Oil Pollution in the Waters of the Danish Sector of the North Sea

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Abstract This chapter deals with cooperation, organization, responsibility, statistics, preventive measures, equipment, etc. in relation to maintaining a clean marine environment in the Danish sector of the North Sea including the coast and harbours. In addition to international conventions, national legislation regulates responsibilities and organization with regard to aerial surveillance and oil spill response. Through multilateral agreements such as the Bonn Agreement, cooperation takes place with other North Sea countries with regard to aerial surveillance, oil spill response, operations, exercises, etc. Besides this international cooperation, there are a range of national collaborations between a number of national authorities and units which also takes place, not only in relation to ships but in relation to oil rigs as well, with an additional set of rules drawn up for the latter. Implementing preventive measures on the marine environment are also discussed in this chapter, together with measures such as vessel traffic zones which have yet to be established in the busiest maritime areas in the Danish part of the North Sea. The section on aerial surveillance and oil pollution statistics examines the numbers of incidents and numbers of oil slicks from ships and platforms. A steady decrease in mineral oil spills from ships has occurred over the last 10 years. During that period only one event requiring action to combat an oil spill has taken place in the Danish sector of the North Sea.

Keywords Aerial surveillance, Danish legal framework, Danish national agencies, Danish North Sea, Maritime transport, Oil pollution, Skagen

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1 Introduction

The Danish sector of the North Sea has always played an important role for Denmark and for the people living along the west coast of Jutland. The sea is used for a multitude of maritime activities including extraction of seafloor resources, commercial fishing, leisure boating, offshore wind parks as well as oil and gas pipelines.

The sea area off Skagen, highlighted in Fig. 1 (top centre), is a bottleneck for sea traffic inbound and outbound between the Baltic Sea and the North Sea which has increased steadily in the last decade, thereby reflecting intensifying international cooperation and economic prosperity. On the basis of AIS data, a picture of the ship intensity in Danish waters is shown [1].

Since the mid-1990s, the Baltic Sea Region has, as a whole, witnessed enormous growth in maritime transport. Despite the decline in the shipping industry in 2008 caused by the economic recession, the Baltic Sea is still one of the most heavily trafficked seas in the world, accounting for up to 15% of the world's cargo transportation [2]. Thousands of sizeable ships pass between the North Sea and Baltic Sea through the Skagen each month, including large oil tankers, ships carrying dangerous and potentially polluting cargoes, as well as international cruise ships.

Looking into the future, a huge growth in the sector is predicted [3]. The number and size of ships are expected to increase substantially in the coming years, including those transporting oil. The massive growth in the shipping sector is

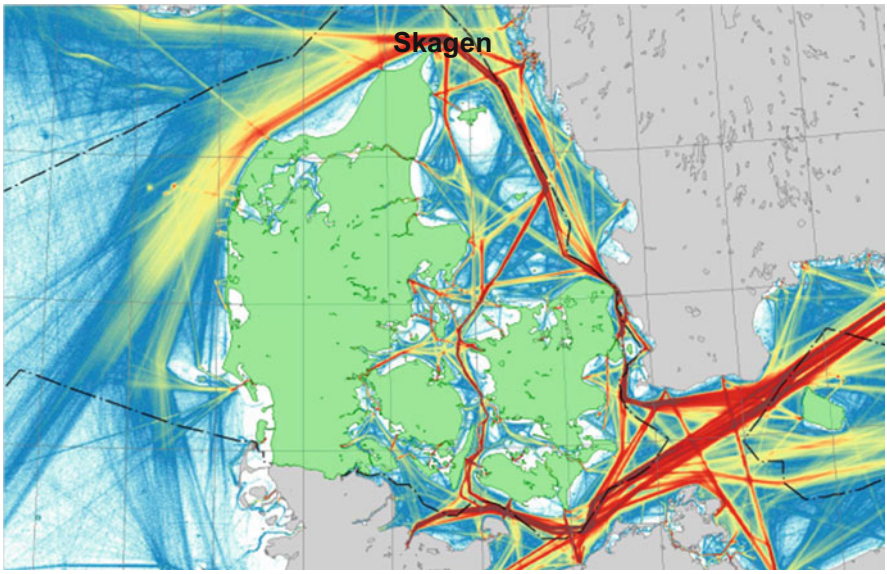

Fig. 1 Intensity of ship traffic in Danish waters, using AIS data (Automatic Identification System). *Source*: Danish Ministry of Defence 2010, page 67 [1]

mainly due to the expansion and construction of oil terminals on the shores of the Gulf of Finland and regional economic growth.

The enormous volume of shipping around Skagen is accompanied by a large risk of accidents including groundings and collisions. Many accidents result in oil spills. A large oil spill in the coastal area of the Danish sector of the North Sea could have serious ecological effects, not just in Danish waters but also potentially those of Norway, Sweden and Germany, for example. Oil spills can have devastating impacts on vast areas of nature as well as on sectors such as fishing, tourism and recreation. Clean-ups after an oil spill can also result in extensive financial costs in both the short and longer term.

2 Responsibility for Aerial Surveillance and Combating Oil Spills and Chemical Pollution at Sea

On 1 January 2000, the Danish Ministry of Defence took over from the Danish Ministry of the Environment the responsibility for aerial surveillance as well as oil spill and chemical pollution response and enforcement of marine environmental legal regulations in terms of collecting evidence (in cooperation with the police) associated with pollution of the sea from ships. In general the operative parts of the tasks are delegated to the Defence Command Denmark.

2.1 The Danish National Legal Framework for Marine Environmental Preparedness

The field of marine environmental preparedness is regulated under the Danish Act on the Protection of the Marine Environment, 2013 [4]. This section examines the aspects of that act as it relates to oil and chemical pollution in Danish waters.

The Danish Act on the Protection of the Marine Environment falls within the remit of the Danish Ministry of Environment and regulates the general protection of the marine environment against all forms of pollution of the sea. In connection with the transfer of responsibility for combating oil and chemical pollution thereon from the Danish Ministry of Environment to the Danish Ministry of Defence, this section reviews some of the Danish Act on the Protection of the Marine Environment in order to reflect the current responsibilities.

2.1.1 The Danish Ministry of Defence's Responsibility

The discharge into the sea of oil, chemicals and waste is generally punishable under the Danish Act on the Protection of the Marine Environment. The Danish rules are based on those set out in the MARPOL Convention [5] and therefore similar emissions regulations in the North Sea must apply. Regarding oil, any discharge within the territorial sea is prohibited, while outside the territorial sea only the discharge of very small amounts of oil is authorized in accordance with well-defined criteria. The Danish Act on the Protection of the Marine Environment further defines that oil in the legal sense should be understood as mineral oil. The term "mineral oil" means any of various colorless, odorless, light mixtures of higher alkanes from a non-vegetable (mineral) source. This is in contrast to, for example, coconut oil or rapeseed oil which is referred to as vegetable oil.

The Danish Ministry of Defence's tasks in the marine environment include surveillance of the sea, oil pollution response as regards oil and chemical pollution. In case of marine pollution originating from ships, the Danish Ministry of Defence can issue notices of detention or notices of enforcement designed in order to reduce pollution or risk of pollution from the ship.

Defence Command Denmark enforces the provisions of the Danish Act on the Protection of the Marine Environment in cooperation with the police. In case of discharge of mineral oil, Defence Command Denmark can search the ship, interrogate the crew and issue an administrative fine. Other illegal discharges than mineral oil are reported to the police.

2.1.2 The Danish Act on the Protection of the Marine Environment, Section 34

The complete task complex for the Danish Ministry of Defence's marine environmental preparedness is based on the Danish Act on the Protection of the Marine

Environment, Section 34. According to this section, the Danish Minister of Defence, in cooperation with the emergency service[1] and other authorities as authorized by the Minister, is responsible for combating oil and chemical pollution at sea and the coastal part of the territorial sea. In practice, "the coastal part" is defined as the sea area which goes into the so-called normal water level line. The wording "other authorities" aims to open up for the possibility for cooperation with, for example, municipal authorities.

2.1.3 Municipal Responsibility the Danish Act on the Protection of the Marine Environment, Section 35

According to the Danish Act on the Protection of the Marine Environment, Section 35, subsection 1, it is the municipal council which, in case of oil or chemical pollution, conducts the rehabilitation of coastlines and control of pollution in ports. The coastline in this regard is defined as the landward side above normal water level line, in practice above the current waterline. The local council is, according to the Danish Act on the Protection of the Marine Environment, Section 35, Subsection 2–4, the responsible body for making contingency plans. The Danish Minister of the Environment and the Danish Minister of Defence should be informed about the content of these contingency plans as well as the corresponding amendments and supplements.

In accordance with the Danish Act on the Protection of the Marine Environment, Section 35, subsection 5, the Danish Ministry of the Environment is responsible for setting up the overall collective emergency preparedness.

2.1.4 The Danish Act on the Protection of the Marine Environment, Section 35, Subsection 6

The Danish Act on the Protection of the Marine Environment, Section 35, Subsection 6, allows the Danish Ministry of Defence, in the case of particularly serious and extensive pollution, to determine that rehabilitation of coastlines and control of pollution in ports should be chaired by the Danish Ministry of Defence or other authorities which the Minister authorizes. The provision only allows the Danish Ministry of Defence an opportunity to take charge of the rehabilitation of coastlines and control of pollution in ports from a coordination point of view. This is merely a method to achieve coordination-oriented management and not a short or long takeover of the responsibility of the area. The Danish Ministry of Defence only conducts the insertion of the capabilities that may be available for the referred task

[1] The Danish Emergency Management Agency (DEMA) is a Danish governmental agency under the Ministry of Defence (see http://brs.dk/eng/Pages/dema.aspx.

but is not responsible for the procurement of these. The responsibility rests with, respectively, the local councils and the port boards in accordance with the Danish Act on the Protection of the Marine Environment, Section 35, Subsections 1 and 3.

2.1.5 Options

In addition to the general provision which confers the Danish Ministry of Defence's responsibility for combating oil spills and pollution at the sea, the Danish Act on the Protection of the Marine Environment also contains a number of provisions that give the Danish Ministry of Defence the tools which are needed in order to solve the overall task. The law allows, for example, the possibility for the Danish Ministry of Defence, without a court, to make any inquiries of a ship which are necessary to prevent or eliminate pollution at the sea if an oil spill from the ship has already happened or if there is a danger of polluting of the sea.

The Danish Ministry of Defence may also, in this situation, prohibit a ship to continue its voyage or other activities or to order that a ship's further sailing must follow certain guidelines. Finally, the Danish Ministry of Environment has the possibility to prohibit a ship calling at Danish ports in case the ship chooses to ignore the injunction as the Danish Ministry of Environment has given in accordance with the Danish Act on the Protection of the Marine Environment. The Danish Act on the Protection of the Marine Environment authorizes Danish Ministry of Defence to detain the polluting ship as security for costs for reasonable measures taken to prevent or minimize pollution.

2.2 The Rule of International Law Based on the Marine Environment

There are a number of rules of international law on the marine environment which, together with the Danish national regulations, provide a framework solving the marine environmental task. The international regulation consists mostly of international conventions ratified by Denmark and thus it has committed to comply with the rules. A wide range of international rules arising from the conventions are incorporated in the Danish Act on the Protection of the Marine Environment provisions. The most important international marine conventions relevant to the North Sea are discussed below:

2.2.1 United Nations Convention on the Law of the Sea (UNCLOS), 1982

The United Nations Convention on the Law of the Sea (UNCLOS), 1982 [6], is informally described as the "sea constitution". This is because the convention was created when, in 1982, the countries concerned decided to merge the customary international law which was in force at the time as regards the oceans and their use. The so-called 1958 conventions, namely, the Convention of 29 April 1958 relating to the territorial sea and the contiguous zone, the Convention of 29 April 1958 relating to the high seas, the Convention of 29 April 1958 relating to the continental shelf and the Convention of 29 April 1958 about fishing on the high seas and conservation of the living resources, together with an optional protocol of 29 April 1958 concerning the compulsory settlement of disputes concerning the interpretation or application of the Conventions of 29 April 1958 about the law of the sea, are largely incorporated into UNCLOS but are still in force. UNCLOS defines each maritime area (e.g. the territorial sea, the exclusive economic zone, the high seas, etc.) and identifies the possibilities of their use including in what extent the coastal states may exercise jurisdiction over these areas. UNCLOS has thus had an important influence on the resolution of the marine environment task, and parts of the Convention on the Law of the Sea are incorporated into the Danish Marine Environment Protection Act 2013 [4].

2.2.2 The MARPOL Convention

The International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) is administered by the International Maritime Organization, IMO [5]. It may be viewed as a form of a "Marine Environment Protection Act" which, amongst other things, regulates technical specifications for ships in order to prevent pollution of the sea. The convention also contains detailed rules on when and in what way ships are allowed to carry out discharges into the sea.

2.3 Multilateral Agreements in Relation to the Marine Environment

In addition to the above-mentioned international conventions, Denmark has signed a number of multilateral agreements with neighbouring countries around the North Sea. The agreements primarily relate to aerial surveillance and oil spill response in dealing with combating marine pollution, but some also contain some elements of cooperation on prosecution. Some agreements have been prepared as conventions, while others are less formal cooperation agreements. The most important of these agreements are reviewed below.

2.3.1 The Bonn Agreement

The Agreement of 9 June 1969 on combating oil pollution in the North Sea (the Bonn Agreement) [7] includes mutual assistance in combating oil and other harmful substances in the North Sea. Furthermore, the agreement includes a commitment of active cooperation through coordinated aerial surveillance [8] of the North Sea. The Bonn Agreement has been signed by Denmark, Sweden, Norway, Great Britain, Ireland, France, Belgium, the Netherlands, Germany and EU.

2.3.2 The Copenhagen Agreement [9]

The "Nordic Convention of 16 September 1971 on cooperation of measures to combat oil pollution at sea", revised 29 March 1993, was changed to the "Agreement between Denmark, Finland, Iceland, Norway and Sweden about cooperation concerning pollution control of the sea after contamination by oil or other harmful substances" [9]. The agreement relates primarily to cooperation in combating pollution of the member states' waters. According to Article 6, the parties should in the best possible way assist each other to ensure collection of evidence associated with illegal discharges of oil and other harmful substances.

2.3.3 Trilateral Agreements: DENGERNETH [10]

In the southern sector of the North Sea, pollution may present a danger to coastal regions of Denmark (including Greenland and the Faroe Islands), Germany and the Netherlands. Bilateral agreements were therefore concluded between the Netherlands and Germany (NETHGER, 1991) on the one hand and between Denmark and Germany (DENGER, 1993) on the other hand to establish close cooperation in response to pollution of the sea.

Subsequently, the competent parties, e.g. the Danish Defence Command, the Ministry of Transport, Public Works and Water Management of the Netherlands and the Federal Ministry of Transport and Building and Urban Affairs of Germany, agreed to extend their existing cooperation to include information exchange on the threat of marine pollution and aerial surveillance in order to prevent and detect pollution. The parties also agreed to establish one composite trilateral arrangement of cooperation instead of having separate bilateral instruments concerning cooperation in combating marine pollution as well as cooperation in aerial surveillance.

The agreement "Danish-German-Netherland Joint Maritime Contingency Plan on Combating Oil and Other Harmful Substances" (DENGERNETH) is fully operational but had not, at the time of writing, been signed by all parties. The plan is an operational agreement which describes in detail the cooperation in aerial surveillance and oil spill response in the border area between Germany, Denmark and the Netherlands.

The plan shall apply as necessary and appropriate to any marine pollution or threat of pollution within the DENGERNETH Response Region, which is or could become of sufficient severity to initiate joint action. The DENGERNETH plan also applies to the Wadden Sea which is a conservation area. Regional sub-plans for Wadden Sea areas may be concluded within the framework of the DENGERNETH plan.

In order to establish a high degree of readiness, annual exercises shall be carried out between the three countries. Instead of these trilateral exercises or in addition, combined exercises in accordance with relevant regulations of the Bonn Agreement may be conducted.

3 National Organization and Responsibilities

Prevention and control of maritime environmental pollution is a shared responsibility involving the state as well as the municipal and private actors.

3.1 Geographical Responsibilities and Allocation of Responsibilities

The allocation of responsibilities between the current emergency responses is as described in sections 2.1.2 and 2.1.3 overall as set out in the Danish Act on the Protection of the Marine Environment [4] Section 34 and Section 35.

In accordance with Section 34, the Danish Ministry of Defence, in cooperation with the emergency service and other authorities as authorized by the Danish Ministry of Defence, is responsible for combating oil and chemical pollution at sea and the coastal part of the territorial sea.

3.1.1 Drilling Rigs, Production Platforms (Oil and Gas), Subsea Pipelines and Similar Installations

Notwithstanding the above, regarding the Danish Ministry of Defence's responsibility for the area, this does not include fixed offshore installations at sea, such as production platforms and drilling rigs, which are covered by the Danish Ministry of the Environment. The responsibility for the immediate response of pollution from drilling rigs, subsea pipelines and related installations as well as the initiative to mobilize equipment to combat lays with the concessionaries, and the initiative to mobilize equipment to combat spills lays with the concessionaries. However, mobilization and initiation of spill combat may be effectuated in cooperation and dialogue with the Environmental Protection Agency. The costs incurred shall be borne by the concessionaires.

3.1.2 The Macondo/Deep-Water Horizon Oil Spill

During the Macondo incident on 20 April 2010, a huge fire engulfed a deep-water horizon petroleum-drilling rig that had exploded in the Gulf of Mexico, killing 11 platform workers and injuring 7 others. After burning for hours, the rig sank on 22 April, resulting in the spread of a large oil slick from the location of the former rig. Over a period of 100 days, attempts were made to stop the oil's gushing and to control its spread. Finally, on 15 July, British Petroleum (BP) succeeded in fitting a tight-sealing containment cap, which stemmed the leak. US government data indicate that 4.9 million barrels of oil leaked before the well was capped.

As a result of the accident in the Gulf of Mexico in 2010, initiatives has been launched in the EU (EU Offshore Directive [11]) and by the oil and gas industry [12] in order to analyse the accident and evaluate whether existing standards and procedures within the offshore oil and gas drilling industry are adequate for risk mitigation and whether the setup of equipment for mechanical recovery is suitable.

3.1.3 Oil Spill Contingency Plans (OSCP)

The oil spill contingency plans (OSCP, see, e.g. ITOPF 2014 [13]) must ensure that the operator has an adequate amount of collection equipment available and that this can be mobilized within a specified maximum response time, in a tiered response, adjusted to different hypothetical spill scenarios described in the contingency plan.

The risk for unintended spillage of oil and chemicals must be held as low as reasonably possible, following the ALARP principle, by taking adequate precautionary actions relative to the risk involved in offshore oil and gas exploration and production.

OSCPs for Offshore Operators in Denmark

In 2014 there is a total of five production units in the Danish licence area (see Fig. 2 [14]) where DONG Energy Exploration and Production is the operator of the Siri/Hejre production unit, HESS Denmark is the operator of the South Arne production unit and Maersk Oil is the operator of the three production units, the Dan asset, the Halfdan asset and the Tyra asset. From the production units discharge of treated produced water from fixed point of discharge takes place. In addition, periodic discharges from mobile drilling rigs take place in connection with exploration, drilling of wells and during well service.

The offshore operators in Denmark are responsible for drawing up contingency plans in case of unintended spillage to the sea from an offshore installation will make it possible to fight oil spill. The contingency plans developed by the offshore operators must be approved by the Danish Environmental Protection Agency (Danish EPA).

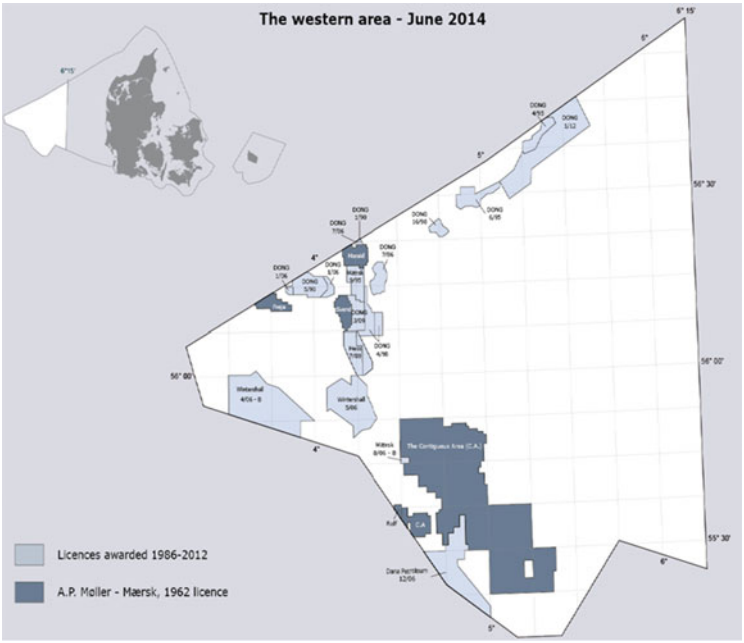

Fig. 2 Danish licence area, west. *Source*: Danish Energy Agency 2014, page 46 [14]

The contingency plans will ensure that the operator has an adequate amount of collection equipment available and that this can be mobilized within a specified response time, specified in a tiered response. In the Danish sector there are tiers 1, 2 and 3, where equipment in the fastest response (tier 1) can be operational within hours of a spill incident, which enhance the probability of gaining a high recovery rate for the spill.

The operator must have equipment for mechanical and chemical response. Chemical response (dispersants) will only be used in extreme emergencies, and any use of dispersant requires permission from the Danish EPA.

It is a requirement that exercises in spill recovery must be held at regular intervals. The Danish EPA may join these drills. The operator covers the cost in connection with an oil spill. The Danish EPA will, in the case of oil spills, reconcile the clean-up efforts with the operator in order to ensure that an attempt to collect the mechanical fightable oil or chemicals will be carried out.

Coordination During Spill Identification and Spill Recovery

All spills must be reported electronically to the Danish Defence Command and Danish EPA. Any spill of oil or chemicals judged to be either physically combatable or above a limit of 5000 l must be reported immediately by phone to the Danish EPA as well as the Danish Defence Command.

Information on spill size and location enables the Danish Defence Command to support the offshore operators with supplementary information and match the spill observations with information from recent aerial surveillance and information from satellite images. Also information is received from offshore installations in order to match information from satellite and aerial surveillance. Support by the aerial environmental surveillance and satellite service of the European Maritime Safety Agency (EMSA, http://www.emsa.europa.eu) thereby may serve to identify and support and focus the effort during recovery of a combatable oil spill or chemical spill by enabling tracking of the extension of the spill in km^2 and assist discern the thickness and the spreading and drift of a spill.

3.1.4 Aerial Surveillance

Danish Sea Environmental Aircraft

The Danish Defence Command undertakes aerial surveillance in the Danish waters, including the area of platforms, using the Royal Danish Air Force's CL-604 Challenger as a sea environmental aircraft. The Challenger performs nearly 200 flight hours in the Danish sector of the North Sea every year, at a speed of about 280 knots. With this speed a large area is covered.

German Sea Environmental Aircraft

In addition to the aerial surveillance performed by Danish sea environmental aircraft, German sea environmental aircraft also perform aerial surveillance to some extent, especially close to the Danish platforms.

EMSA

The aerial surveillance is further supported by the satellite service provided by EMSA CleanSeaNet Service [15]. In 2014 the Defence Command received more than 250 satellite images provided by EMSA covering the Danish part of the North Sea.

Tour d'Horizon [16]

All members of the Bonn Agreement agreed on performing a flight mainly along the offshore installations, of at least 600 nautical miles. The aircraft crew will concentrate on all detectable pollutions from various sources. Roughly the area between 52° north and 63°north is to be surveilled. These flights are carried out according to an agreed yearly scheme.

Coordinated Extended Pollution Control Operations (CEPCOs) [16]

A CEPCO can be defined as a continuous sequence of aerial surveillance flights supported by sea-borne assistance – and where possible also with data from satellite observations – to ensure a permanent presence (e.g. over a period of 24 h) in a sea area with high shipping intensity. This high level of deployment is only possible when several (neighbouring) contracting parties cooperate intensively to ensure continuity and optimal coordination of the surveillance activities. The aims of the operation are, inter alia:

1. To enhance the enforcement of discharge provisions at sea
2. To increase the deterrent effect of aerial surveillance efforts
3. To improve the cooperation between the participating authorities

3.1.5 Oil Pollution Response

Combat Readiness in the Form of Environmental Equipped Ships

The Danish Defence Command is the responsible authority in relation to the supervision and control of pollution of the Danish waters. Furthermore the Danish Defence Command is responsible for the deployment of the required pollution control in the event of a pollution incident at sea and to coordinate efforts. In addition to the use of their own assets in the event of an oil pollution combat situation, the Danish Defence Command can also arrange that other authorities or private parties/civilian actors become involved in the pollution response at sea in Danish waters. The Danish Defence Command may further, in accordance with international agreements, request assistance from other countries.

Combating Methods Used in Connection With Oil Spills in the Danish Sector of the North Sea

Denmark has its own capacity for oil pollution response.[2] The combat method is primarily mechanical collection where the booms confine the oil and then picks it up with skimmers.

The premise is that all oil spills which can be fought must be fought. Generally, dispersants (chemical control) is not used in the Danish sector of the North Sea. In special cases, the Danish Ministry of the Environment may authorize the use of chemicals to combat an oil spill. The specific requirements for methods and equipment, and how quickly action needs to take place, are described in each operator's contingency plans.

[2] In case of the oil and gas operators, parts of the response equipment are provided by OSRL in the UK, who are contracted by the operators.

International Cooperation Regarding Oil Spill Response

Denmark participates in several regional conventions and agreements which in case of a major oil spill ensure that the countries concerned will aim to support each other. For example, OSPAR [17] countries cooperate on the use of equipment across borders, if the need arises in case of a large oil spill. In addition, Denmark has entered into operational agreements with Sweden, Germany and the Netherlands.

OSPAR: International Cooperation to Protect the Marine Environment

The OSPAR Commission is responsible for the 1992 Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR Convention) [17], which includes the North Sea. Signatories to the Convention are Denmark, the Netherlands, Norway, the UK, Germany, France, Ireland, Iceland and Spain. The first four countries represent close to 100% of the total production of oil and gas in OSPAR.

The OSPAR Commission works to protect ocean and marine biodiversity. The framework of OSPAR's work is determined by a number of recommendations and legally binding decisions.

3.2 Marine Environment Organization

Marine environment organizations can be divided into two main areas: (1) organization for oil and chemical pollution response at sea (the Danish Ministry of Defence's responsibility) and (2) organization for oil pollution response on the coast and in harbours (the municipal council's area of responsibility).

3.2.1 Organization for Oil Pollution and Chemical Pollution Response at Sea

The Danish Defence Command is responsible for oil and chemical pollution response at sea. In case of pollution at sea, the Danish Defence Command coordinates the operational deployments at sea via the Maritime Assistance Service (MAS).

3.2.2 Organization for Oil Pollution Response and Chemical Pollution Response on the Coast and in Harbours

The municipalities have in accordance with the Danish Act on the Protection of the Marine Environment [4] responsibility for rehabilitation of the coastline and

pollution response in harbours. The municipal council provides a contingency plan for implementation of rehabilitation of coastlines in case of significant pollution of coastlines in the municipality and for pollution response in ports.

In case of beach rehabilitation after very extensive oil pollution, the situation typically will be that the local authorities will have the management of the actual rehabilitation task within their own municipality while the overall coordination of resources will be led by the Danish Ministry of Defence.

3.3 Sailing Equipment for Oil Spill Response

3.3.1 Danish Naval Assets

At the time of writing, Denmark has two environmental vessels, the *Gunnar Thorson* and the *Gunnar Seidenfaden*, which were built in 1981. They are 56 m long with a displacement of 1,660 tonnes. They can reach a speed of 12 knots and their tank capacity for recovered oil is 311 tonnes. These two vessels, which have a crew size of 16, can both be used without limitations in the North Sea.

Denmark also has two smaller environment vessels, the *Mette Miljoe* and the *Marie Miljoe*, which were built in 1980. They are 30 m long and can reach a speed of 9 knots and their tank capacity for recovered oil is 64 tonnes. Both vessels, which have a crew size of 6, are designed for coastal navigation which means that the ships are not allowed to operate further offshore than 45 nautical miles and they are allowed only to operate within a defined line along the Danish west coast.. This means that the ships only have a limited ability to cover the Danish sector of the North Sea.

In addition to the environmental vessels, three barges are attached to the marine environmental vessels and can be deployed in conjunction with them. The collected oil from an operational area can be pumped into the barges and these can accommodate 300 tonnes each.

Denmark will in the coming years build new response vessels to replace the current ones. While plans for new vessels are not detailed, they will continue to fulfil the role of current vessels for marine environmental protection and environmental monitoring and for oil spill recovery,

3.3.2 Rescue Boats

The Royal Danish Navy has 14 closed and 18 open fast sailing rescue boats. These vessels have the capability to be used to counter oil pollution at sea. The response time of the rescue boats along the Danish west coast is 20 min every day of the year.

The rescue boats can be used for field exploration, transportation tasks and collection of oil samples from the sea.

Rescue boats can be deployed within a distance of 20 nautical miles from their starting point, and the endurance is maximum 8 h. The rescue boats participate in organized exercises in local areas where launching booms in shallow water are one of the challenges.

3.3.3 The Danish Naval Home Guard

The Danish Naval Home Guard (NHG) participates actively in the resolution of the marine environment task. This is partly done by towing and laying booms and towing barges. The booms are laid either from the coast or from an NHG unit where booms are stored. These booms may come either from the shore or from own unit, where booms are stored.

The volunteers in the NHG practice and educate themselves in close cooperation with personnel from the Danish Navy in solving the marine environment task. NHGs practise their efforts with both single vessels and as a larger coordinated cooperation effort with several vessels, nationally as well as internationally.

NHG vessel's response time is 1 h in relation to major environmental disasters. The vessels are strategically placed around Danish waters so that no matter where pollution is found, an NHG vessel will often be one of the first assets reaching the action area. The NHG vessels' main task is to launch and tow booms.

All NHG vessels are thus an important part of the marine environment preparedness because the reaction time in relation to pollution, no matter where in the Danish waters it occurs, will be relatively short due to the placing of the vessels.

3.3.4 Cooperation with Private Stakeholders

The practical element of the task of cleaning up after a marine environmental pollution accident is a task that can be solved by all of the community's available capabilities.

The result is that, when needed, the Danish Defence Command has the opportunity, at short notice, to hire private stakeholders/civil actors. The private actors will, amongst other things, be able to deliver vessels which are able to provide tug assistance and recover oil spill at sea.

Maersk Oil and Gas/Esbjerg Guard Ship Company

The Danish Defence Command has signed an agreement on mutual assistance with Maersk Oil and Gas in relation to oil spill preparedness. Maersk Oil and Gas is able to combat oil pollution at sea using available equipment which consists of equipment for confinement and recovery

The Esbjerg Guard Ship Company (ESVAGT) and chartered offshore supply vessels are designed to bring the containment and collection equipment and

perform the task for Maersk Oil and Gas. The equipment is operated by personnel from ESVAGT, in cooperation with the crews of the mobilized units selected for the action. ESVAGT's units are in accordance with the agreement on a 24 h alert which means that ESVAGT only can be used as a follow-up response. Nevertheless, the capacities in ESVAGT framework are an essential resource in the event of a pollution incident in the North Sea.

ESVAGT has two emergency teams with containerized equipment. Each team has skimmers, booms, power pack for inflating the booms and specially educated personnel. Ships for transporting equipment and personnel are appointed/chartered in each case.

3.4 Other Partners

3.4.1 The Danish Emergency Management Agency

The Danish Emergency Management Agency's primary task is defined in the Emergency Management Act [17]; with subsequent amendments, it only includes responsibilities at the shore and in the associated water areas like lakes and rivers.

The Danish Emergency Management Agency does not have an independent functional or economic responsibility in relation to pollution response at sea. However, it does assist at contractor base on the basis of the Emergency Law, Section 8, the defence – the Danish Defence Command – with contributions in relation to the solution of tasks in accordance with the Danish Act on the Protection of the Marine Environment. The work will involve tasks related to oil pollution response in shallow water and in places where the naval vessels cannot enter.

3.4.2 The Local Authority's Preparedness

As noted previously, local councils have, in accordance with the Danish Act on the Protection of the Marine Environment, the responsibility of coastline clean-up related to oil pollution above the normal water level line. In practice, it is the coast above the current water's edge. The question about the organization of the individual municipality's readiness to perform its duties in accordance with the Danish Act on the Protection of the Marine Environment is not further regulated. It is thus the individual municipality which makes the decision about the mobilization's size and design. After consultation with the municipal organizations, the Environment Minister draws up guidelines for the content of municipal emergency plans in accordance with the Danish Act on the Protection of the Marine Environment, Section 36 [4].

3.4.3 Nord

The Danish Defence Command has an agreement with the company Nord relating to the transport and processing of oil and chemical waste collected by the Navy's marine environmental ships.

3.4.4 The Police

The police are, in accordance with the Danish Act on the Protection of the Marine Environment [4], Section 35, not assigned specific tasks or skills in relation to the marine environment. They will, however, be included in the authority cooperation which is established through extensive pollution in order to ensure the best possible performance of police operations such as traffic control, roadblocks, press office and issuing of warnings and directions to the civilian population related to oil spill response. The Danish Defence Command may, by appointment, use the police's command and control facilities when a major pollution response must be coordinated locally in Danish waters.

4 Preventive Measures on the Marine Environment

The purpose of implementing preventive measures on the marine environment is to promote shipping safety for the maritime traffic. It will indirectly help prevent pollution of the marine environment. In Denmark it is considered essential that, on the one hand, there should be a focus on maintaining adequate preparedness if an accident were to occur and pollution of the environment is a fact and that, on the other hand, there should also be a focus on promoting risk reduction measures which will reduce the risk of an accident at sea and consequently pollution.

4.1 The Safety of Navigation in the Danish Sector of the North Sea

At the time of writing, no traffic separation schemes, vessel traffic services nor shipping lanes are established in the Danish sector of the North Sea. In this regard, there are currently no specific plans in the pipeline.

4.2 Hailing of Ships

With regard to surveillance and enforcement of the marine environment, the routine hailing (contacting) of ships passing through Danish waters is performed. When performing a hail, a maritime surveillance centre or a naval unit will call up a ship in order to obtain information about the ship's owner, cargo, insurance company and content of the oil record book. All calls are completed by informing the ship that, in accordance with the MARPOL 73/78 Convention [5], it is not legal to discharge anything other than clean water in Danish waters.

5 Oil Spill Statistics

5.1 Incidents in the Period 2010–2014

5.1.1 Collision Between Golden Trader and Vidar

Within the five-year period 2010–2014 (inclusive), there was only one serious incident in the Danish sector of the North Sea. On 10 September 2011, the Maltese flagged bulk carrier *MV Golden Trader* and the Belgian flagged fishing vessel *Vidar* collided in the North Sea, off the Danish Coast.

Several days after the collision, the Swedish Accident Investigation Authority informed the Marine Safety Investigation Unit of a severe pollution incident, which had been reported on the Swedish western coast. Analysis carried out during the course of the safety investigation confirmed that the oil washed ashore had leaked from a breached heavy fuel storage tank fitted to the *Golden Trader*. It was estimated that the total amount of heavy fuel oil lost on board was approximately 450 m^3.

The immediate causes of the collision were determined to be an inaccurate interpretation on board *Golden Trader* of the developing close quarter situation and potential navigational practices on board *Vidar*.

5.1.2 Spill of Crude Oil During Bunkering from the Syd Arne Platform

Between 2010 and 2014, no major oil spill incidents occurred at the platforms inside the Danish EEZ. However, prior to that period, a major spill incident took place at the Syd Arne platform area in December 2008. During bunkering of crude oil from storage facility on the seafloor beneath the Syd Arne production platform to a tanker, an oil spill was observed. When the spill was observed, pumping was stopped and the authorities were informed. A Danish sea environmental aircraft on a reconnaissance flight was directed to observe the oil spill and estimated the oil volume to more than 650 m^3 in this area. The spill was recovered by two strike

teams that were mobilized from Esbjerg Harbour to collect the oil. No dispersants were used. A minor additional spill happened due to back-flushing in the bunkering system.

Danish and German environmental aircrafts, as well as data from side-looking airborne radar (SLAR), served to focus and enhance the recovery rate during the mechanical combat of the spill. Spill recovery was, at one stage, hindered due to failure of skimmer pump. Estimated recovery rate was app. 20% of the calculated spill size, as approximately 28,000 l seawater with crude oil was collected and brought ashore before weather conditions and spreading and thinning of the oil hindered the collection of oil. A root cause investigation and precautionary action was taken to avoid similar spill incidents during bunkering of crude oil offshore. Furthermore, a tier 1 response, as described in the section "OSCPs for Offshore Operators in Denmark", within few hours is now possible due to equipment on a standby vessel, which served to enhance recovery rates of spills.

5.1.3 Other Incidents

During the period 2010–2014, a plurality of groundings, collisions and loss at sea have taken place in the Danish sector of the North Sea, but these events had no or only a minor impact on the marine environment.

5.2 Observations of Possible Oil in the Danish Sector of the North Sea

5.2.1 All Observed Spills in the Danish Sector of the North Sea Using Bonn Agreement Data

During the 10-year period from 2000 to 2010, the number of observed slicks confirmed as oil spills [8] ranged from 33 slicks in 2000 and 2009 to as high as 164 in 2008 using both aerial surveillance and satellite surveillance data (see Fig. 3). The use of satellite surveillance from 2004 onwards means that it is possible to identify slicks during the hours of darkness, a time when intentional oil spills may occur, and has broadened the geographical coverage of surveillance activities beyond what is possible using aerial surveillance only.

However, the number of slicks does not necessarily provide a complete picture of what has been happening in the Danish North Sea Region. Figure 4 compares the number of flight hours per year against the number of observed slicks for the 20-year period from 1990 to 2010. There was wide variability both in the number of flight hours conducted and in the number of observed slicks, and this is reflected also in the ratio of flight hours to observed slicks, a way of identifying whether there has been any specific trend over time (see Carpenter, 2007 [18])

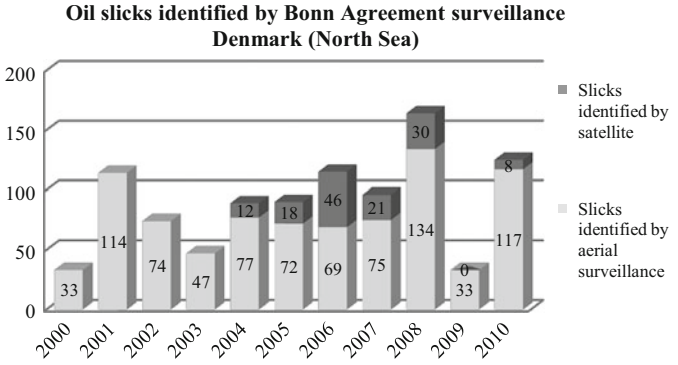

Fig. 3 Oil slicks observed by aerial and satellite surveillance in the waters of the Danish sector of the North Sea, 2000–2010

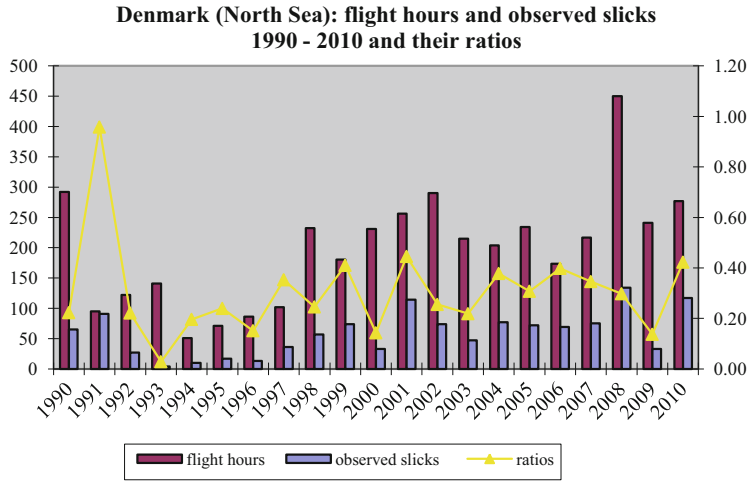

Fig. 4 Number of flight hours and observed slicks between 1990 and 2010 in Danish North sea waters and the ratio of slicks to flight hours

In 1990 there were 292 h of aerial surveillance flights conducted in the Danish North Sea Region. This subsequently fell to only 51 h in 1994, rising to a high of 450 h in 2008. The number of observed slicks in the same years was 65, 10 and 134 slicks, respectively. Also for those same years, the ratio of slicks to flight hours is 0.22, 0.03 and 0.30. The highest ratio of slicks to flight hours occurred in 1992 where 91 slicks were observed during just 95 h of aerial surveillance flights, giving a ratio of 0.96. However, across the whole 20-year period, the next highest ratio is 0.45 in 2001, all other years being lower than that value.

What Figs. 3 and 4 illustrate is that there continues to be wide variations year on year in the Danish North Sea Region but that, with increases in the number of flight

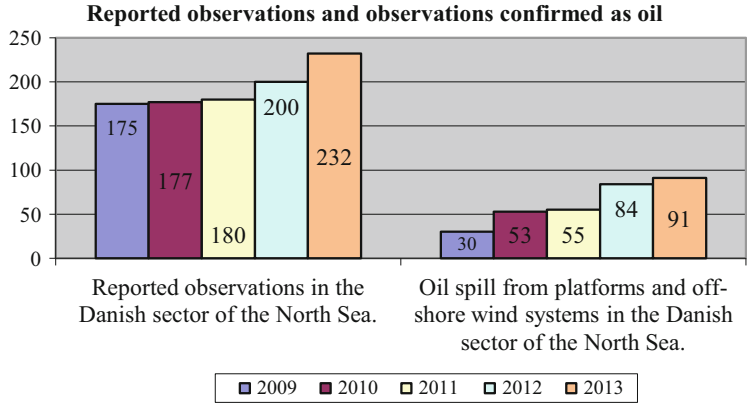

Fig. 5 Observed and confirmed oil spills from platforms and offshore wind systems in the Danish sector of the North Sea

hours and the use of satellite surveillance, it is possible to more accurately identify slicks and also the source of those slicks.

5.2.2 Observed Spills from Oil Platforms

During the period 2009–2013, there was an increase in reported observations of possible oil spills from oil platforms in the Danish sector of the North Sea of 33%, from 175 to 232 possible spills (see Fig. 5). At the same time, reported observations of oil and chemical spills from oil rigs and offshore windmills increased by 203% from 30 to 91. It is estimated that the reason for the increase in oil spills from platforms and offshore wind systems in the Danish sector of the North Sea is due to better cooperation between the land-based authorities and the operators of offshore installations in relation to effective reporting of spills. Hence, the increase in incidents does not reflect a significant real-term increase in the volume of oil and chemical spills. Several quite small spills, some of which reflect nearby-major-spill incidents, are now included in the statistics, which makes it possible to identify the causes of incidents and to enhance procedures to avoid any incidents that may lead to unplanned discharges to the sea.

5.2.3 Observed Discharges from Shipsy

Between 2009 and 2013, there has been a steady decline in observed discharges confirmed as coming from ships in all Danish waters. Ninety-five discharges from ships were observed during 2009 in Danish waters, while in 2013 only 39 discharges were observed. This is a reduction of 68%.

In 2012 and 2013, less than 10 oil spills are estimated to originate from ships in the Danish sector of the North Sea in each of the years.

6 Conclusions

Monitoring for, and handling of, oil pollution in the waters of the Danish sector of the North Sea remains a priority in a region which is one of the most highly trafficked maritime regions in the world. Despite the economic recession of the late 2000s, the area, which is the gateway between the North Sea and the Baltic Sea, is expected to see continued growth in shipping traffic. This brings with it an ongoing risk of accidental (and potentially deliberate) oil and chemical pollution from shipping.

The Danish sector of the North Sea Region is regulated at multiple levels, from international conventions such as UNCLOS and MARPOL, by regional agreements such as the OSPAR Convention and the Bonn Agreement, by EU legislation such as directives such as the EU Offshore Directive and also through bilateral and trilateral agreements with its neighbouring countries (Germany and the Netherlands). Responsibility for aerial surveillance and for combating oil spills at sea lies with Danish Defence Command.

This chapter sets out the range of legislative measures under which surveillance and pollution handling activities occur in the region. It also sets out the responsibilities of the various stakeholders, from the Danish Defence Command to the municipal authorities, and of private companies and civil agencies. It discusses the range of surveillance activities taking place in the region under the aegis of the Bonn Agreement, for example, and the range of equipment available to handle spills ranging from Danish naval assets to equipment operated by private companies.

What this chapter shows is that continued high volumes of shipping traffic, and continued production from offshore oil and gas platforms in the Danish North Sea, means that there also continues to be oil spills in the region coming from both ships and oil platforms. However, ever more accurate surveillance methods and the use of satellite surveillance, for example, can be interpreted to mean that the sources of spills can be determined more accurately, giving the potential for the companies responsible to be held accountable for helping clean up spills and for the costs of their environmental impacts.

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