OSPAR COMMISSION

Protecting and conserving the North-East Atlantic and its resources

Assessment of discharges, spills and emissions from offshore oil and gas operations on the Danish Continental Shelf 2009-2013

Hazardous Substances & Eutrophication Series

2016

OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the “OSPAR Convention”) was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. The Contracting Parties are Belgium, Denmark, the European Union, Finland, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Convention OSPAR

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998.
Les Parties contractantes sont l'Allemagne, la Belgique, le Danemark, l’Espagne, la Finlande, la France, l’Irlande, l’Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d’Irlande du Nord, la Suède, la Suisse et l’Union européenne.

Assessment of the discharges, spills and emissions from offshore oil & gas operations on the Danish Continental Shelf 2009-2013

Contents

Executive Summary

This report presents the discharge, spill and emission data from offshore oil and gas operations on Danish Continental Shelf (DCS) over the period 2009–2013 and the assessment of the data. The annual data is provided in the Data Annex. For 2010 and 2012 the data comprises data on discharges to the sea and emissions to air from drilling activities in the sea around the Faroe Islands.

Level of Activity

The Danish Continental Shelf is a mature petroleum region, and the production is declining. However, there is still a high activity level, with 8 wells drilled in 2013, new fields have initiated production in the last few years and additional fields are about to come into production in the coming years.

Discharges & spills

The total quantity of *dispersed*[1] *oil (aliphatic oil)* discharged to sea from produced water and displacement water decreased markedly during the 2009–2013 period.

Produced water and displacement water discharges are the main contributors to the oil discharges from the petroleum industry. The total volume of produced water discharged decreased slightly, while displacement water discharges remained stable between 2009 and 2013. The decline in produced water discharges was partly due to the successful implementation of injection strategies and partly due to a decline in the water production.

The annual average dispersed oil content in produced and displacement water also decreased markedly over the period. A maximum of 2 installations on the DCS in any one year failed to meet the performance standard for oil content as an annual average. The maximum amount of oil discharged with water exceeding the performance standard was 7 tonnes in 2009.

The total number of oil spills to sea increased on the DCS between 2009 and 2013, but the quantity of oil released through these spills decreased markedly over the period.

Chemicals

The total quantity of chemicals reported *used* offshore decreased markedly over the period. 40 150 tonnes of chemicals were reported used in 2013. Of this, only 0,35% belonged to the category “substitution chemicals”. No chemicals on the OSPAR List of Chemicals for Priority Action (LCPA) were used in the period.

The total quantity of chemicals *discharged* into the sea over the period 2009 – 2013 was reduced from approx. 30 000 tonnes down to 13 776 tonnes. Of these only 42 kg belonged to the substitution chemicals category. No LCPA substances were discharged during the period.

The number of chemical spills to sea was at a low level from 2009 – 2011, but increased in regards to smaller spills markedly in 2012 and 2013. The amount of chemicals spilled however, did not increase.

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[1]. “Aliphatics” and “aromatics” are defined by the reference method set in OSPAR Agreement 1997—16 (Solvent extraction, Infra-Red measurement at 3 wavelengths). In that context, “aliphatics” and “dispersed oil” mean the same thing.

The total quantity of chemicals spilled to sea varied over the period, but did not in general decrease over the period.

Atmospheric Emissions

Atmospheric emissions are not regulated by OSPAR measures, but they are reported annually to OSPAR. There was a downwards trend between 2009 and 2013 for the atmospheric emissions of CO_2 and NO_x, while the emission of nmVOC has more than halved. The decrease for nmVOC was mainly accredited to implementation of vapour recovery units on the ships that collect the oil from the operators using under water storage tanks. The methane emissions remained stable, while the emissions of SO_2 after a stable period increased in 2013.

Récapitulatif

Le présent rapport présente les données sur les rejets, les déversements et les émissions pour les opérations pétrolières et gazières offshore sur le plateau continental danois (DCS) durant la période 2009–2013 et l'évaluation des données. Les données annuelles sont présentées dans l'Annexe. Pour les années 2010 et 2012, des données sur les rejets en mer et les émissions atmosphériques provenant des activités de forage en mer autour des îles Féroé sont incluses.

Niveau d'activité

Le plateau continental danois est une région pétrolière parvenue au stade de la maturité, et la production est en déclin. On observe toutefois encore un niveau d'activité élevé, avec 8 puits forés en 2013, la mise en production de nouveaux champs au cours des dernières années et d'autres champs sur le point d'entrer en production au cours des années à venir.

Rejets et déversements

La quantité totale d'hydrocarbures dispersés[2] (hydrocarbures aliphatiques) rejetée en mer dans l'eau de production et l'eau de déplacement a diminué de manière significative durant la période 2009–2013.

Ce sont les rejets d'eau de production et d'eau de déplacement qui contribuent le plus aux rejets d'hydrocarbures de l'industrie pétrolière. Le volume d'eau de production rejeté a légèrement diminué, tandis que les rejets d'eau de déplacement sont restés stables entre 2009 et 2013. Le déclin dans les rejets d'eau de production a été dû en partie à la réussite de la mise en oeuvre de stratégies d'injection et en partie à un déclin dans les quantités d'eau de production.

La quantité moyenne annuelle d'hydrocarbures dispersés présente dans l'eau de production et l'eau de déplacement a également considérablement diminué durant la période. Au cours de n'importe quelle année, un maximum de deux installations sur le DCS a manqué de satisfaire à la norme de performance pour la moyenne annuelle de la teneur en hydrocarbures. La quantité maximale d'hydrocarbures rejetée avec l'eau au-delà de la norme de performance a été de 7 tonnes en 2009.

[2]. Les composés « aliphatiques » et « aromatiques » sont définis par la méthode de référence énoncée dans l'Accord OSPAR 1997-16 (Extraction par solvant, mesure par infrarouges à 3 longueurs d'onde). Dans ce contexte, les termes « aliphatiques » et « hydrocarbures dispersés » ont le même sens.

Le nombre total de déversements d'hydrocarbures en mer a augmenté sur le DCS entre 2009 et 2013, toutefois la quantité d'hydrocarbures déversée a diminué de manière significative durant la période.

Produits chimiques

La quantité totale de produits chimiques utilisés offshore a diminué considérablement durant la période. On a déclaré l'utilisation de 40 150 tonnes de produits chimiques en 2013. Sur cette quantité, seuls 0,35 % appartiennent à la catégorie « produits chimiques de substitution ». Aucun produit chimique figurant sur la Liste OSPAR de produits chimiques devant faire l'objet de mesures prioritaires (LPCA) n'a été utilisé durant la période.

La quantité totale de substances chimiques rejetée en mer durant la période 2009 – 2013 a diminué d'environ 30 000 tonnes à 13 776 tonnes. Sur cette quantité, seuls 42 kg appartiennent à la catégorie de produits chimiques de substitution. Aucun produit chimique de la LCPA n'a été rejeté durant la période.

Le nombre de déversements de produits chimiques en mer était à un niveau bas de 2009 à 2011. Toutefois le nombre de petits déversements a augmenté de manière significative en 2012 et 2013, malgré ce fait la quantité de produits chimiques déversée en mer n'a pas augmenté. La quantité totale de produits chimiques déversée en mer a varié durant la période, mais en général n'a pas diminué.

Émissions atmosphériques

Les émissions atmosphériques ne sont pas réglementées par des mesures OSPAR, mais elles sont notifiées une fois par an à OSPAR. On a observé une tendance à la baisse entre 2009 et 2013 pour les émissions atmosphériques de CO_2 et NO_x, l'émission de COVnm a diminué de plus de la moitié. La diminution des COVnm est essentiellement attribuée à la mise en place d'unités de récupération des vapeurs sur les navires qui collectent les hydrocarbures auprès des opérateurs utilisant des cuves de stockage sous l'eau. Les émissions de méthane sont restées stables tandis que les émissions de SO2, suivant une période de stabilité, ont augmenté en 2013.

1. Introduction

This report provides an assessment of the discharges, spills and emissions to the North Sea from offshore oil & gas exploration and production installations on the Danish Continental Shelf (DCS) during the period 2009–2013. The purpose of the report is to assess trends related to the effectiveness of the OSPAR measures and the national regulation. Trends have been assessed using expert judgement and not by statistical analyses.

The assessment is based on data submitted by the operators on the DCS to the Danish Environmental Protection Agency (DEPA) and reported by Denmark in the annual OSPAR report on discharges, spills and emissions from offshore oil and gas installations. For 2010 and 2012 the data also comprises data on discharges of certain offshore chemicals to the sea and emissions to air from drilling activities in the sea around the Faroe Islands reported to DEPA by the Faroese Environment Agency. These discharges and emissions to air comprise typically below 1% of the discharges and emissions in the North Sea in the same years and do therefore not have any significant influence on the assessments and conclusions in this report. The assessment is based on the data available at the time when the annual OSPAR report was submitted (see the Data Annex).

Where relevant, the performance on the DCS has been compared to the overall performance in the OSPAR area, using the following sources:

- "Draft OSPAR report on discharges, spills and emissions from offshore oil and gas activity in 2013" (EAP meeting 2015);
- "Assessment of the OSPAR report on discharges, spills and emissions to air from offshore oil and gas 2010—2012" (OSPAR Commission 2014).

It should be noted that Denmark is a medium to small sized oil and gas producer in the OSPAR region. Emissions and discharges on the DCS therefore contribute only to a small degree to the total emissions and discharges in the North Sea area. As OSPAR trends in performance are mainly driven by the larger oil and gas producing countries in the North Sea area, making a comparison of performance can be challenging.

The operators have used procedures for sampling and analysis given by the Danish Environment Protection Agency (DEPA), and quality assurance procedures described by DEPA. Certified laboratories have been used.

2. Setting the scene

Measured in toeq Denmark has in the period 2009 – 2013 gone from being the third largest producer of oil and gas in the OSPAR region to the fourth largest, but the DCS is a maturing basin, and production on the DCS has been declining since 2004. The decline has continued in the period 2009 – 2013. Despite this, new oil and gas resources have been explored and additional production facilities have since then been or are presently being established by both existing and new operators.

Figure shows the official Danish production data in tonnes of oil equivalents.

The number of installations with discharges and emissions has between 2009 and 2013 changed from 20 to 14. The change is mainly due to the 2010 change in the way drilling activities are counted (see below).

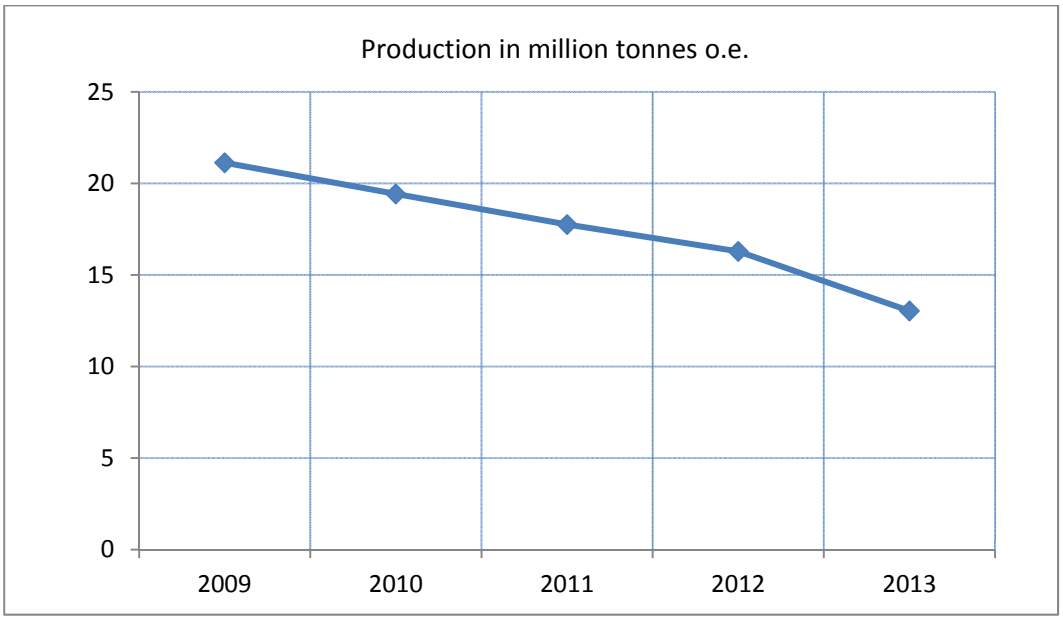

Figure 1: *Annual total production of oil equivalents on the Danish Continental Shelf*

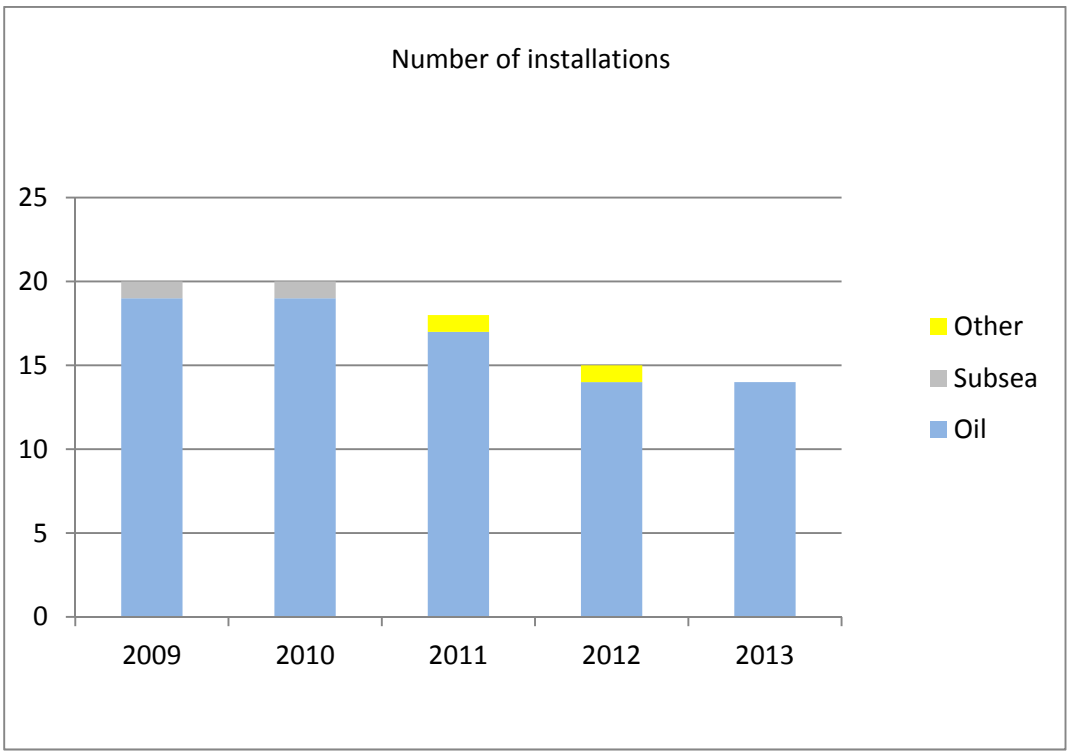

Figure 2: *Number of installations on the Danish Continental Shelf*

The way in which OSPAR recorded and reported drilling activity changed in 2010. Before 2010, 'drilling years' were determined based on the time the rig spent offshore. Since 2011, the number of wells drilled in each calendar year has been reported to better reflect drilling activity.

The reported drilling activity on the DCS increased slightly between 2012 and 2013, as shown in Figure 3.

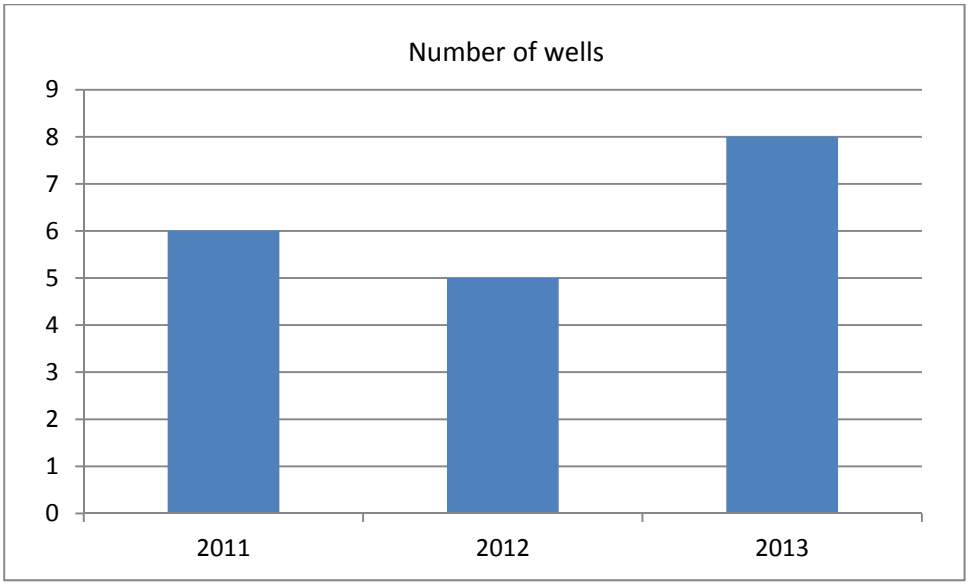

Figure 3: *Number of wells drilled on the Danish Continental Shelf 2009 - 2013*

3. Environmental Management

In accordance with OSPAR Recommendation 2003/5 to Promote the Use and Implementation of Environmental Management Systems (EMS), the offshore action plan of 2005 agreed between the Danish offshore operators and the Ministry of Environment comprised the goal that all operators by 2006 should establish EMS that should be ready for certification or other similar scheme. The EMS should cover both the production and exploration activities of the individual operator. Based on this agreement the three present Danish operators with production activities in the DCS have established such EMS according to the ISO 14001 standard and subsequently these have been certified. The operators prepare annual environmental reports that are made available to the public. DEPA does not issue formal approvals related to the operator's EMS, but DEPA's inspections both on- and offshore also include examination of relevant parts of the EMS systems. In addition, the discharge permits include requirements for the operators to conduct at least one annual independent verification of the Oil in Water sampling, analysis and reporting procedures and of the procedures related to the measurements of the flow of produced water discharged to the sea or re-injected, including procedures for maintenance and calibration of flow meters.

4. Oil discharges

4.1 Discharges of oil to sea

Discharges of dispersed oil are regulated in accordance with OSPAR Recommendation 2001/1 (as amended). The permits for discharge of produced water include a condition that the oil content as a monthly flow weighed average must not exceed 30 mg dispersed oil per litre of produced water discharged to the sea or re-injected. The limit value is waived if the total discharge of dispersed oil over the last 12 months (rolling total) has been below 2 tonnes.

Produced water and displacement water

The total volume of produced water on the DCS has reduced by 4% from 2009 – 2013. Produced water discharges decreased by about 8% from 2009 to 2013 (Figure 4). The decrease was small, but seems consistent over the period. From 2009 to 2012 the discharges of displacement water has reduced by 14%, while from 2012 to 2013 there was an additional and marked reduction resulting in a total reduction in the discharges from 2009 to 2013 of 43%. The volume of re-injected produced water varied slightly, but has increased by 4% between 2009 and 2013, which seems to be part of a positive trend over the period.

The decline in produced water discharges can partly be attributed to the increase in produced water injection. This indicates the successful implementation of measures to reach OSPAR goals. However, a similar proportion of the decline may be explained by a general decline in the water production on the DCS.

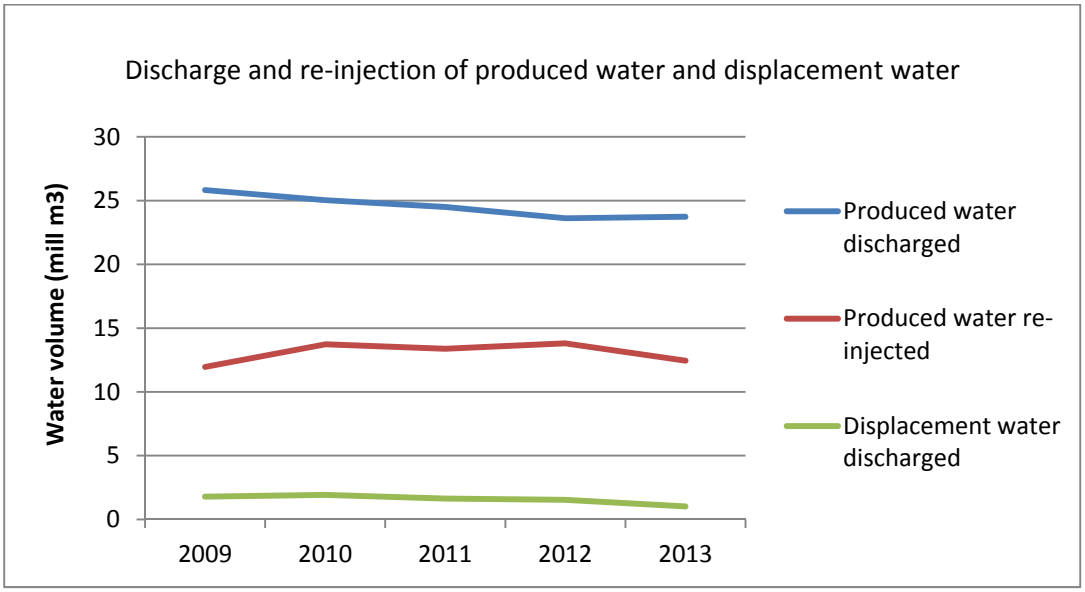

Figure 4: *Discharges and injection of produced water and displacement water on the DCS 2009—2013*

Comparing this with OSPAR overall figures shows that:

- The produced water discharges in Denmark and in the OSPAR area have reduced between 2009 and 2013 (by 8% and 17% respectively). The reductions both on the DCS and in the OSPAR area are partly due to increased amounts of water injected and partly due to declines in water production;

- The discharges of displacement water reduced in the OSPAR region by 5%, while on the DCS there was a 43% reduction. . The sharp decrease from 2012 to 2013 is partly due to a shut-down of the production in the second half of 2013 by one of the operators discharging displacement water. In 2014, where the production was resumed, the discharges of displacement water on the DCS increased by 14% compared to 2013, but were still 32% lower than in 2009.

Dispersed oil discharged

The total quantity of dispersed oil discharged with produced water and displacement water went from 340 to 178 tonnes or 48% decrease over the period (Figure 5). The OSPAR goal of reducing the discharges of dispersed oil with produced water to 85% of the level in 2000 was reached in 2010. The 85% level, which on the DCS is equal to 222 tonnes, has since then been set as the national yearly maximum for the total discharge of dispersed oil allowed on the DCS from all the offshore oil and gas activities (named "the national ceiling"). Within this framework the individual discharge permits contains conditions on how much of the 222 tonnes of dispersed oil the individual operators are allowed to discharge to the sea each year.

The dispersed oil discharged with produced water accounted for more than 99% of the total amount of oil discharged and for some years it was 100%. The average dispersed oil concentration in produced water and displacement water, was in the same period reduced from 12,3 mg/l to 7,2 mg/l (Figure 5).

The figures for the dispersed oil concentration in produced and displacement water in the OSPAR area vary, and no temporal trend can be observed over the 2009 - 2013 period. The average concentration on the DCS was significantly lower than the average concentration in the OSPAR area in 2013 (7,2 mg/L and 11,8 mg/L, respectively).

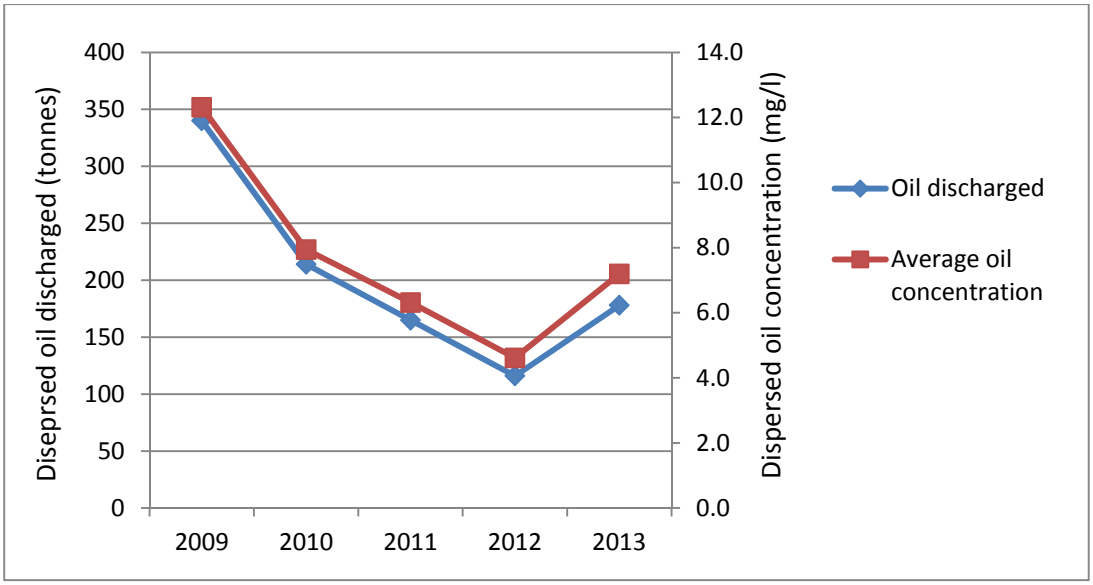

Figure 5: *Quantity and concentration of dispersed oil discharges 2009—2013*

Recommendation 2001/1 sets a performance standard for the discharge of dispersed oil in produced water. Since 2007 OSPAR has set the performance standard at 30 mg/l. For regulatory purposes in the DCS this is calculated as a monthly flow weighted average irrespective of the number of samples taken per day. However, for comparison within OSPAR an annual average is used.

As can be seen from Figure 6 in 2009 two installations failed to meet the 30 mg/l annual average dispersed oil concentration, while in 2010 and 2012 was only one and in 2011 and 2013 none. The installation that failed to meet the performance standard in 2012 had that year an average re-injection rate of 97,6%. One of the reasons for not reaching the goal was that when the injection

stops, small quantities of water with high concentrations of dispersed oil can be discharged. Such installations could discharge produced water over a longer period in order to stabilise the water cleaning process and thereby reduce the average oil concentration. However, in the actual case the operator informed DEPA that they always prioritize to maintain the highest possible re-injection rate to reduce the total amount of produced water discharged, even though this in turn will imply a risk of exceeding the monthly limit value of 30 mg/l. DEPA agrees to this approach as the amount of produced water discharged is very limited, because the operator complies with the rolling 12 month total maximum discharge of 2 tonnes of dispersed oil discharge and as the re-injection is coupled with continuous efforts to reduce the oil concentration in the produced water.

The quantity of dispersed oil discharged by installations that failed to meet the performance standard has been reduced markedly during the period 2009 – 2013, from 7 tonnes in 2009 to 0 tonnes in both 2011 and 2013.

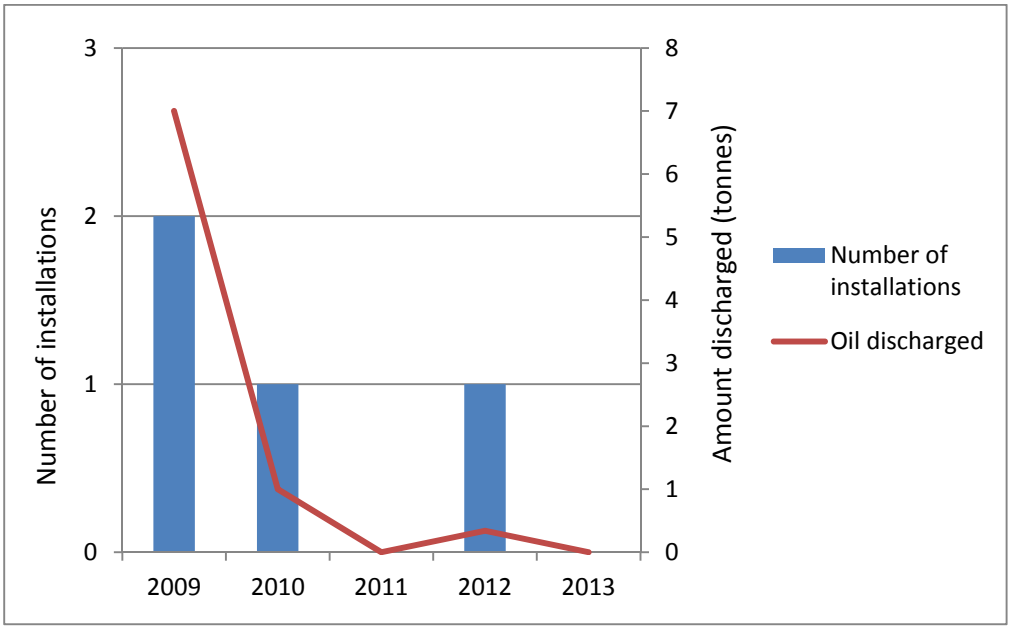

Figure 6: *Installations failing to meet performance standards for concentration of oil in water discharged and amount oil discharged because of the excess in concentration*

Denmark also reports the dissolved oil content (as represented by BTEX components) in produced water discharges. OSPAR has not issued recommended discharge levels for these components as they rapidly biodegrade in seawater once discharged. The discharge of dissolved oil[3] (BTEX) in produced water has in the period from 2009 to 2013 period showed a maximum of 216 tonnes in 2010 and since then a steady fall to 89 tonnes in 2013. Over the period 2009 to 2013 the discharges on the DCS fell by 54%, compared to a 12% increase in the OSPAR area. At some of the installations on the DCS the decrease is caused by start of production from new parts of the reservoir where the crude oil contains significantly less amounts of aromatics.

[3] "Aliphatics" (or "dispersed oil") are regularly and frequently measured, while the sampling is much less frequent for "aromatics". Therefore data on "aromatics" may be less reliable.

4.2 Risk-based Approach (RBA)

In 2012 OSPAR adopted Recommendation 2012/5 for a risk-based approach to the management of produced water discharges from offshore installations. Denmark has not yet implemented the Recommendation through a regulation or by issuing specific requirements in the permits for the installations discharging produced water, but a RBA implementation plan was agreed with the Danish operators in 2013. A draft of a Danish manual for undertaking and reporting of the RBA calculations has been developed and are presently being finalised amongst others based on experiences from RBA calculations for one third of the discharge points. It is expected that all discharge points for produced water will be covered by the RBA by the end of 2016, resulting in calculated field specific Environment Impact Factors (EIFs). One EIF refers to a volume of water of 100 000 m^3 where the PEC/PNEC ratio exceeds 1 for one or more components in the produced water. In 2016 DEPA will, in cooperation with the offshore operators, consider how requirements on RBA can be incorporated into the Danish regulations and permits for discharge of produced water.

4.3 Spills of oil to sea

The total number of oil spills to the sea has doubled on the DCS between 2009 and 2013, but in the same period the amount of oil spilled fell by 50%. The vast majority of the spills were much smaller than 1 tonne, as the average spill size seen over the five years of spills in the category < 1 tonne was 42 kg.

The quantity of oil released has, as expected, shown larger variations since it is mainly driven by the small and variable number of spills larger than 1 tonne.

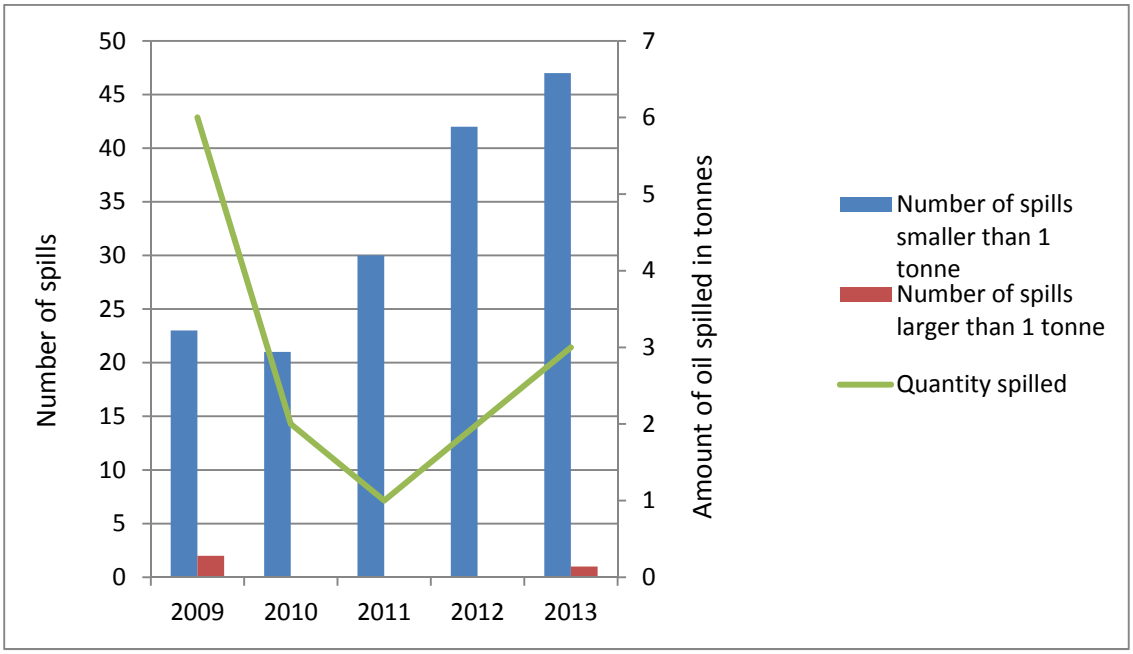

Figure 7: *Number of oil spills and total quantity of the spills on the DCS 2009—2013*

Comparing figures from DCS to overall figures from OSPAR indicates the following:

- Between 2009 and 2013 there was a marked increase in the number of spills on the DCS. This is opposite to the trend observed in the OSPAR area until 2012, but in 2013 there was a significant increase especially in the number of spills larger than 1 tonne in the OSPAR area;

- Between 2009 and 2013, the reduction in the amount of oil spilled was approximately 50% on the DCS, while there was a 25% reduction across the OSPAR region. Large variations in both the number and quantity of the spills from year to year across the OSPAR area, however, make a genuine comparison difficult.

The amount of oil spilled on the DCS was between 0,76 and 1,7% (weight) of the amount of dispersed oil discharged with produced water and displacement in the same period.

4.4 Discharges of organic phase fluids

Discharge of cuttings contaminated with organic phase fluids (OPF) at a concentration greater than 1% by weight on cuttings is prohibited based on OSPAR Decision 2000/3. Denmark regulates this through conditions in the discharge permits. Although some technologies are able to reduce the concentration of oil to below the 1% limit, no cuttings contaminated with OPF were discharged on the DCS between 2009 and 2013.

5. Chemicals

5.1 Chemical Use & Discharge

In this document, the following applies:

The term *substitution chemical* is short for *chemicals which contain one or more substances which are candidates for substitution*, according to OSPAR Recommendation 2010/4.This includes chemicals which are:

- on the OSPAR LCPA;
- inorganic with LC_{50} or EC_{50} less than 1 mg/l;
- have biodegradation less than 20%; or
- meets two of three criteria:
    - biodegradation less than 60%;
    - BCF larger than 100 or Log $P_{ow} \geq 3$; or
    - LC_{50}/EC_{50} less than 10 mg/L.

The goal of OSPAR Recommendation 2006/3 is that discharges of substitution chemicals should be phased out by 2017. In addition OSPAR Recommendation 2005/2 set a goal that Contracting Parties should have phased out the discharge of substitution chemicals on the OSPAR 2004 List of Chemicals for Priority Action (LCPA) by 1 January 2010. There are no OSPAR measures against the other categories of chemicals classified within HMCS, as these are deemed not to pose a significant risk to the environment.

On the DCS all use and discharge of offshore chemicals (except for emergency use) requires a permit. The permit reflects the amount of chemicals the individual operators have applied to use and discharge per year in the period of the granted permission. In accordance with the offshore action plan mentioned above, discharge of offshore chemicals on the LCPA was to be phased out by the end of 2005, but in reality the offshore operators on the DCS stopped all discharges of LCPA chemicals by 2004. The plan also stipulates that the discharge of other substitution chemicals should be phased

out by the end of 2008. By 2012 the discharges of substitution chemicals had been reduced to 0,13% of the discharge in 2005.

As none of the operators applied for discharge of substitution chemicals in connection with the renewal of their discharge permits by January 2013, DEPA decided to include a general condition in the permits prohibiting discharge of such chemicals. Discharge of substitution chemicals is now only acceptable if an evaluation carried out after a method agreed between the operator and DEPA shows that the discharge of the substitution chemical – apart from being the best solution technically and in regards to safety – is also from an environmental point of view the best solution. The operator shall also document that alternative offshore chemicals have been evaluated.

Evaluation, ranking and choice of offshore chemicals is the operator's responsibility. DEPA examines the characteristics of the individual offshore chemicals through the pre-screening forms and if necessary the HONCF forms, which are accessed through the Danish Product Register.

DEPA lists offshore chemicals approved for use and discharge, according to the categories of offshore chemicals with no OSPAR measures that is a) Ranking category and b) PLONOR chemicals and inorganic substances not containing substitution chemicals. The listing however is only carried out for offshore chemicals that the operators have applied to use and discharge.

These common (and as such identical) lists are part of the discharge permits given to the individual operators who can use and discharge all the chemicals on the lists. However, if an offshore chemical on the lists was not originally included in the application from an individual operator, the operator is required to inform DEPA when they want to use and discharge such a chemical and also inform DEPA if the chemical replaces another chemical that was included in the original application. A new permit though is not required. If the operator wants to use and discharge an offshore chemical not on one of the two lists, an application to DEPA is required. In principle DEPA does not limit the amount of yellow and green offshore chemicals used or discharged.

The total amount of offshore chemicals used fell by 46% between 2009 and 2013, while the discharge was reduced by 58% from 2009 to 2010. Over the years from 2011 to 2013 the discharge increased in 2011 but returned to 2010 levels by 2013, as the discharge in 2013 was 56% lower than in 2009 (Figure 8).

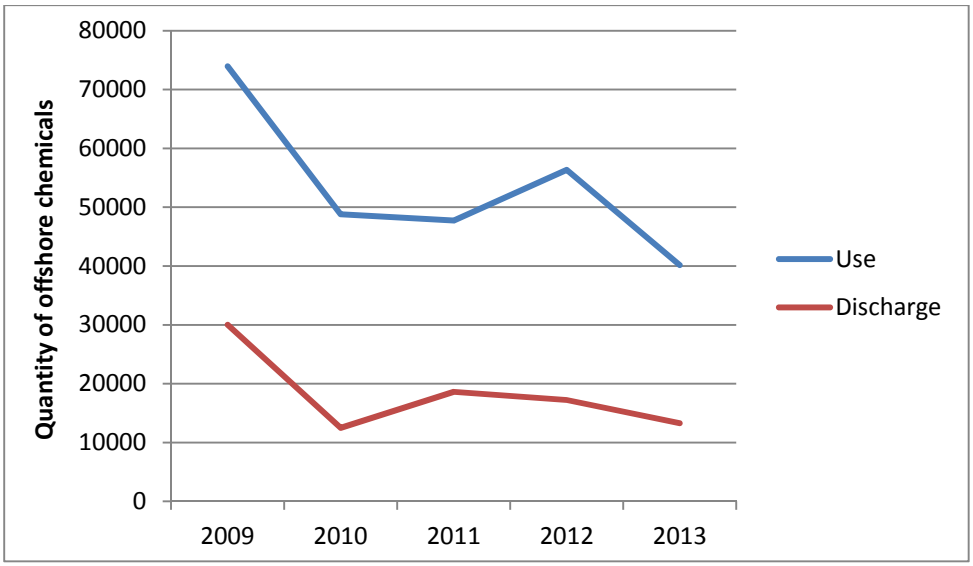

Figure 8: *Total quantity of offshore chemicals used and discharged on the DCS 2009—2013*

Chemicals Used

The total quantity of chemicals *used* on the DCS in 2013 was 40 150 tonnes out of which 65% were chemicals on the PLONOR list and between 35% (wt.) were other non-substitution chemicals (Figure 9). In the same year use of substitution chemicals represented 0.35% (Figure 10). No chemicals on the List of Chemicals for Priority Action (LCPA-substances) were used in the period.

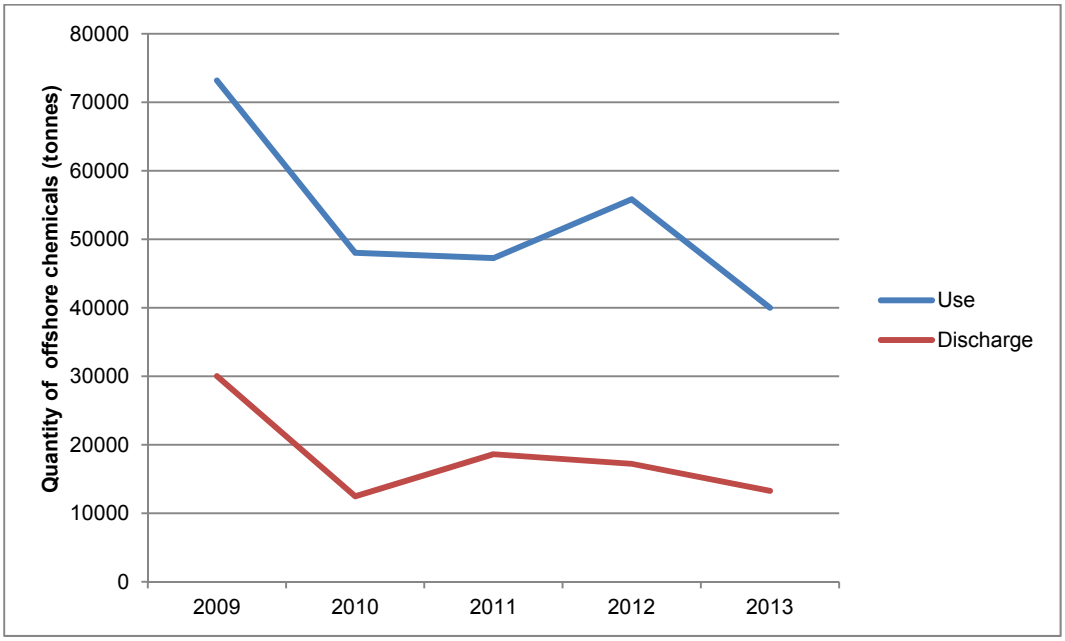

Figure 9: *Quantities of chemicals not containing substitution candidates used and discharged 2009—2013*

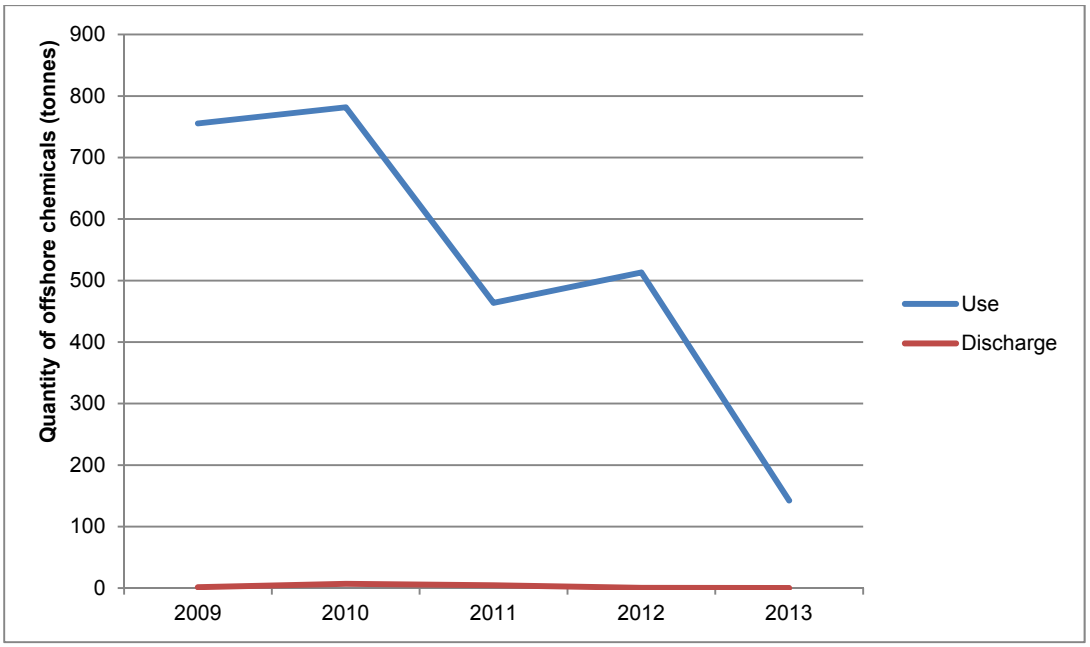

Figure 10: *Quantities of substitution chemicals (except LCPA chemicals) used and discharged 2009—2013*

According to OSPAR documents, the figures for 2013 demonstrate that almost 66% of chemicals used were on the PLONOR list, 33% were other non-substitution chemicals and approx. 1% were substitution chemicals. Use of LCPA chemicals was negligible. Thus,:

- the percentage of PLONOR chemicals used in 2013 was slightly lower or the same on the DCS in 2013 than the average in the OSPAR area in 2013; while
- the percentage of other non-substitution chemicals was slightly higher on the DCS compared to the OSPAR area; and
- the percentage substitution chemicals was significantly less on the DCS than in the OSPAR area.

Chemicals Discharged

The total quantity of chemicals *discharged* to the sea on the DCS in 2013 was 13 776 tonnes. 60% of these were listed on the PLONOR list, while the remaining 40% (wt.) were other non-substitution chemicals (Figure 9). No LCPA chemicals were discharged and the discharge of substitution chemicals were only 42 kg or 0,0003% of the total discharge.

According to OSPAR, the corresponding overall figures for 2013 were 75% chemicals on the PLONOR list, 24% other non-substitution chemicals and less than 1% chemicals on the LCPA list or other substitution chemicals. Thus,

- the percentage of PLONOR chemicals discharged on the DCS was lower in 2013 than the average in the OSPAR area in 2013; while
- the percentage of other non-substitution chemicals was higher on the DCS;

- the reported percentage of substitution chemicals was much lower on the DCS compared to the OSPAR area. This was primarily due to the early phase out of substitution chemicals on the DCS as a national measure by 2012.

5.2 Chemical Spills

The number of chemical spills to the sea was at a low level from 2009 – 2011, however the number of spills smaller than 1 tonne increased markedly in 2012 and 2013 (Figure 11). The amount of chemicals spilled through these spills did, however, not increase similarly, as the average size of the spills decreased markedly in 2012 and 2013. In regards to chemical spills larger than 1 tonne the number remained very small over the period. The total quantity of chemicals spilled to sea varied markedly over the period as the bulk of the spilled amount originated from 1 or 2 larger spills in the respective years. Consequently there is no clear trend in the amount of chemicals spilled per year, apart from concluding that the amount spilled does not seem to decrease.

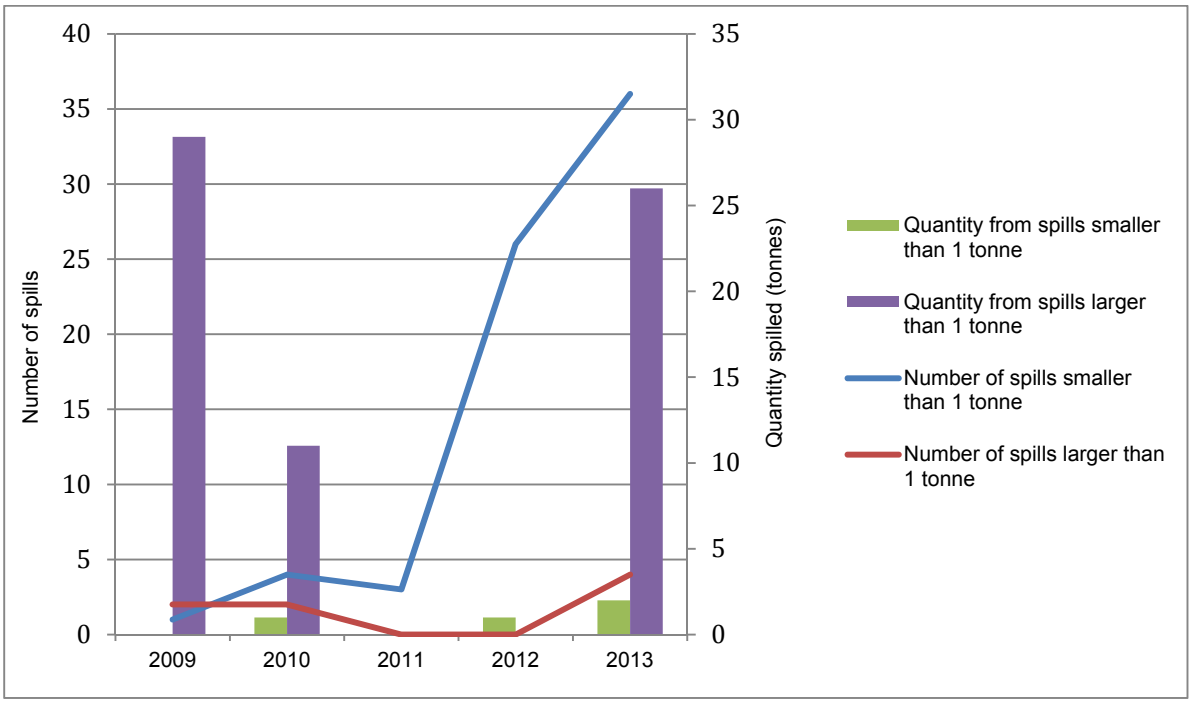

Figure 11: *Number and quantity of chemical spills on the Danish Continental Shelf 2009—2013*

In the OSPAR area there seems to be an increasing trend in the number of spills. There was a large reduction in the total volume spilled, but this again seems to be caused by the large spills on the NCS in 2009 and 2010 and seems not to represent a positive trend due to implementation of OSPAR measures.

Consequently:

- there is a clear tendency for an increase in the number of smaller spills on the DCS which is similar to the trend in the OSPAR area;
- there is no clear trend in the quantities spilled on the DCS, while the decreasing trend in the OSPAR area over the 2009—2013 period were mainly due to exceptionally large spills on the NCS in 2009 and 2010.

6. Emissions to air

Atmospheric emissions are not covered by OSPAR measures or harmonised OSPAR measuring methodologies, but the reporting of these emissions is part of the annual reporting to OSPAR that is a requirement in the discharge permits issued by DEPA.

Of the atmospheric emissions reported to OSPAR the emissions of NO_x from the offshore combustion plants (the LCPs) are regulated through approvals of the plants according to the Danish Act on Environmental Protection. In addition the operators has since 2010 been paying an emission tax of 5 DKK/kg NO_x emitted, as the tax in 2012 was raised to 25 DDK/kg NO_x emitted. From 2016 the tax will again be reduced to 5 DKK/kg NO_x emitted.

The above-mentioned offshore action plan included a goal for the reduction of the atmospheric emissions of nmVOC. As such the emissions should from 2005 to 2010 be reduced from 3200 to 2300 tonnes. Another goal of the plan was that the operators, which load oil onto ships from storage tanks, should only use ships that were equipped with vapour recovery equipment. Both goals were met by the end of 2010.

Atmospheric emissions of CO_2 are regulated through the Danish CO_2 allowance scheme[4], as the emissions are reported annually to the Danish Energy Agency (DEA).

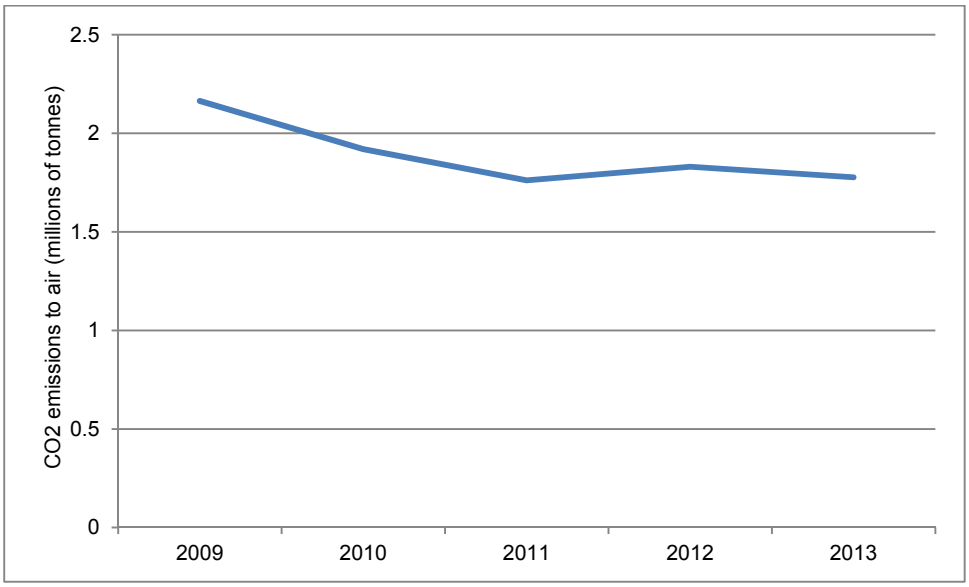

Figure 12: *Emissions of CO2 on the Danish Continental Shelf 2009—2013*

[4] According to Directive 2003/87/EC of the European Commission and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC.

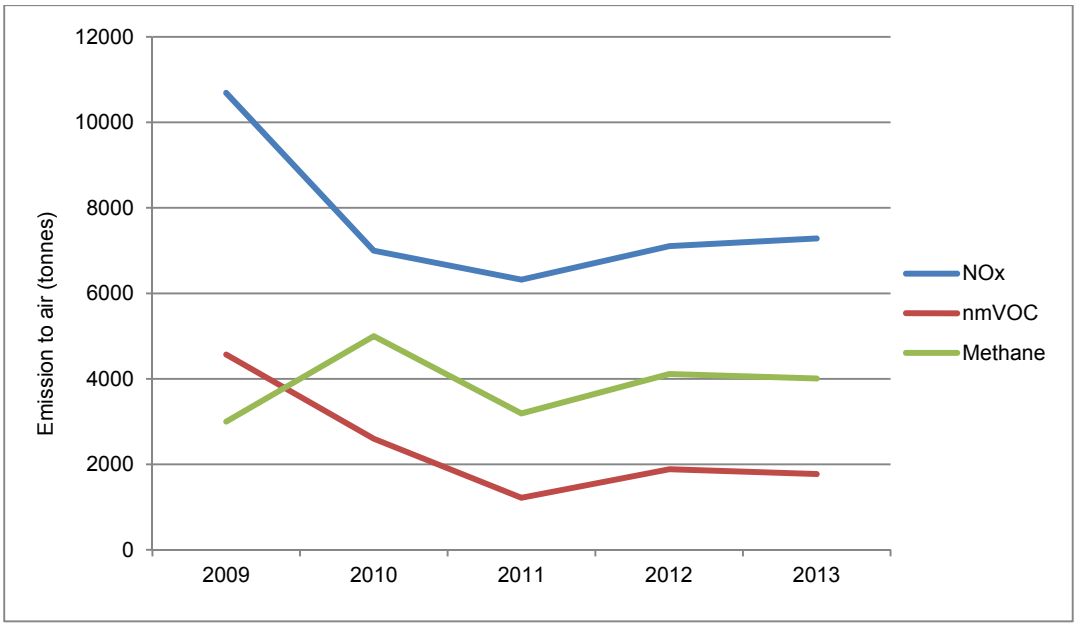

Figure 13: *Emissions of NOx, methane and nmVOC on the Danish Continental Shelf 2009—2013*

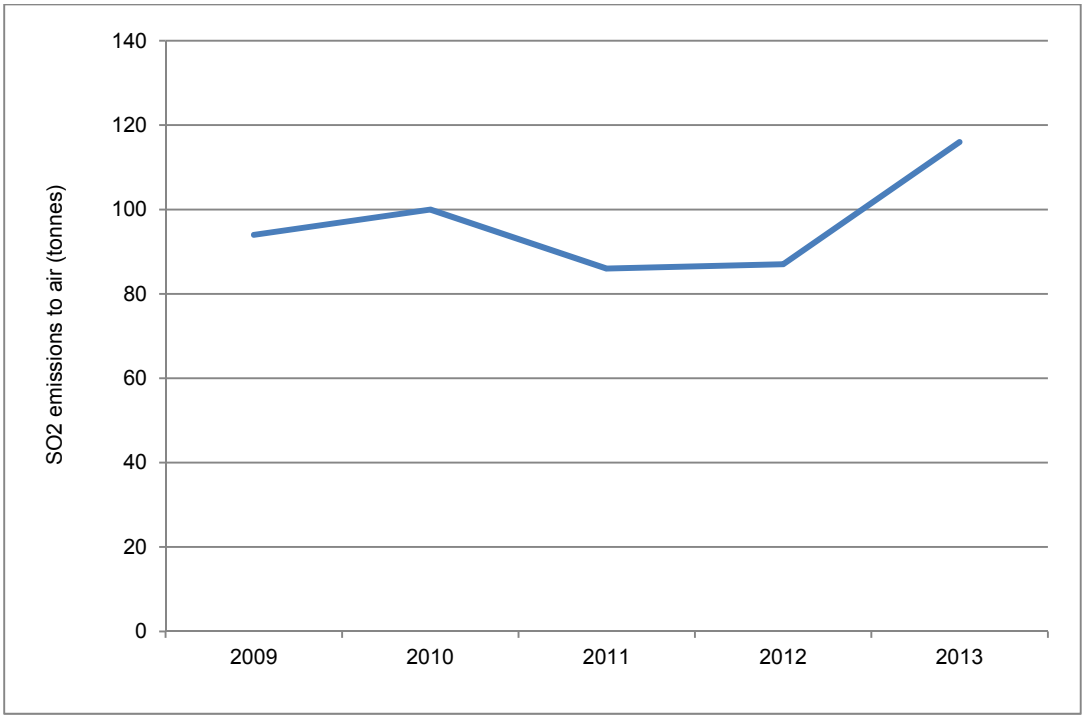

Figure 14: *Emissions of SO2 on the Danish Continental Shelf 2009—2013*

There was a general downwards trend between 2009 and 2013 for the atmospheric emissions of CO_2 on the DCS (Figure 12). A similar but somewhat more marked downward trend was found for the emissions on NO_x (Figure 13) but only from 2009 to 2010 where after it remained stable. The emissions of non-methane VOC (nmVOC) were reduced by more than 50% from 2009 to 2013, while the emission of methane more or less remained the same over the period (Figure 13). As mentioned above the reduction of the emission of nmVOC was in agreement with the Danish offshore action plan, as it required the implementation of vapour recovery units on ships collecting oil from

underwater storage tanks. The emission of SO_2 was relatively stable over the period, apart from an increase by 26% in 2013 compared to the average of the emission from 2009 – 2012.

Comparing DCS figures to OSPAR overall figures for the period 2009 - 2013, we find:

- CO_2 emissions showed a slight downward trend on the DCS, while it remained stable in the OSPAR area;
- Apart from a marked fall in the NO_x emissions on the DCS from 2009 to 2010 the emission remained stable in the remaining part of the period similar to the trend in the OSPAR area;
- Methane emissions have remained stable both on the DCS and in the OSPAR area;
- Non-methane VOCs reduced by more than 50% on the DCS, while the reduction in the OSPAR area was 17%;
- SO_2 emissions increased by 26% in 2013 compared to the period 2009 – 2012, which is similar to the increase by 26% in the OSPAR area.

7. QA procedures in Denmark

7.1 Counting of installations

In OSPAR, the number of installations is detailed in the "Inventory of oil and gas offshore installations in the OSPAR maritime area ". The number of installations reported annually to OIC, as reflected in table 2 of the present report, only comprises installations with discharges to the sea and emissions to air.

7.2 Reporting in regards to dispersed oil

The content of this section describes the regulation as it is today, despite that some of the regulatory requirements in the discharge permits have been introduced after 2013.

In Denmark operators are required to both quantify the amount of produced and displacement water discharged and to determine the concentration of dispersed oil in the discharge.

The concentration of dispersed oil is determined by sampling the discharge stream on a routine basis and analysing the samples in accordance with the requirements in the discharge permits based on OSPAR Recommendation 2001/1. Operators are required to sample discharge streams once per day and within the same 1 hour time interval each day. If more samples are taken (normally only relevant for discharges of produced water), the concentrations of dispersed oil in all the samples are to be reported in the monthly discharge reports to DEPA, but only the concentration value from the first sample are included in the calculation of the monthly weighed concentration average and in turn in the calculation of the total amount of oil discharged for that month. This procedure is valid during stable operational conditions, meaning that only few and smaller fluctuations in the oil concentration are registered through the online oil in water monitor.

If there is a risk of unstable operating conditions (see list below) or if bigger fluctuations in the oil concentration or concentrations of dispersed oil in the produced water above 100 mg/l are registered through the online monitor, the operator is required to initiate sampling of the produced water 3 times per day at an 8 hourly interval. The increased sampling frequency shall be continued until 3 subsequent samples show a concentration of dispersed oil below 20 mg/l. A weighted daily

average concentration of dispersed oil is calculated based on the 3 individual concentrations multiplied by the amount of produced water discharged from the time of the first the sample and until the 2nd and 3rd samples respectively are taken.

The increased sampling frequency has to be started in advance of the initiation of activities that potentially can lead to unstable operating conditions. If this is not possible due to *e.g*. a shut-down of the discharge of produced water to the sea, the increased sampling frequency should be restarted when the discharge is resumed.

Unstable and potentially unstable operating conditions comprise:

- Pigging operations;
- Planned well service operations and other maintenance operations that could influence the stability of the oil/water separation processes;
- Well clean-up operations, including coiled tubing;
- Tests of new offshore chemicals that could influence the stability of the oil/water separation processes;
- Change of equipment;
- Start up or shut down;
- Other situations, where DEPA, according to requirements in the discharge permits, has been notified by the operator of upcoming activities that could have a significant influence on the stability of the oil/water separation processes.

The sampling frequency during both stable and unstable operating conditions is higher than the minimum required under OSPAR Recommendation 2001/1.

In addition the operators are required to report to DEPA if the concentration of dispersed oil has for 5 consecutive days been above 30 mg/l. The operator shall at the same time inform DEPA what action they have taken to ensure that the monthly concentration average will not exceed the 30 mg/l limit value.

It is also a requirement in the discharge permits that online analysers for process monitoring are installed at all produced water discharge points to provide a real time indication of produced water quality so that any deterioration in quality can be responded to as quickly as possible. During DEPA's inspections print outs from the records made by the online monitors are examined and if relevant compared to the actions taken by the operator to reduce the oil concentration if the discharged water. The operators have so far evaluated that measurements done by the online monitors are not accurate and stable enough to be used for the monthly reporting of dispersed oil in the produced water.

While operators are required to report analysis results in accordance with the OSPAR Reference method all operators continue to undertake onsite analysis using infra-red techniques and the results are then converted to an OSPAR Reference Method result using correlation graphs, which are updated every three months.

Sampling and analysis of produced water and displacement water have to be done according to national or international standards and in accordance with the principles of good laboratory practise. The standards will be specific for each type of sample and each analysis. In regards to the

quantification of the discharges of produced water and displacement water the discharge permits does not comprise specific requirements for the maximum uncertainty on the flow measurements.

The operators are required to report both monthly and annually according to requirements in the discharge permits. The quality of data submitted is the responsibility of each operator. They are required to carry out a systematic review of their own data. The operators have to include details related to this in their management systems. DEPA may at any time request to see the documentation.

As mentioned above the permits include requirements that the operators in the first half of each calendar year conduct and report to DEPA the results of an independent verification of both the oil in water sampling, analysing and reporting procedures and of the procedures related to the measurements of the flow of produced water discharged to the sea or re-injected including procedures for maintenance and calibration of flow meters. If the verification shows significant deviations from the prescribed procedures the verification shall be repeated and reported to DEPA in the second half of the same year.

7.3 Reporting in regards to use and discharge of offshore chemicals

Operators on the DCS are required to record the use and discharge of all offshore chemicals in accordance with the terms and conditions of the permit. Operators are required to report the use and discharge to DEPA on a yearly basis. The reporting covers both the production and drilling activities carried out by the operator. There are no specific requirements in the discharge permits on how the operators should quantify the use and discharge of offshore chemicals, so it can in principle vary from operator to operator and in relation to the activities for which the chemicals are used and discharged. In some cases the reporting is based on quantities shipped from suppliers, which may only provide a rough estimate over a certain period but will average out over the year or longer periods. In other cases the operators record daily consumption from stock tanks on board the installation which provides a more accurate and consistent measurement. There is no measurement uncertainty requirement.

The operators' chemical management systems and methods of reporting are also reviewed during offshore inspections.

Appendix 1: OSPAR Measures associated with Offshore Oil and Gas industry

Discharges contaminated with oil

PARCOM Recommendation 86/1 of a 40 mg/l Emission Standard for Platforms[5];

OSPAR Reference Method of Analysis for the Determination of the Dispersed Oil Content in Produced Water (OSPAR Agreement number: 2005—15);

OSPAR Recommendation 2001/1 for the Management of Produced Water from Offshore Installations (as amended);

OSPAR Recommendation 2012/5 for a risk-based approach to the Management of Produced Water Discharges from Offshore Installations

Use and discharge of drilling fluids and cuttings

OSPAR Decision 2000/3 on the Use of Organic-phase Drilling Fluids (OPF) and the Discharge of OPF-contaminated Cuttings;

Guidelines for the Consideration of the Best Environmental Option for the Management of OPF-Contaminated Cuttings Residue (OSPAR Agreement number: 2002—8);

Chemicals used and discharged offshore

OSPAR Decision 2000/2 on a Harmonised Mandatory Control System for the Use and Reduction of the Discharge of Offshore Chemicals (as amended);

OSPAR Recommendation 2010/4 on a Harmonised Pre-Screening Scheme for Offshore Chemicals;

OSPAR Recommendation 2010/3 on a Harmonised Offshore Chemical Notification Format (HOCNF) (as amended);

OSPAR Recommendation 2006/3 on Environmental Goals for the Discharge by the Offshore Industry of Chemicals that Are, or Which Contain Substances Identified as Candidates for Substitution;

OSPAR Recommendation 2005/2 on Environmental Goals for the Discharge by the Offshore Industry of Chemicals that Are, or Contain Added Substances, Listed in the OSPAR 2004 List of Chemicals for Priority Action.

[5] PARCOM Recommendation of a 40 mg/l Emission Standard for Platforms, 1986 was revoked for produced water only by OSPAR Recommendation 2001/1 for the Management of Produced Water from Offshore Installations. However, this measure is still applicable in relation to ballast water, drainage water and displacement water from offshore installations.

Appendix 2: Data Annexes

Table 1: Number of installations on the DCS with discharges to the sea, or emissions to the air 2009—2013

2009	2010	2011	2012	2013
20	20	18	15	14

Table 2: Oily aqueous discharges to the maritime area

Table 2a: Oil discharged in displacement and produced water (in tonnes), 2009—2013

2009 (GC-FID)	2010 (GC-FID)	2011 (GC-FID)	2012 (GC-FID)	2013 (GC-FID)
Dispersed	Dispersed	Dispersed	Dispersed	Dispersed
340	214	165	116	178

Table 2b: Dissolved oil discharged in displacement and produced water (in tonnes), 2009—2013

2009	2010	2011	2012	2013
Dissolved	Dissolved	BTEX	BTEX	BTEX
195	216	178	136	89

Table 2c: Total volume of produced water and displacement water discharged, and produced water injected (in m^3/year), 2009—2013

	2009	2010	2011	2012	2013
Produced water discharged	25 825 176	25 035 734	24 493 493	23 613 367	23 730 068
Produced water re-injected	11 956 839	13 728 593	13 372 434	13 805 970	12 446 062
Displacement water discharged	1 782 612	1 913 130	1 632 449	1 535 173	1 017 358
Total	39 564 627	40 677 457	39 498 376	38 954 510	37 193 488

* Produced water

** Displacement water

*** Injected produced and displacement water

Table 3: Installations which do not meet OSPAR performance standard for dispersed oil in aqueous discharges

Table 3b: Number of installations with discharges failing to meet the 30 mg oil/l performance standard, valid from 2007 onwards, and quantity of oil discharged by these installations (in tonnes)

	2009	2010	2011	2012	2013
Number of installations exceeding 30 mg/l	2	1	0	1	0
Quantity of dispersed oil discharged	7	1	0	0,34	0

Table 4: Use and discharges of organic-phase drilling fluids (OPF) and cuttings

Table 4a: Quantities of oil and other organic-phase fluids discharged via cuttings (in tonnes), 2009 - 2013

2009	2010	2011	2012	2013
Total OPF	Total OPF	Total OPF	Total OPF	Total OPF
0	0	0	0	0

Table 4b: Number of wells drilled with OPF, with discharge of contaminated cuttings to the maritime area, 2009 - 2013

2009		2010		2011		2012		2013	
OBF	non-OBF OPF	OBF	non-OBF OPF	OBF	Other OPF	OBF	Other OPF	OBF	Other OPF
0	0	0	0	0	0	0	0	0	0

Table 5: Spillage of oil and chemicals

Table 5a: Number of oil spills, 2009—2013 - Spills less than 1 tonne and spills above 1 tonne

2009		2010		2011		2012		2013	
≤ 1 **t**	> 1 **t**	≤ 1 **t**	> 1 **t**	≤ 1 **t**	> 1 **t**	≤ 1 **t**	> 1 **t**	≤ 1 **t**	> 1 **t**
23	2	21	0	30	0	42	0	47	1

Table 5b: Total quantity of oil spilled, in m^3, 2009—2013

2009		2010		2011		2012		2013	
≤ 1 **t**	> 1 **t**	≤ 1 **t**	> 1 **t**	≤ 1 **t**	> 1 **t**	≤ 1 **t**	> 1 **t**	≤ 1 **t**	> 1 **t**
2	4	2	0	1	0	2	0	0	3

Table 5a: Number of chemical spills, 2009—2013 - Spills less or equal to 1 ton and spills above 1 ton

2009		2010		2011		2012		2013	
≤ 1 **t**	> 1 **t**	≤ 1 **t**	> 1 **t**	≤ 1 **t**	> 1 **t**	≤ 1 **t**	> 1 **t**	≤ 1 **t**	> 1 **t**
1	2	4	2	3	0	26	0	36	4

Table 5b: Total quantity of chemicals spilled, in m^3, 2009—2013

2009		2010		2011		2012		2013	
≤ 1 **t**	> 1 **t**	≤ 1 **t**	> 1 **t**	≤ 1 **t**	> 1 **t**	≤ 1 **t**	> 1 **t**	≤ 1 **t**	> 1 **t**
0	29	1	11	0	0	1	0	2	26

Table 6: Emissions to air, 2009—2013

CO_2 (in million of tonnes)

2009	2010	2011	2012	2013
2,16	1,92	1,76	1,83	1,78

NO_x (in thousand of tonnes)

2009	2010	2011	2012	2013
10,69	7,00	6,32	7,11	7,28

nmVOCs (in thousands of tonnes)

2009	2010	2011	2012	2013
4,57	2,60	1,22	1,89	1,77

CH_4 (in thousand of tonnes)

2009	2010	2011	2012	2013
3,00	5,00	3,19	4,11	4,01

SO_2 (in tonnes)

2009	2010	2011	2012	2013
94	100	86	87	116

Table 7: The use and discharge of offshore chemicals, 2009—2013

Table 7a: Quantity of offshore chemicals used in kg/year

	2009	2010	2011	2012	2013
PLONOR [B]	45 732 541	31 219 003	31 661 190	34 759 511	26 031 851
List of Chemicals for Priority Action	0	0	0	0	0
Inorganic LC_{50} or EC_{50} < 1 mg/l	8 550	0	0	0	0
Biodegradation < 20%	515 528	526 585	178 803	351 620	110 595
Substance meets two of three criteria	231 350	255 166	284 938	161 457	31 930
Inorganic, LC_{50} or EC_{50} > 1 mg/l	11 660 616	3 992 862	2 207 877	1 663 514	1 386 349
Ranking	15 792 136	12 798 467	13 381 005	19 425 435	12 589 045
Total	**73 940 721**	**48 792 083**	**47 713 813**	**56 361 537**	**40 149 770**

Table 7b: Quantity of offshore chemicals discharged in kg/year

	2009	2010	2011	2012	2013
PLONOR [B]	24 603 595	10 780 790	13 966 161	12 334 663	7 978 977
List of Chemicals for Priority Action	0	0	0	0	0
Inorganic LC_{50} or EC_{50} < 1 mg/l	0	0	0	0	0
Biodegradation < 20%	1 061	6 645	4 244	357	42
Substance meets two of three criteria	360	303	341	0	0
Inorganic, LC_{50} or EC_{50} > 1 mg/l	431 845	304 808	146 321	123 525	142 595
Ranking	4 987 546	1 396 299	4 505 310	4 758 740	5 154 321
Total	**30 024 407**	**12 488 845**	**18 622 377**	**17 217 285**	**13 275 935**

Table 7c: Chemicals spilled in kg per year

Prescreening category	2009	2010	2011	2012	2013
PLONOR [B]	40	40	0	79	25 008
List of Chemicals for Priority Action	0	0	0	0	0
Inorganic LC_{50} or EC_{50} < 1 mg/l	0	0	0	0	0
Biodegradation < 20%	0	0	0	0	1 422
Substance meets two of three criteria	0	0	0	0	0
Inorganic, LC_{50} or EC_{50} > 1 mg/l	0	0	0	0	0
Ranking	0	27 500	64	112	1 463
Total	**40**	**27 540**	**64**	**191**	**28 265**

Table 8: Denmark total production in oil equivalents (million tonnes)

2009	2010	2011	2012	2013
21,14	19,43	17,76	16,29	13,04

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