types of) tugboats;
   - the timing of mooring operations in relation to water levels and the shape and cargo of the vessel.

*To the Port of Rotterdam Authority and DHMR:*
5. Together with national and international ports, draw up additional safety requirements on seagoing vessels with single-walled fuel tanks.

**With regard to oil recovery:**

*The Port of Rotterdam Authority, DHMR and Rijkswaterstaat:*
6. Invest in knowledge and innovation in relation to oil clean-up and restricting the spillage of oil. Make use of the knowledge available abroad.
7. Develop scenarios about oil spillages or spillages of other substances in which factors such as tide, current, and type and volume of the substance play a role, and use these scenarios in the operational choices and preparations for disasters.
8. In the event of a disaster, ensure that aerial support is immediately available and ensure that information and images can be rapidly exchanged and used.
With regard to the organisation of crisis management:

To the Minister of Infrastructure and Water Management:
9. Ensure that Rijkswaterstaat actually fulfils its responsibility for the quality of the surface water in the port of Rotterdam. This calls for cooperation agreements with the other stakeholders at tactical, operational and strategic level. Check whether these matters are also well-organised at other locations in the country.

To the Port of Rotterdam Authority, DHMR, the Rijnmond-Rotterdam Security Region and Rijkswaterstaat:
10. Improve preparations for large-scale oil spills at operational and strategic level, by drawing up a disaster management plan and organising joint exercises.
A.1 The Dutch Safety Board

The Dutch Safety Board investigates incidents with the aim of learning lessons, in order to enhance safety in the Netherlands. To this purpose, the Safety Board identifies the direct and underlying causes of the incident, because these often reveal structural safety shortcomings. The Safety Board identifies these structural safety shortcomings and formulates recommendations to correct them. The Board operates in a broad policy field and is free to choose which accidents to investigate, based on its own judgement, but is also sometimes obliged by legislation to conduct an investigation. The Dutch Safety Board also undertakes theme-based investigations in which multiple similar incidents and accidents are investigated, all with the aim of mitigating risks.

A.2 Background to the investigation

In accordance with EU Directive 2009/18/EC and the Dutch Safety Board Act (Rijkswet Onderzoeksraad voor veiligheid), the Dutch Safety Board has a legal obligation to investigate certain types of shipping accidents. In accordance with this obligation, on 3 July 2018, the Board decided to launch a short investigation into the collision involving the Bow Jubail, and the subsequent large-scale oil spill on 23 June 2018. The decision was taken to investigate both the cause of the collision and the tackling of the environmental damage after the ship leaked fuel oil. The statutory remit of the Safety Board includes the investigation of environmental damage.

In the period July - September 2018, the immediate consequences of the collision were recorded and relevant investigation material was collected, while interviews were held with those directly involved. This resulted in a relatively clear picture about the events and the causes of the collision. As concerns the oil clean-up operation, however, many technical and administrative questions remain. On 16 October 2018, the findings of the investigation represented sufficient grounds for the Safety Board to continue the investigation as an extended investigation.
A.3 Purpose

The aim of the Safety Board in undertaking this investigation was to focus attention on the complex public and private relationships within the port of Rotterdam. The incident involving the Bow Jubail, in particular the efforts to control the resultant environmental damage led to the decision to examine the cooperation between the parties involved and to consider the balance in economic, safety and other interests.

The aim of this investigation is to contribute to improving safety for people and the environment in the port of Rotterdam. The Dutch Safety Board expects that by better managing the safety risks prior to and during a (large-scale) oil spill, the seriousness of the consequences of such an incident can be reduced.

A.4 Definition

In the case of the Bow Jubail, there were in fact two incidents. The first was the nautical incident, namely the collision with the jetty, which resulted in the puncturing of the vessel. The second incident involved the presence of a large volume of fuel oil in the water.

In a nautical sense, the investigation was restricted to identifying the cause of the collision. Collisions with objects on shore or with other vessels occur with some regularity in port areas, and as a rule have no far-reaching consequences. For that reason, the first part of the investigation was focused on the factors which in the specific case of the Bow Jubail resulted in a large-scale leakage of fuel from the mooring vessel.

The pollution of both the surface water and the deeper waters in and around the port of Rotterdam demonstrated that the puncturing of a (seagoing) vessel in the port can result in large-scale environmental damage in a far wider area. If a spill occurs, the consequences are generally irreversible and the only option that remains open is to attempt to limit these consequences as far as possible. The incident involving the Bow Jubail led the Dutch Safety Board to investigate crisis management in the port of Rotterdam, with specific focus on oil clean-up. The Safety Board opted to investigate and describe the incident involving the Bow Jubail and its effects right from the start of the incident on Saturday afternoon 23 June 2018 through to the end of the crisis situation on Sunday afternoon 24 June 2018. After that time, no new developments relevant for this investigation took place.

In the part of the investigation relating to the pollution, the main focus was on the technical and administrative aspects of the large-scale oil clean-up operation in the port of Rotterdam. The technical aspects related primarily to the question whether the tools and methods employed in dealing with the leakage from the Bow Jubail were adequate. The administrative aspects investigated by the Safety Board aimed at determining whether the organisation of the public and private parties involved in the oil clean-up were sufficiently prepared for such an operation.
A.5 Investigation questions

As concerns the collision and the puncturing of the Bow Jubail, the investigation focused on the following investigation question:

Which factors led to the puncturing of the fuel tank of the Bow Jubail which resulted in the leakage of a large quantity of fuel oil?

In accordance with international shipping regulations, Norway was involved in this incident as a 'State with a substantial interest', as a consequence of which this nautical section of the investigation was undertaken in collaboration with the Norwegian sister organisation AIBN. The Dutch Safety Board occupied the leading role.

As concerns the procedures to tackle the consequences following the occurrence of the oil spill, the investigation focused on the following investigation question:

To what extent does this incident in the port of Rotterdam give grounds to improve or adjust the approach employed, both at technical and administrative level?

With the following sub questions:

- To what extent were the technical resources (oil containment screens, oil-spill response vessels, etc.) and expertise (specialists) on hand adequate and attuned to the latest developments in the field?
- To what extent did the administrative approach to the oil clean-up operation reflect a smoothly functioning and harmonised crisis organisation?

A.6 Data collection

Data collection on board the Bow Jubail
Immediately following the report of the collision, the Safety Board visited the site and collected data on and around the vessel. This included photographic material of the situation on board the vessel and the jetty, information from the VDR and data from interviews with the crew.

Public sources, retrieved documents and interviews
As part of this investigation, the Dutch Safety Board studied a large number of public documents, including the Port Regulations, covenants and contracts between the various stakeholders, etc. In addition, the Safety Board requested documentation and figures

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27 Both organisations carried out the on-site investigation, together. This involved jointly interviewing the crew of the Bow Jubail and sharing investigation information.

28 The present investigation report was drawn up and published by the Dutch Safety Board. Norway is entitled to issue comments on a draft version of this report, and was given the opportunity to do so, see also Appendix B.
from the various parties involved. Around 40 interviews and telephone conversations
were held with representatives of these organisation. In November 2018, the investigation
team also attended an exercise of the Stichting Schermenpool Rotterdam.

Other investigations
The Safety Board took note of a number of other investigations carried out in response
to this incident. These investigations were:

- On behalf of the owner of the Bow Jubail, Odfjell SE, the insurers (P&I Club) launched
  an investigation into the events on board the Bow Jubail on 23 June 2018.
- The Netherlands Public Prosecution Service launched a criminal investigation both
  into the maritime and environmental aspects of the accident. The Dutch Safety Board
  has been in touch with the Public Prosecutor about the progress of this criminal
  investigation. Relevant investigation information as recorded by the Harbour Police
  was handed over to the Safety Board.
- The Port of Rotterdam Authority evaluated the incident with external assistance
  (CrisisLab). This did not result in a separate investigation report, partly because the
  Safety Board was investigating the incident.
- The Rotterdam Rijnmond Security Region commissioned an external investigation
  specifically into the effectiveness of the Coordinated Incident Management Procedure
  (GRIP) upscaling. This investigation was undertaken by the Institute for Safety (IFV).
- Rijkswaterstaat carried out an internal investigation and evaluation of the incident.

Legislation and regulations
In addition to the document study, interviews and conversations, the Safety Board
mapped out and analysed the relevant legislation and regulations.

A.7 Analysis and judgement

The information obtained was mapped out and further analysed using a number of
analysis methods. A detailed chronological chart was first produced using the STEP
method, to identify the various events and the relationships between them. Subsequently
the collision between the ship and the quayside was investigated using the Tripod
method: in which direct causes and contributing factors were mapped out in order to
gain an insight into the safety risks that were present. With regard to crisis management,
an understanding was gained into the hierarchical lines and responsibilities of the various
stakeholders and the relationship with legislation and regulations using the STAMP
method.

The Safety Board assessed its findings according to an assessment framework (see
Appendix C). This consisted on the one hand of a legal framework that brings together
national and international legislation, regulations and guidelines, and on the other hand
a framework drawn up by the Board itself, based among others on its own previous
investigations and scientific insights. This assessment framework allows the Safety Board
to identify expectations of the stakeholders, over and above the limits of the legal
framework.
A.8 Supervisory committee

For the purposes of this investigation, the Dutch Safety Board appointed a supervisory committee, consisting of external experts who can offer expertise relevant to the investigation. These members were appointed to the supervisory committee in their personal capacity. The committee met on three occasions to exchange thoughts and ideas with the Safety Board and the team members regarding the format and findings of the investigation, the conclusions and possible potential solutions. The committee fulfilled an advisory role within the investigation. The Dutch Safety Board is responsible for the report and the recommendations. The committee is composed as follows:

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
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</thead>
<tbody>
<tr>
<td>M.B.A. van Asselt (chairwoman)</td>
<td>board member, Dutch Safety Board</td>
</tr>
<tr>
<td>J. van der Vlist</td>
<td>extraordinary board member, Dutch Safety Board</td>
</tr>
<tr>
<td>J.G. van Erp</td>
<td>professor of Public Institutions, University of Utrecht</td>
</tr>
<tr>
<td>E. Leemans</td>
<td>maritime consultant; former director Stichting De Noordzee (SDN)</td>
</tr>
<tr>
<td>C. Oudendijk</td>
<td>former harbour master Amsterdam</td>
</tr>
<tr>
<td>B. Vree</td>
<td>former CEO Smit International; former CEO APM Terminals</td>
</tr>
<tr>
<td>W. Koops</td>
<td>former lecturer NHL Stenden University of Applied Sciences</td>
</tr>
<tr>
<td>Vice Admiral (Rtd) J.W. Kelder</td>
<td>former Commander of Dutch Naval Forces</td>
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A.9 Project team

The project team consisted of the following persons:

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
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<tbody>
<tr>
<td>A. Umar</td>
<td>investigation manager</td>
</tr>
<tr>
<td>H.J. Korver</td>
<td>project manager (from 15 October 2019)</td>
</tr>
<tr>
<td>R.J.H. Damstra</td>
<td>project manager (until 15 October 2019), investigator</td>
</tr>
<tr>
<td>M. Schipper</td>
<td>investigator</td>
</tr>
<tr>
<td>H.W. Verzijl</td>
<td>investigator</td>
</tr>
<tr>
<td>A.T. Visser</td>
<td>investigator (external, until 1 July 2019)</td>
</tr>
<tr>
<td>M.H. Verschoor</td>
<td>Investigation development consultant</td>
</tr>
<tr>
<td>P. Boers MA</td>
<td>secretary rapporteur</td>
</tr>
<tr>
<td>H. van Rooij</td>
<td>consultant</td>
</tr>
<tr>
<td>S.Lalmohamed</td>
<td>project support</td>
</tr>
<tr>
<td>R. Lagendijk</td>
<td>project support</td>
</tr>
</tbody>
</table>
The following persons contributed:

<table>
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<tr>
<th>Name</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>M. Zeinstra</td>
<td>external consultant (NHL Stenden University of Applied Sciences)</td>
</tr>
<tr>
<td>S. Steenbrink</td>
<td>external consultant (NHL Stenden University of Applied Sciences)</td>
</tr>
</tbody>
</table>
RESPONSES TO THE DRAFT REPORT

In accordance with the Dutch Safety Board Act, a draft version of this report was submitted to the various stakeholders. The following parties were asked to check the report for factual inaccuracies and inconsistencies:

- Minister of Infrastructure and Water Management
- Odfjell SE
- LBC Tank Terminals
- Dutch Pilots Association
- Board of the Rotterdam Rijnmond Security Region
- Board of Directors of the Port of Rotterdam Authority and Rotterdam Harbour Master
- HEBO Maritiemservice

The Norwegian sister organisation Accident Investigation Board Norway (AIBN) was also given an opportunity to issue comments on part of the report.

The reactions received were dealt with in the following manner:

- Rectifications to factual inaccuracies, additions at detail level and editorial comments were adopted by the Safety Board (wherever relevant). The appropriate sections of text have been adjusted in the final report. These reactions are not reported separately.
- Wherever the Dutch Safety Board did not adopt the content of reactions, an explanation of this decision is given. These reactions and the explanatory notes appear in a table that can be accessed via the website of the Dutch Safety Board (www.onderzoeksraad.nl).
FRAME OF REFERENCE

C.1 Introduction

The mission of the Dutch Safety Board is to improve safety in the Netherlands, in particular in those situations in which citizens are dependent for their safety on the government, companies or other institutions. Based on that mission, in the current investigation, the Board has passed judgement on the management of safety risks arising from (oil) spills in the port of Rotterdam. The investigations by the Safety Board do not address issues of blame or liability. The aim of the investigations is to draw lessons so as to reduce the risk of a similar incident in the future or to mitigate its consequences. The intention of this specific investigation was to contribute to reducing the public concern brought about by this incident.

For each of its investigations, the Safety Board draws up an assessment framework to indicate which aspects it included in its considerations. The underlying principle is that all relevant actors have a responsibility towards society to manage safety risks as systematically and effectively as reasonably possible.29 The assessment framework provides an outline description of the nature of those responsibilities in the opinion of the Safety Board. By identifying deviations from the assessment framework the Board is able to clarify where, in its judgement, safety improvements can be achieved. The assessment framework for the current investigation consists of the following elements:

- Safety management;
- Nautical safety;
- Crisis management and incident control.

C.2 Safety management

The Safety Board expects visitors and organisations that undertake or facilitate high-risk activities to do more than merely comply with the requirements of legislation, regulations and (international) guidelines. Below, a description is given of what the Dutch Safety Board expects and the way in which the various stakeholders fulfil their individual responsibility for safety.

29 The Safety Board expects all stakeholders to consciously and transparently set off the risks against the effort, time and investments needed to mitigate and/or manage those risks. The underlying principle is derived from the so-called ‘ALARP’ principle (As Low As Reasonably Practicable).
1. **Insight into risks**
The starting point for achieving the required safety level is an assessment of the system followed by an inventory of the accompanying risks.

2. **Demonstrably effective and realistic safety strategy**
Next, to prevent undesirable/unintended occurrences or to manage their consequences, businesses and organisations must lay down a realistic and practical safety strategy. In other words, they must at all times take all available measures to mitigate the identified risks, unless the mitigation tasks bring with them demonstrably unreasonable costs or other negative consequences. In making this assessment, all relevant legislation and regulations, standards, guidelines and best practices from the sector, together with their own insights and experience within the organisation, should be taken into account.

3. **Implementing and ensuring compliance with the safety strategy**
The management of a company or organisation is responsible for determining and subsequently implementing and enforcing a safety strategy. This includes:
   - a description of the way in which the specified safety strategy will be put into practice, with clear attention for actual targets and the resultant measures.
   - a transparent, uniform allocation of responsibilities, accessible to everyone within the organisation, both on the shop floor and in the implementation and enforcement of safety plans and measures.
   - a clear record of the required staffing levels and expertise for the various tasks.
   - the clear and active centralised coordination of all safety activities.

4. Continuous improvement of the safety strategy, learning from incidents
A system approach to safety also means that existing assumptions by the management must be periodically examined against advancing insight. It is essential that all users of a system have the opportunity to contribute their own experiences and possible solutions for practical improvement, that sufficient time and capacity be provided to identify and evaluate risks, and that the way in which the risks are reduced is embedded throughout the organisation. In other words, the safety strategy must be continuously fine-tuned on the basis of:
   - risk analyses undertaken periodically (and at least in the event of any change to the underlying principles), together with observations, inspections, audits and safety cases (*proactive approach*).
   - a system of monitoring and investigation of incidents and (near) accidents and an expert analysis (*reactive approach*).

5. **Supervision by management, involvement and communication**
The management/supervision by the affected parties/organisations:
   - are responsible internally for clear and realistic expectations in respect of safety ambitions, and are responsible for a climate of continuous improvement of safety on the shop floor, at the very least by setting a good example, and providing sufficient people and resources.
   - must communicate externally in a clear manner, and on the basis of clear and specified agreements with the environment, on the general work approach, the method of assessing that approach specifically in the event of deviations, etc.
6. Just culture
To ensure the optimum management of safety risks, within the organisation and within the sector, a culture is needed that is aimed at learning from incidents. In the safety sector this is referred to as a just culture. This describes an organisation culture in which employees and others are willing and able to call one another to account for unsafe behaviour and are encouraged to report incidents without having to fear punishment for their actions, omissions, mistakes or decisions. A just culture is also a culture in which gross negligence and deliberate violations are not tolerated.

C.3 Nautical safety
To ensure that shipping traffic passes safely and rapidly through Dutch waters, specifically the following interests must be served in accordance with the Shipping Traffic Act:

- Ensuring the safe and rapid passage of shipping traffic;
- Maintaining shipping lanes and guaranteeing their usability;
- Preventing or restricting damage by shipping traffic to water management, banks and flood defences, or civil engineering structures located in or above shipping lanes;
- Preventing or restricting external safety risks in relation to shipping;
- Preventing and restricting pollution due to shipping.

Ensuring the safe and rapid processing of the almost 30,000 seagoing vessels and 120,000 inland shipping vessels that annually visit the many navigable waterways and docks of Rotterdam requires considerable effort by a number of parties. Employees of the Port of Rotterdam Authority, pilots from the Dutch Pilotage Service (Nederlandse Loodswezen (NL)), tugboat services, boatmen of the mooring and unmooring organisation the Koninklijke Roeiers Vereeniging Eendracht (KRVE) and the shipping traffic participants themselves must work together to ensure nautical safety in the port. The tasks, responsibilities and powers of all these parties, whether or not based on legislation and regulations, are described in more detail below.

Port of Rotterdam Authority
The large number of docks, the huge numbers of visiting vessels, the considerable diversity of vessel types and cargo types, the resultant necessarily diverse port infrastructure, and the fact that Rotterdam is a tidal port are elements that can together generate a wide variety of potential safety risks. These risks may relate to undesirable events and/or undesirable effects such as risks to public health, damage and pollution.

If, despite its best efforts, an unsafe situation does arise, the Harbour Master of the Port of Rotterdam Authority must ensure that its effects are limited. If this is not possible, additional focus must be placed on preventive measures. Concretely, in relation to nautical safety the Safety Board expects the Port Authority to ensure adequate and permanent shipping traffic control, in accordance with its tasks, legal powers and responsibilities under public law, that it cooperates with other nautical service providers to ensure that shipping traffic is handled rapidly and safely, that it takes the lead in risk inventory and risk management activities (in collaboration with other nautical service providers in the port and owners and operators of port infrastructure elements such as
quaysides and jetties), and ensures that commercial and economic interests in no way negatively affect safety.

**Rotterdam Harbour Master’s Division**

As an officially recognised element of the emergency services, the Harbour Master’s Division of the Port of Rotterdam Authority is also tasked with guaranteeing the continuity and safety of shipping traffic and the environment together with the other emergency services.

**Pilots**

Seagoing vessels entering a port experience local circumstances that are not always immediately clear to the crew. This not only relates to finding the ideal route within the port but also relates to, for example, the applicable sailing rules, up-to-date knowledge of currents and tides and knowledge of quaysides, jetties and other mooring locations. For the safety of the port itself and for the captain of a seagoing vessel, who bears final responsibility for everything that happens with and on his vessel, it is essential that this knowledge be present on board, as the vessel enters the port.

Seagoing vessels that sail to and from Dutch seaports are in principle required – in accordance with the Shipping Traffic Act – to seek assistance from a pilot. The Pilotage Act determines that piloting may in principle only be provided by authorised and registered pilots. The Pilotage Act specifies that the task of the pilot is to advise the captain or shipping traffic participant, but that subject to permission of the captain, the pilot may also act as the shipping traffic participant. Pilots are expected to advise the captain of a seagoing vessel and:

- to provide the captain and crew with accurate knowledge and experience of specific local sailing routes, docks, tides, currents, jetties and quaysides, traffic control systems, traffic flows and other information on board relevant for safe passage;
- to reach clear agreements on who acts as the traffic participant on board;
- as an independent traffic participant or on behalf of the captain, to guide tugboats and boatmen;
- as an independent traffic participant or on behalf of the captain, to be responsible for communication with tugboats, boatmen, traffic controllers, other shipping traffic and local authorities, and where necessary to translate this communication (generally in Dutch) and to adequately report on such communication to the captain.

**Tugboat services and boatmen**

Seagoing vessels almost always require assistance in manoeuvring to their mooring, and during the mooring process itself. That assistance is provided by tugboats and boatmen, who carry the hawses from the ship to shore, and secure them there. The extent to which and the way in which these parties are involved is not determined by the captain of the tugboat. The tugboat captain receives orders from the vessel to be assisted, generally via the pilot and via the ship’s radio. However, the captain of the tugboat is responsible for the safety of his own vessel, and his crew.

To ensure that the ship that receives assistance is able to manoeuvre safely and efficiently, the crew of the tugboat can be expected:
• to continuously monitor and respond to the ship’s radio channel via which a link has been established to the vessel;
• to immediately confirm and follow orders issued from the vessel;
• to adequately notify the vessel of the position and activity of the tugboat in respect of the vessel;
• to warn the vessel and the environment of any potentially hazardous situations.

Ship Manager and crew of the Bow Jubail
For vessels such as the Bow Jubail, the international SOLAS Convention requires that a safety management system is operated on board, that satisfies the requirements laid down in the specially developed International Safety Management Code (ISM-Code).

The ISM Code specifies that a ‘company’ is formally designated to take over the obligations and responsibilities imposed by the ISM Code from the owner of the vessel. In the Netherlands, instead of the word ‘company’, the term ‘ship manager’ is commonly used. In the event of the Bow Jubail, the ship manager was Odfjell Management AS. This means that the approach to (environmental) safety as implemented on board a vessel must be integrated in the safety management system (SMS) drawn up and implemented subject to the responsibility of the ship manager. This includes developing, implementing and maintaining procedures, plans and work instructions aimed at guaranteeing the safety of crews, the vessel and the environment and ensuring that tasks are allocated to qualified personnel. It should be noted that the ISM Code does not provide a precise description of what the term qualified personnel means. Instead this is described in the STCW Convention. In addition to requirements relating to training and experience, this convention also refers to training in what is known as Bridge Resource Management.

With regard to the Bow Jubail, the assessment framework for nautical safety for Odfjell Management AS and the crew consisted of the safety management system implemented on board made up of procedures, work instructions and checklists relating to sailing practice in the port, sailing with a pilot on board, mooring the vessel, the performance of the bridge team and the correct functioning and operation of the vessel (more specifically rudder, propulsion system and bow thruster). The requirements imposed on training and experience of crew members were also part of the assessment framework.

C.4 Crisis management and incident control

Crisis management
The Security Regions Act (Wet veiligheidsregio’s - Wvr) specifies that the mayor and aldermen in a municipal area are responsible for crisis management (Article 2 Wvr). Within his municipality, the mayor has overall command in the event of a disaster or in the event of a serious fear that a disaster is about to occur. This enables him to issue commands to organisations that are not subject to his authority, but that do participate in disaster management in his municipality (Article 5 Wvr). In accordance with the
subsidiarity principle, the mayor gives no orders to the functional chain but requests upon the relevant National Commander to ensure that the necessary measures are taken.

The Wvr makes no distinction between incident control on the water or on land. As a consequence, this Act also relates to incident control on (inland) waterways that form part of the municipality. Although parallels can be drawn to the situation on land (for example to incidents in the chemical industry), in practice working on water demands a completely different approach and additional agreements are required, since in working on the water, generally speaking, other crisis partners and other circumstances apply. With that in mind, the Institute for Safety (IFV) on behalf of the Safety Council (Veiligheidsberaad) has drawn up a manual for dealing with incidents on water entitled *Handboek incidentbestrijding op water*.31

**Water quality management**

On the basis of environmental legislation, including the Environmental Management Act and the Waters Act, responsibility for the quality of Dutch waters lies with the water quality manager. In the port of Rotterdam that is Rijkswaterstaat. This does not necessarily mean that responsibility for water quality must in all cases be maintained by Rijkswaterstaat itself. Rijkswaterstaat must certainly ensure that the process functions properly, but under its permanent responsibility is able to outsource implementation to other parties.

The water quality manager is responsible for the preparation for incidents relating to environmental pollution, thermal contamination, nuclear contamination and botulism. To make this possible, the following requirements must be fulfilled: a plan adopted at administrative level, a scenario, an alarm table or an on-call system, designated, trained and exercised staff, backed up by checklists/instructions and high-quality equipment. All plans, procedures and instructions must be periodically updated by the water quality manager. The water quality manager must also consider the process for disaster management plans.

Water quality management consists of ensuring the quality of the water both in normal circumstances and during and following an incident. The water quality manager must both make maximum efforts to prevent water becoming polluted with substances that enter the surface water and to ensure the recovery from the consequences of pollution.

**Oil clean-up**

Dealing with large oil spills on the water is almost always an uneven battle, even if only because of the delays for those responsible for cleaning up the water with their equipment, quite simply because they have to travel to the site of the spill. Once they arrive, the spilled oil has often already spread over a large area, certainly in a tidal port like Rotterdam. It is therefore essential that all the relevant parties be prepared for various types of oil spills, according to a carefully coordinated clean-up plan, so that no unnecessary time is lost during implementation.

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31 The most recent version of this manual dates from 2015.
In line with the previously described principles of safety management, this means that a risk analysis must first be carried out. The outcome of the analysis is the probability of various scenarios, and the accompanying expected quantities of oil (be it cargo or fuel oil). On that basis, containment plans can be drawn up, that take account of the degree of risk for the environment, optimum containment and removal methods, ecologically or economic vulnerable areas, etc. On the basis of these plans, DHMR, Rijkswaterstaat and the VRR can and must make preparations in terms of organisation, coordination, staffing, equipment, knowledge of (tidal) flows and models that make it possible to estimate the spread of the oil, etc.
### VESSEL DATA

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<tr>
<th>Vessel data</th>
<th>Bow Jubail</th>
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<tr>
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</table>
FUEL OIL AND OIL CLEAN-UP

E.1 Fuel oil

Fuel oil is obtained from the distillation of petroleum, either as a distillate or as a residue. Small molecules such as those in propane, naphtha, gasoline for cars and aviation fuel have a relatively low boiling point and are removed at the start of the distillation process. Heavier petroleum products such as diesel and lubricating oil are far less volatile and distil more slowly. Bunker oil is even heavier and almost literally sinks to the bottom of the drum. In shipping, heavy fuel oil is often used as bunker oil. The heaviest product released during the petroleum distillation process is asphalt.

Fuel oil is characterised by its high density (920 to 1020 kg/m³), which increases the probability of ‘submerging’. Spilled oil with a density that is higher than that of the water into which the oil is spilled, will sink to the bottom. Only if the density of the oil and that of the surrounding water is identical or differs only slightly does the oil remain floating on the surface of the water. The oil can then easily submerge, for example as a result of wave action or any other form of motion on the water surface, so that it remains located somewhere between the surface and the bottom.

Because the surface tension of water is greater than that of oil, oil easily spreads out in a thin layer. Spilled oil spreads across water in all directions, until it is restricted, for example by a bankside or an oil containment screen. Under the influence of wind and (tidal) current, an oil slick spreads rapidly downstream and downwind. The speed with which oil spreads across water depends to a considerable degree on the viscosity of the oil, which in turn is dependent on the composition of the oil and the temperature of the surroundings. An oil slick rarely spreads out evenly; numerous different layer thicknesses can occur in an oil slick, which can be distinguished by the different colour tones. It is only clearly visible from the air where the ‘thicker’ oil layers are located. The refraction of light makes this more difficult to see, from a vessel.

Various mechanisms can influence the density of the oil and play a role in whether or not the oil becomes submerged. If may for example be caused by the evaporation of lighter components from the oil, changes to ambient temperature, the absorption of sediment in the oil and photo oxidation of the oil.

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32 997 kg/m³ and 1025 kg/m³ for freshwater and salt water respectively.

33 Surface tension is the natural phenomenon according to which the surface of a liquid at a liquid-gas transition acts as a resilient layer.
In addition to the temperature of the oil, the salinity of the water also has an effect. Salt water has a higher density than freshwater. The so-called ‘salinity’ of the water in the port of Rotterdam varies, depending on the moment in time and the water depth. The tide brings in salt water from the sea, and freshwater is carried down from the rivers. This dynamic interaction means that the density of the water in the port of Rotterdam is not identical in all locations and at all depths.

As a result, the oil can float back to the surface after shedding absorbed sediment, absorbing a lighter material, a change in ambient temperature or a change in the salt content of the water (salinity).

E.2 Oil clean-up

The degree of success of any oil clean-up operation is first and foremost determined by the speed with which the operation swings into action. In particular in the case of large-scale contaminations and spills involving heavier oil products such as fuel oil, the contaminants do not ‘disappear’ as a result of natural processes, but spread out over the water. If an oil slick is not effectively dealt with in open water, it eventually results in pollution of banks, jetties and vessels. An oil clean-up involves two phases: containment of the oil, followed by removal.

**Oil containment screens (containment)**

Oil that is released into the surface water spreads rapidly to form a thin layer. Close to the spill site in particular (in other words, the source), oil containment screens can prevent the further spread of that layer. Using screens of this kind, oil can also be ‘guided’ in the desired direction, for example in order to protect vulnerable areas. By dragging the screens, widespread floating oil can be concentrated, before being removed.

In addition to the draught of the screen itself, the effective functioning of a screen depends on the flow speed of the water in relation to the (stationary) screen. If the flow speed of the water is greater than 0.3 metres per second in a direction perpendicular to the screen, the oil floating on the water will flow beneath the screen, and at higher wind speeds, there is a realistic possibility that the screen will break. The wind can also negatively influence the functioning of oil containment screens. Above a wind speed of 5 Beaufort, the wind simply blows the oil over the screen. At a wave height of more than one and a half metres, screens are no longer effective.

**Oil removal sweeping arms (oil removal)**

For the second phase of the operation, the mechanical removal of oil, Rijkswaterstaat developed a sweeping arm system in the nineteen seventies and eighties. The sweeping arm consists of a wooden screen made of oil-repellent concrete ply, attached to a welded framework, between two floats. The sweeping arm is attached to the side of the oil removal vessel and dragged through the water, sweeping a mixture of oil and water that is dumped into a collection trough, on board. Depending on the height of the waves, the maximum speed of operation is around three kilometres per hour.
Dynamic oil removal

If the flow speed is too high and on wide waters, oil containment screens can only be deployed to guide the oil in the desired direction. An alternative approach to keeping the oil in one place is the use of sweeping systems, that actually remove the oil during the sweeping process. The sweeping system then passes through a floating oil slick, concentrates the pollution in the desired location, and then removes it. Sweeping systems can also be used in combination with oil containment screens, in order to increase the width of the sweep. One approach that is often used is the so-called open U configuration, which massively increases the effectiveness of the system: two vessels concentrate the oil into a narrow track.

During employment of sweeping systems including oil containment screens on open water, one requirement remains that the vessels are constantly assisted by air support. From on board a ship there is insufficient overview of the entire area of pollution, and it is not possible to precisely estimate where the concentrated oil (slicks) are floating on the water.

E.3 Organisation of oil containment and removal

The port of Rotterdam is a location where not only goods are transhipped, but also where vessels take on fuel. During all these activities, a whole variety of substances may be spilled and released into or onto the surface water, resulting in polluted quayside walls, jetties and sloping banks. Pollution not only has consequences for the environment, but also for the economy. The Port of Rotterdam Authority formulated the operating principle that in 95% of all cases, the maximum delay to a vessel as a result of a spill may not exceed five hours.

HEBO Maritiemservice

To contain the spread of oil spills, on 1 January 2010, the Port of Rotterdam Authority entered into an agreement with the company HEBO Maritiemservice based in Zwartsluis (HEBO), for a period of 5 years. For the years 2015 and 2016, the agreement was mutually extended, and in 2017, it was renewed for a further 5 years.

The principle according to which this agreement was entered into was that the Port of Rotterdam Authority demands continuous (24 hours a day, 7 days a week) availability from HEBO, to swing into action to limit the consequences of a spill (pollution) or incident, irrespective of weather conditions, unless the safety of the company’s staff is put in danger. To meet this requirement, HEBO has a pool of staff, equipment and a fleet available in Rotterdam. The Port Authority expects HEBO to be able to supply sufficient capacity within five hours to remove in theory at least 350 m³ of spilled product. If a second incident occurs during this same timeframe, HEBO is required to provide the capacity to remove 175 m³ of spilled product per incident, in the same five-hour period.

Containment screen pool

The Schermenpool Rotterdams Havengebied (SRH; in English: Rotterdam Port Area Containment Screen Pool (SRH) was established on 5 October 2001 as the result of a
collaborative venture between the Harbour Master’s Division of the Port of Rotterdam Authority and the oil handling terminals, brought together in the Deltalinqs organisation. The SRH was established in response to the idea that the oil containment screens already available within the port and industrial area of Rotterdam could be jointly deployed, thereby considerably reducing both the number of screens required, and the resultant costs.

Since October 2004, the SRH has enjoyed foundation status. Since that time, too, the Joint Fire Brigade (Gezamenlijke Brandweer - GB) has become part of the SRH. The fire brigade manages the equipment and is responsible for transport and maintenance. The SRH operates in the Botlek and Europoort area. It offers its services in return for an annual fixed fee charged to participants, and a fixed hourly rate for other users. The SRH is ISO certified.

When the SRH is deployed, the fire brigade transports the screens from a storage location to the launch location. The Duty Officer of the Harbour Master’s Division Rotterdam (OvD-DHMR) involved in the incident decides on the launch location. In principle, the screens are transported to the spill location by vessels of the KRVE (Koninklijke Roeiers Vereeniging Eendracht). If the spilled material makes it necessary to wear breathing apparatus, patrol vessels of the Harbour Master’s Division (DHMR) of the Port of Rotterdam Authority take over this task.

The pollutant is contained and removed on the basis of the Cooperation Procedure for the Handling of Spills (SAM – Samenwerkingsprocedure Afhandeling Morsingen) which in turn is based on agreements between the DHMR and Deltalinqs. The aim is to deploy a uniform notification procedure that ensures rapid and effective handling of incidents involving spills in the Western Rotterdam port area.

On the basis of a risk analysis carried out by the Port of Rotterdam Authority to examine the area of operation of the SRH, a number of fixed locations were identified where permanent containers of screens are stationed. In addition, additional containers with screens are available at a number of variable locations close to fire stations. In deciding where to place the containers, account was taken of space available, the arrival times and the locations with a recognised increased risk profile.

The SRH has access to:
- 15 movable containers
- 17 aluminium racks for the storage and transport of oil containment screens
- 11 oil containment screens with a length of 300 metres (Lamor, type FOB 750)
- 3 oil containment screens with a length of 225 metres (OCS, type FFB 75-T)
- 3 oil containment screens with a length of 400 metres (Elastec, type FCB 90 II)
- 1 oil containment screen with a length of 150 metres, intended for training purposes, including a reel.

The SRH carries out an annual exercise involving the Joint Fire Brigade, the Harbour Master’s Division, the boatmen (KRVE) and one of the companies that is a member of the SRH. In this joint exercise, a scenario is tackled to practise the rolling out of a containment screen.
PLANNING FRAMEWORKS

Regional crisis management organisation

The regional organisation for disaster and crisis management in the Netherlands is primarily structured along the lines of the Security Regions Act and related regulations. This Act ensures that security regions fulfil a coordinating role in tackling disasters and managing crises, by both organising and facilitating cooperation between parties inside and outside the region.

A security region is a region established according to joint rules within the Security Regions Act that operates as a legal entity and that applies to municipalities in a particular area. It is the exclusive authority of the chairman of the security region to take command over tasks relating to enforcing public order and related emergency services in the event of a disaster or crisis that affects more than one local area. The Act also regulates the way in which security regions play a coordinating role in tackling disasters and managing crises by organising and facilitating joint action between stakeholders inside and outside the region. In a security region, various administrative bodies and services work together in implementing tasks in the field of firefighting, medical assistance, public order and safety. Depending on the nature, seriousness and trend of the impending incident, other relevant partners can also be involved, in the form of public or private organisations. In dealing with incidents, work is undertaken according to the Coordinated Regional Incident Management Procedure (GRIP). According to this procedure, the central principle is that larger incidents need to be dealt with in mutual coordination. Because more resources and layers of administration can become involved, incident control must be dealt with according to a multidisciplinary approach. This approach involves several bodies each of which have their own responsibility such as the Incident Site Commanders (CoPI) who are responsible for tackling the incident at the point of source, and the Regional Operational Team (ROT) that focuses on the affected area.

In the Security Regions Act, it is determined that a crisis management organisation consists of:

- Joint emergency centre
- On site emergency coordination team (CoPI)
- Regional Operational Team (ROT)
- Policy team (municipality or regional)

There are 25 security regions in the Netherlands that correspond to the former police regions. A region combines the complete territory of a number of municipalities. The collaborative organisation is governed by the participating municipalities.
Specified and optional planning for the Security Region

In order to ensure the smooth harmonization of tasks, legal powers and responsibilities, senior staff of the security regions take measures to prepare for disasters, serious accidents and crises. In the framework of those preparations, senior staff of each security region are required by law to draw up at least the following plans:

• A regional risk profile;
• A regional policy plan;
• A regional crisis plan.

The regional risk profile contains an analysis of the risks present in the security region in question. The policy for the implementation of the imposed tasks is described in the regional policy plan. The regional crisis plan outlines the organisation, tasks, responsibilities and legal powers in relation to disaster management and crisis management.

Regional Risk profile of the Rotterdam Rijnmond Security Region (VRR)

In the risk profile of the VRR, an inventory and analysis have been drawn up of the risks identified in the Rotterdam Rijnmond region, including relevant risks from other security regions. This risk inventory consists of an overview of the high-risk situations present, and the types of incidents that can arise as a consequence. Subsequently, the capacity available in the security region and its partners are considered, in relation to the risks. In total, 29 risk scenarios have been identified for the VRR, that have been classified in seven themes. These themes are:

• natural environment;
• built environment;
• technological environment;
• vital infrastructure and facilities;
• traffic & transport;
• health;
• social and societal environment.

The incident involving the Bow Jubail, whereby a vessel collided with a jetty, was punctured and as a consequence lost a large quantity of oil cannot be specifically placed in any one of these scenarios. The most relevant scenario is scenario 20: collision between seagoing vessel with bunker vessel, while the situation also bears similarities to scenario 16: pollution of the drinking water network.

In the risk profile, this scenario is not classified as one of the risks with the highest probability. Over the past few years the number of oil spills in the port of Rotterdam has in fact fallen steadily. Whereas there were around 600 spills in the mid-1990s, in 2009, for example, there were just 193, the majority of which involved less than 250 litres. The most recent incident involving an oil spill was in January 2007 when severe winds caused the mooring lines of the container vessel CMA-CGM Claudel to break, as a result of which the out-of-control vessel damaged oil jetty 2 of the Maasvlakte Oil Terminal, and 800m³ of Light Crude oil spilled into the harbour.
Specific Disaster Management Plan
On the basis of the Security Regions Act, by government decree, categories of facilities and categories of disasters and aviation locations can be designated for which the governing body of the security region must draw up a specific disaster management plan. In that plan, the measures are summarised that must be taken in the event of a disaster relating to the object in question. In the Security Regions Decree, those facilities are designated for which a disaster management plan drawn up by the board of the security region is required. In brief, these are facilities in which large amounts of hazardous substances are or can be processed, certain airports and certain categories of waste facilities. In these disaster management plans, the measures are summarised that must be taken in the event of a disaster.

Waters Act
In the Waters Act, a number of provisions are laid down which relate to disaster management and crisis management. As a result, the managers of maritime structures are required by law to undertake risk analyses, and to draw up disaster management plans that correspond to disaster management on land. These plans must also be exercised and updated.

The Waters Act also makes it possible for certain subjects to be further elaborated in a government decree (the Waters Decree, for example). In an appendix to the Waters Decree, a list is provided of which waterways, civil engineering structures and flood defences are controlled by National Government, and the actual management processes are further elaborated in the Waters Regulation. By provincial order (Water Regulations) the government bodies are designated that are responsible for those water systems or parts of water systems that are not managed by Rijkswaterstaat. Generally speaking, these are the water authorities. In general, Rijkswaterstaat is the responsible manager for the main navigable waterways in the Netherlands and the North Sea, and for maritime structures, while the municipalities and water authorities bear the same responsibility for regional waters. The detailed overview of the main navigable waterways in the Waters Decree in turn designates those areas that are not subject to these regulations, such as the harbour basins in Rotterdam.

Disaster management and crisis management on water
Within the Security Regions Act, no distinction is made between incident management on the water or on land. This means that the Security Regions Act also applies to incident management on (inland) waters designated as managed by municipalities. It is, however, clear that there is an understanding within the security regions that additional agreements are needed for working on water and that a fundamentally different approach is required in comparison to working on land. This is because when dealing with water incidents, other crisis partners and circumstances are involved. Against that background, security regions may draw up additional plans without being required to do so, by law. These are referred to as Incident Management Plans (IBP). IBP plans are supplementary to the Regional Crisis Plan, which specifies how disaster management and crisis management are dealt with within the security region, and which describe how the relevant crisis partners – that may differ from the regular crisis partners – should prepare jointly to
provide assistance in the event of specific incidents. Scenario 2 describes the action to be taken in the event of pollution of the surface water.

As far back as 2006, the Minister of the Interior and Kingdom Relations and the Minister of Transport and Water Management commissioned the starting of the ‘Waterrand’ project, the aim of which is to arrive at a uniform doctrine for incident management on the water. The objectives involved establishing an effective organisation for emergency services in the event of incidents on the water, and the development of a uniform national strategy, and adequate cooperation between the various stakeholders. In 2009, one of the results of this project was a first version of the Manual for incident management on the water.

In 2012, the Safety Council, at the request of various security regions and crisis partners called upon the Institute for Safety (IFV) to update the manual. In 2015, this resulted in a revised manual, that took into account the experiences accrued since 2009. The manual does not provide binding regulations but is intended to raise the level of preparation wherever necessary, via descriptions of good practices and by presenting useful tips and standards. Because this manual was commissioned by the Safety Council, and brings together all accumulated knowledge in this area, it is to be expected that the contents of the manual are supported by the security regions.

The manual emphasises that tackling incidents on the water requires cooperation from many different organisations in order to deal with an incident successfully. These are often different organisations from those that are involved on land. This is the ultimate case of cooperation between land and water. To demarcate the planning process for incidents on water, the manual employs a geographical unit referred to as the Integrated Risk Water System. An Integrated Risk Water System is a ‘logical unit of surface waters for the parties involved in incident management’.

An Integrated Risk Water System is generally not restricted to a single security region or even a single nautical management area. According to the manual, for each Integrated Risk Water System, one security region must take on the supra-regional coordinating role with respect to incident management on the water. This security region is referred to as the coordinating security region. In the preparation phase, this region is the central focus for planning and exercising for incident management on the water. One key element of this process is reaching sound agreements with (national) water parties. To ensure that all parties are involved in the security region and to organise the harmonization process, according to the manual, the coordinating security region must appoint a waters officer for each water area. This officer fulfils a networking function, and his task is to ensure that the incident and emergency organisations active in the water in question are correctly harmonised by means of sound planning and agreements, initiated by the coordinating security region.

Also on the basis of the risk assessment of navigable waterways by Rijkswaterstaat, and the numbers of actors involved in a (supraregional) incident on navigable waterways, according to the manual, it is considered probable that an IBP plan is required for each
Integrated Risk Water System. In an IBP plan, agreements are laid down on the four primary processes of crisis management (reporting and alarms, management and coordination, upscaling and downscaling and information management) and the operational elaboration of the expected maritime scenarios (e.g. SAR, hazardous substances, etc.). An IBP plan can also be used to arrange subjects like foreseeable measures, response times, etc. The starting point for each IBP is that the plan covers the entire Integrated Risk Water System, that the scope is multidisciplinary and that it is applicable to all levels of upscaling, but does not relate to the monodisciplinary elaboration.

The manual outlines a doctrine for incident management on the water, and provides starting points for example for the elaboration of an IBP plan, aimed at reinforcing the preparations for incident management on the water. For example, model protocols, model job descriptions, model prevention standards and model process descriptions as well as other indicators are provided. The manual also provides a description of a number of categories of incidents which could occur on or below the water, the so-called Navigable Waterway Incident Scenarios (VIS). These VIS scenarios are useful in determining the picture of incident management on the water, and clarifying the tasks, legal powers and responsibilities of nautical parties.

Based on a VIS scenario, the assistance needs expressed in terms of the number of victims expected, the scope of the fire or size of the polluted area can be mapped out. The assistance needs are then translated into the initial deployment requirement for each party in each process. If following an incident report a VIS scenario is announced, the units from the parties involved as referred to in the VIS scenario are deployed. According to additional information and further developments, the decision can be taken to further upscale (escalate).
CRISIS AND DISASTER MANAGEMENT IN THE PORT OF ROTTERDAM

Safety is above all a local issue, and municipalities are responsible for the organisation of the fire brigade service, disaster management and crisis management and medical support. On the other hand, municipalities are often too small to be able to respond adequately to all forms of disasters and crises. In addition, disasters and crises are often not restricted to a single municipality. In order to overcome these difficulties, municipalities have been combined in Security Regions.

Depending on the nature and scale of the incident, the emergency services are deployed. Larger incidents require deployment of more resources and coordination between administrative layers, and as such are tackled differently from minor incidents. To provide a suitable structure and to ensure that upscaling and downscaling take place in a structured manner, the Coordinated Regional Incident Management Procedure (GRIP) was created. Within the Security Regions, this GRIP procedure is applied nationally, and determines how coordination takes place between the emergency services organisations.