



BG NORGE

Document responsible: J. P. Aabel

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0 Summary

The drilling operations of Orange are planned to start in June 2007. Orange is located north of Cod, approx. 260 km from the Norwegian coast. This is an area with many exploration and production wells and many installations.

As basis for planning and management of the drilling operation, identifying and implementing risk reducing measures, including oil spill contingency systems, an environmental risk analysis has been carried out.

The analysis has included all relevant spill incidents and also planned operational discharges. The environmental risk is expressed as the combination of frequency of occurrence and environmental impact. The dimensioning oil blow-out rates have been defined to the maximum rate of 278 m³/day. The frequency and magnitude of acute spills of crude oil, diesel, hydraulic oil, oil based and water based drilling mud has been addressed based on statistics from the oil industry and also internal records from the rig owner. Planned operational discharges have been described based on the information presented in the Discharge Permit Application which has already been presented to the authorities.

The environmental impact has been analysed using totally 16 parameters to describe the outcome and extent of pollution and operational discharge. These parameters include what is considered the most important environmental aspects of the spill and discharge scenarios. A classification matrix with categories from 0 to 5 has been defined as basis for the impact classification.

The environmental risk is expressed as a risk index which is calculated on basis of both the frequency of occurrence and the environmental impact value. The results show that spills of diesel and oil based mud are considered to represent the highest risk elements for the drilling operation. Also operational discharges of drill cuttings give a high contribution to the environmental risk. Major oil spills represent a risk for potential large environmental impacts, but the risk associated with such events is considered very low, and well within the risk acceptance criteria of the company. In general the environmental risk level associated with the drilling operation is considered very low compared to other operations closer to the coast or environmentally sensitive areas. The oil has no potential for reaching the coastline.

Based on the results from the risk analysis, different types of risk reducing measures has been described that will be further considered and implemented during the detailed planning phase and during the HSE management of the operation.

1 BASIC INFORMATION

1.1 Introduction

The location of the well is presented in Table 1 and in Figure 1.

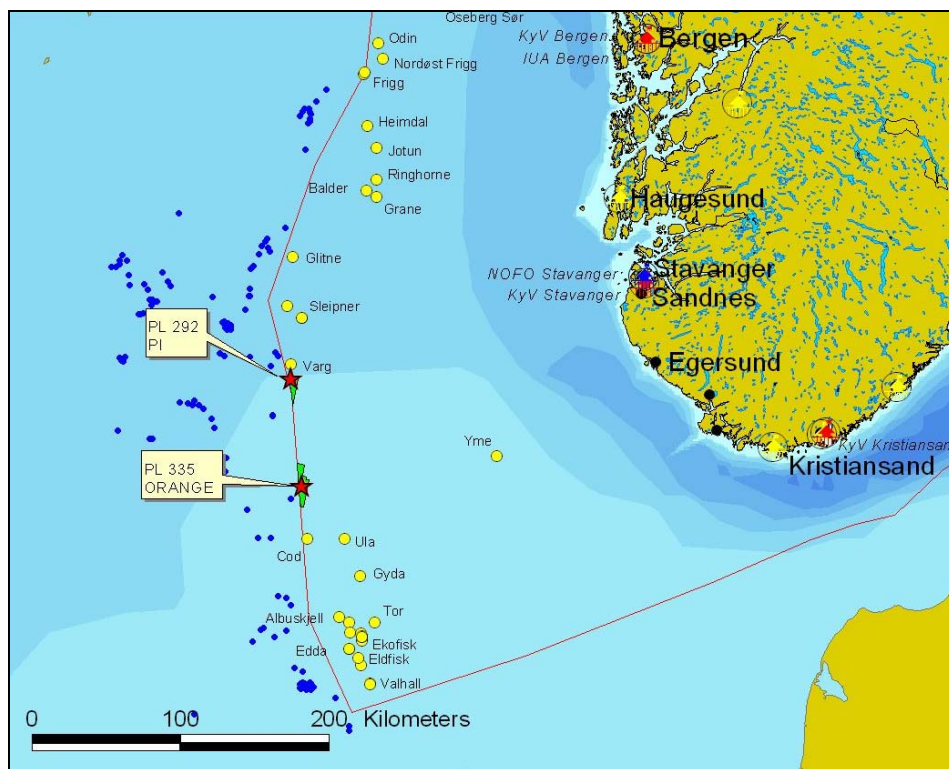


Figure 1. Location of Orange.

Key information is given in Table 1.

Table 1. Key information for the well.

	PL 335 - Orange
Position	2°15'55" N, 57°22'44" E
Drilling period	Spring - summer
Water depth	83 meter
Weighted (average) oil blow-out rate – surface release	150 m ³ /d
Maximum oil blow-out rate – surface release	278 m ³ /d

1.2 Abbreviations

DN	Direktoratet for naturforvaltning (www.dirnat.no) (Directorate for Nature Management).
KyV	Kystverket (www.kystverket.no) (Norwegian Coastal Directorate).
MI	Meteorologisk Institutt (www.met.no).
MRDB®	Marine Resource Data Base (www.dnv.com/environmentalcons).
NOFO	Norwegian Clean Seas Organisation (www.nofo.no).
OLF	Oljeindustriens landsforening (www.olf.no) (Norwegian Oil Industry Association).
Ptil	Petroleumstilsynet (www.ptil.no) (Petroleum Safety Authority).
SFT	Statens forurensningstilsyn (www.sft.no) (State Pollution Control Authority).
SMO	Spesielt Miljøfølsomme Områder (Particularly Sensitive Areas).

1.3 Rules and regulation

Norwegian regulations require the operators to operate in a safe and prudent manner (the Framework regulations (FR) §8), and to reduce the risk in their activities (FR-§9). The operator must define acceptance criteria for environmental risk (the Management regulations (MR) §6), and analyse the environmental risk to assess compliance with the acceptance criteria (MR-§16). Based on the results from the environmental risk assessments, a contingency analysis for relevant spill scenarios shall be carried out (MR-§16) as basis for establishing an (oil spill) contingency organisation (the Activity regulations (AR) §66) and contingency plan (AR-§67) for the activity. The operators are also required to co-operate in establishing contingency facilities (FR-§29-30, AR-§65) and to consider regional contingency systems (AR-§69).

1.4 Policy and requirements

BG Norge has established environmental objectives and requirements for the drilling operations as described in the document HSSE Programme – Orange Well Project (BG 2007). These describe acceptance criteria for environmental risk and requirements for assessment of chemical usage and discharges with focus on reduction, reuse, recycling and substitution, combined with effective waste management.

1.5 Acceptance criteria for environmental risk

The BG Norge acceptance criteria for operation specific environmental risk is based on the OLF recommendations as described in NORSOK Z-013, rev 1 (March 1998), and are comparable to the criteria used by most operators in the Norwegian oil and gas industry (Table 2).

Table 2. Environmental risk acceptance criteria for drilling operation.

Environmental damage	Operation specific acceptance criteria (per operation)
Minor (< 1 year recovery time)	$< 1,0 \times 10^{-3}$
Moderate (1-3 years recovery time)	$< 2,5 \times 10^{-4}$
Considerable (3-10 years recovery time)	$< 1,0 \times 10^{-4}$
Serious (>10 years recovery time)	$< 2,5 \times 10^{-5}$

1.6 Activity and well description

The drilling operation is planned using the jackup rig Mærsk Guardian (Figure 2). The rig will position itself by jacking down the three legs into the seabed substratum. The lengths of the legs are 157 m, and enabling the rig to drill at a maximum depth of 107 m. Planned start up at Orange is June 2007, and the operations will take approx. one month, depending on the success during the drilling operation.



Figure 2. Mærsk Guardian.

The location of the field is shown in Figure 3. The well is planned vertically to a depth of approx. 3000 m TVDSS. Water based drilling mud will be used in the sections, except from the 8 ½ “ section where oil based drilling mud will be used for technical reasons. One drill stem test and one sidetrack could be conducted for Orange. The well configurations are shown in Figure 4.

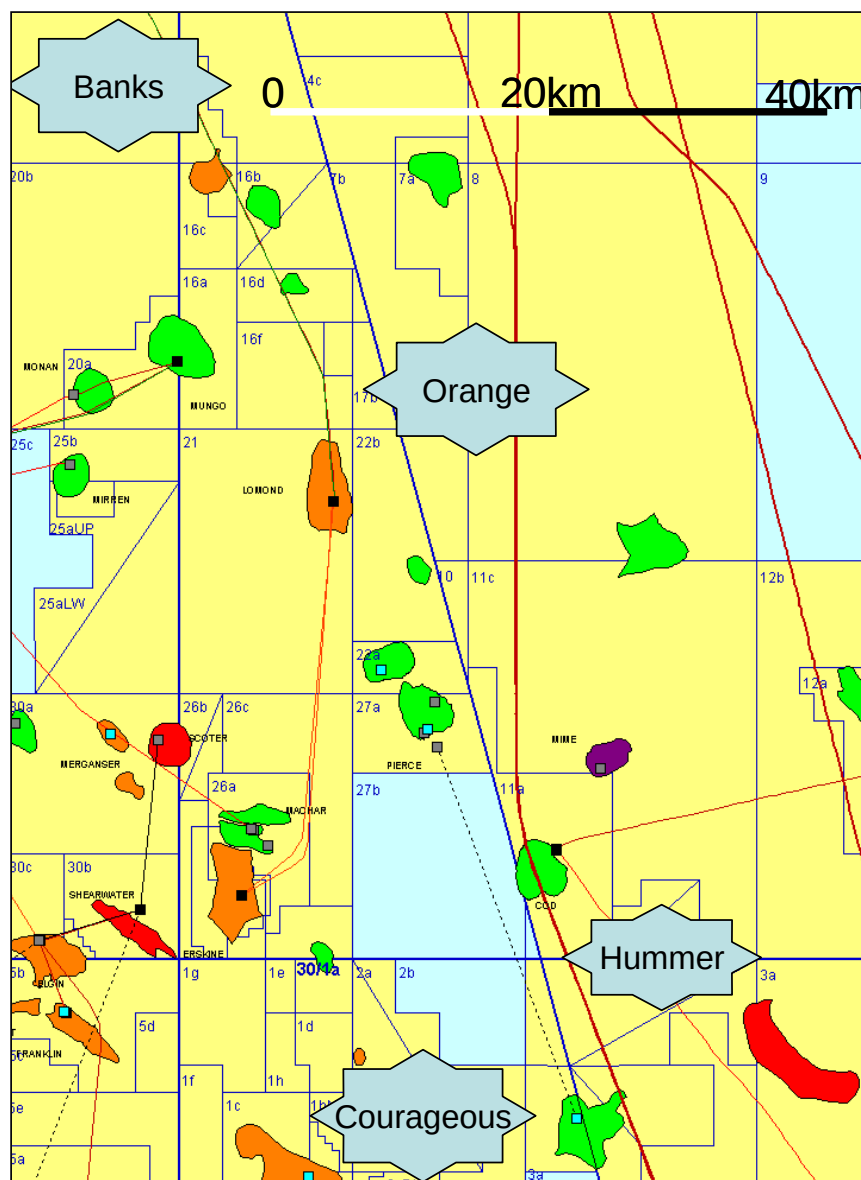


Figure 3. Location of the reservoirs at Orange



BG Group		Location: Well Name: Slot Number: Target Name: Rig: Water Depth: RTE (above MSL)		Norway Orange Block 7/7 Forties Sand Marsk Guardian 83 m 25 m		Slot & Target Coordinates		Target sizing	Directional Plan	Well Objectives		
						Geo / UTM	Local (well)					
						Slot :	N E	6 359 825 455 825	m/s m/s	To prove hydrocarbon reserves		
						Target :	N E	6 359 825 455 825				
						Target Depth (m TVD SS) :		2 840				
Hole Size (inches)	Depth, m (MD RKB) (TVD RKB)	Casing Details Size, Weight, Grade, Connection, Length	Cement		Mud		Directional & Surveying	Logging & Evaluation	Lithology	Well Schematic		
			Details	Lead	Tail				Name	m TVD RKB Formation Type & Top (in MD RKB)		
36"	187 (187)	30" X52 1.5" WT H8G 3 x 30" X52 1.5" WT INT-JTS 1 x 30" X52 1.5" WT Shoe JT Sea bed to Section TD (80 m)	Cement Type: Mudwater Type: Weight (SG): Dispers (N): RH Static Temp: Planned TOC: Comments:		TBA Seawater TBA 300 % 50 degF Sealed	Mud Type: Weight (SG): Displacement at TD: Comments: Displace to 1.30 SG mud before running conductor string.	Sea Water & H-2O 0.1 RW 1.30 SG Seawater WDM	MWD inclination only	None			
26"	888 (888)	20" 0.625 WT, X56, RL48 Sea bed to Section TD (580 m)	Cement Type: Mudwater Type: Weight (SG): Dispers (N): RH Static Temp: Planned TOC: Comments:	Class G Seawater TBA 100 % TBA Sealed	Class G Seawater TBA 100 % TBA Sealed	Mud Type: Weight (SG): Displacement at TD: Comments: Displace to 1.30 SG mud before running 13 3/8" casing string.	Sea Water & H-2O TBA 1.30 SG Seawater WDM	MWD/MR	None			
17 1/2"	1480 (1480)	13 3/8" 72ppf, L80 Dlno Vam Sea bed to Section TD - (1382 m)	Cement Type: Mudwater Type: Weight (SG): Dispers (N): RH Static Temp: Planned TOC: Comments:		TBA Fresh Water TBA TBA 200 m above shoe	Mud Type: Weight (SG): PV (cP): YP (lb/100sqft): APG (g/g): SBR (N): VTRP (ml @ 250°F): ES (Vol%): Pam 6 @ 120°F: Gels 10x / 10m	KCL/Glycol WDM TBA	MWD/GRI/RES/PWD	TBA			
8 1/2"	3040 (3040)	9 5/8" 53.5ppf, L80 VAM Top (Sea bed to hole problem depth)	Cement Type: Mudwater Type: Weight (SG): Dispers (N): RH Static Temp: Planned TOC: Comments:		TBA Fresh Water TBA TBA 200 m above shoe	Mud Type: Weight (SG): PV (cP): YP (lb/100sqft): APG (g/g): SBR (N): VTRP (ml @ 250°F): ES (Vol%): Pam 6 @ 120°F: Gels 10x / 10m	LTOEM TBA	MWD/GRI/RES/PWD	TBA			
Prepared By: Drilling Engineer			Reviewed By: Senior Drilling Engineer			Reviewed By: Drilling Superintendent			Approved By: Sub-surface Team Leader			Approved By: Well Engineering Manager

Figure 4. Orange well design.

1.7 Defined situations of hazard and accident (DSHA)

Exploration drilling in offshore areas implies a risk for acute spills to sea. Major incidents are blow-outs during drilling into the reservoir zone. Minor incidents include small spills of crude oil (well releases), diesel (from the rig or from supply vessels), oil based or water based drilling mud (from the rig or during transfer from supply vessel) or hydraulic oil (from the rig).

With respect to environmental risk and acceptance criteria, and oil spill contingency, the dimensioning incidents are blow-outs. Minor incidents and also planned operational discharges are included in the risk assessment in order to provide a complete risk picture for the drilling operation, and to form a basis for identifying technical and/or operational measures and best practices to reduce the overall environmental risk.

There is some uncertainty regarding the fluid type that may be discovered at Orange, but this assessment has used oil as the "worst case" from an environmental perspective. The development strategies and recovery factors differ substantially depending if oil or gas is discovered. The most likely fluid is gas, but both gas and an oil composition were included in the study carried out by Well Flow Dynamics (WFD 2006). Blow-out rates have been calculated and simulations have been performed for a dynamic kill operation by using a relief well with direct intersection into the blow-out well. Weighted blow-out rate is 950 stb/d (150 Sm³/d) of oil in the oil case and 1900 stb/d condensate (300 Sm³/d) for the gas case.

Blow-outs of condensate will evaporate or will be mixed into the sea at a much higher rate than blow-outs of oil. In this report it has been focused on discharge of oil, generally representing a much higher environmental risk than blow-outs of condensate.

1.7.1 Blow-out and well releases

Potential blow-out scenarios for the drilling operation include both topside and subsea blow-out, from either open hole or from a hole with restrictions (eg. drill string in the hole), and with different flow pathways such as directly through drillhole, outside casing or from annulus.

Generic blow-out frequencies for exploration drilling (normal wells) in Norwegian areas has been calculated by Scandpower to $2,3 \times 10^{-4}$ per drilling operation for blow-outs and $2,4 \times 10^{-4}$ per drilling operation for well releases (Scandpower 2003).

Blow-out releases pathways have been assessed based on statistics from the North Sea and Gulf of Mexico. It is approx. 78% probability that a blow-out will through annulus, approx. 11% probability that it will occur through drillpipe, and approx. 11% probability that it will occur through open hole. The historical probability for subsea and topside blow-outs are 71% and 29% respectively (Scandpower 2003). But since the drilling operation is undertaken from a jackup, a potential blow-out from the well at Orange will occur topside at the rig. Well releases will also occur from the drilling rig.

In relation degree of penetration of the reservoir, a probability distribution of 55% and 45% has been applied, for drilling to only the top of the reservoir or the entire reservoir, respectively.

The probability of full blow-out rates versus restricted rates has been calculated as 30% and 70%, respectively. In this respect, a restricted rate refers to 5% opening of the BOP in relation to full opening rate.

The potential duration of blow-outs are subjected to significant uncertainty. Based on available statistics, Scandpower has estimated blow-out durations for topside blow-outs (Figure 5). The maximum duration of a topside blow-out is assessed to approx. 40 days (98% percentile). Blow-outs with such long duration will most probably have to be stopped by drilling a relief well. The 90% probability percentile show a duration of approx. 12 days. Weighted blow-out duration is calculated to 15 days (90% - 12 days and 10% - 40 days).

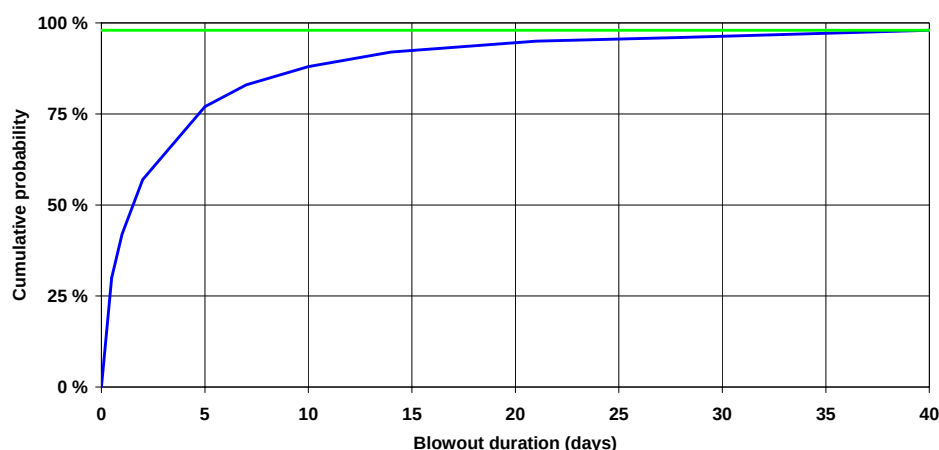


Figure 5. Duration probability distribution for topside blow-outs (from Scandpower 2003).

The maximum duration of well releases is 15 minutes (Scandpower 2003).

The blow-out rates for the Orange well have been estimated based on model simulations carried out by Well Flow Dynamics (WFD 2006), which is based on available information about reservoir characteristics and drilling program / well design (see section 1.6).

Three blow-out scenarios have been defined:

- Scenario 1: Blow-out through drillpipe – topside release
- Scenario 2: Blow-out through annulus – topside release
- Scenario 3: Blow-out through open hole – topside release.

Important input parameters that have been applied are listed in Table 3.

Table 3. Input data for blow-out rate simulations, oil case.

Parameter	Value N/7-7-A Orange	Unit
Oil density	834	kg/m ³
Gas density	1,0	kg/Sm ³
GOR	196	Sm ³ /Sm ³
Top reservoir	2960	m tvd ss
Reservoir temperature	116	°C
Reservoir pressure	317,2	bar
Permeability	25	mD
Net Pay	29	m
Skin S	2	-

1.7.2 Orange N/7-7-A, blow-out scenarios

Figure 6 shows the different scenarios that have been used for the calculation of blow-out rates.

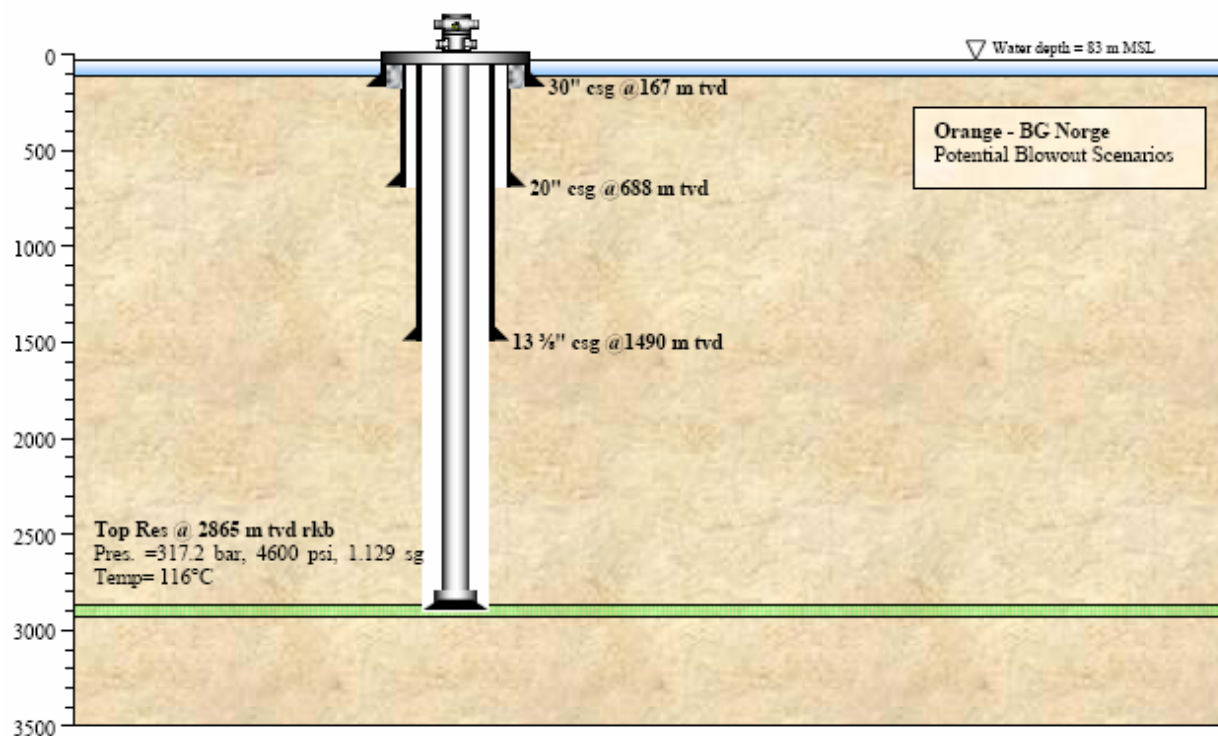


Figure 6. Schematic illustration of blow-out scenarios Orange.

The resulting simulated blow-out rates are summarised in Table 4.

Table 4. Summary of blow-out rates.

Scenario (flow pathway)	Penetration of reservoir (top / entire)	Opening of BOP (restrictions)	Oil blow-out rate (Sm ³ /d)	Probability (%)
1 – through drillpipe	Top reservoir	Open BOP	56	1,8
		Restricted BOP	59	4,2
	Entire reservoir	Open BOP	278	1,5
		Restricted BOP	266	3,5
2 – through annulus	Top reservoir	Open BOP	56	12,9
		Restricted BOP	43	30,0
	Entire reservoir	Open BOP	278	10,5
		Restricted BOP	262	24,6
3 – through open hole	Top reservoir	Open BOP	56	1,8
		Restricted BOP	40	4,2
	Entire reservoir	Open BOP	278	1,5
		Restricted BOP	262	3,5

The overall weighted blow-out rate is calculated to 150 m³/day. The maximum blow-out rate of 278 m³/day is used further for assessment of potential environmental impacts.

1.7.3 Minor spills of oil and chemicals

In 2005 there were totally 147 spills of different types of oils with a total discharge of 377 m³, compared to 77 m³ in 2004 and 877 m³ in 2003 (OLF 2006). Six of the discharges exceeded 1 m³. One of the discharges constituted 340 m³ of the total spill volume (approx. 90%).

In exploration drilling there were totally 6 spills of different types of oils with a total discharge of 1,20 m³, compared to 0.01 m³ in 2004 and 0.20 m³ in 2003 (OLF 2006).

The acute discharge of chemicals and drilling mud were totally 418 m³ in 2005, compared to 696 m³ in 2004 and 961 m³ in 2003 (OLF 2006). There were 44 incidents with spill size less than 0,05 m³, and 49 incidents with spill size between 0,05 and 1 m³. The number of spills above 1 m³ was 37. Totally there were reported 130 spills. These data do not segregate between production and exploration operations.

In exploration drilling there were totally 12 spills of chemicals and drilling mud with a total discharge of 43,2 m³, compared to 61,2 m³ in 2004 and 65,7 m³ in 2003 (OLF 2006). In 2005 there were 14 exploration wells drilled (NPD 2006), which implies a frequency of 0,86 spills per drilling operation. The statistics do not separate between chemical spills and drilling mud/oil spills, and it is therefore assumed 50% for each. The spill frequency for hydraulic oil is considered to be lower because these products are used in closed systems, and a frequency of 0,43 is used (50%).

The average spill size is estimated to 1 m³ based on the distribution of spill sizes for diesel and hydraulic oil¹.

For WBM and OBM drilling mud the spill size is estimated to 50 m³ and 1 m³, respectively.

¹ Several hoses of hydraulic oil under high pressure are exposed to wind and spray of sea water, several locations underneath the lower rig deck with direct route to sea. Corrosion may develop rapidly on hoses that have been subjected to wear and tear and where protection material has been removed. Such an incident occurred in 2005 on the rig "Eirik Raude" (Ocean Rig) in the Barents Sea. A correspondingly scenario is probable on most drilling rigs. On "Eirik Raude" the spill was first reported to be 1,5 m³, but later investigations showed that the spill was approx. 0,9 m³.

Relevant acute spill scenarios for the drilling operation with respect to diesel, hydraulic oil, OBM and WBM, are based on these statistics, see section 1.7.5.

1.7.4 Operational discharges

Planned discharge of drilling mud

Water based drilling mud will be discharged to sea during the drilling operation, mainly during drilling of the top-hole sections in the start of the operation. The planned discharge to sea is totally approx. 3.000 tonnes depending on the final choice of using WBM or OBM for the lowest sections. The density of WBM is in the range 1,4-1,6 s.g. All of the chemicals planned discharged are PLONOR chemicals.

Planned discharge of drilling cuttings

In total 1500 tonnes of cuttings will be discharged to sea from the two top-hole sections (36", 24" and 17,5" holes) with WBM hanging on.

Planned discharge of cementing chemicals

The planned discharge of cement is 110 tonnes whereof Dyckerhof G Cement and Tuned light XL constitutes approximately 50 % each of the cement fractions used. PLONOR cementing chemicals that are planned discharged are Dyckerhof cement (37 tonnes), calcium chloride (2,7 tonnes), Econolite which is a silicate (1,8 tonnes), EZ-FLO which contains silica (around 40 kg), and HR-4L which is a modified lignosulphonate (0,5 tonnes). Seven yellow chemicals are planned discharged, Tuned Light dominating with 12 tonnes yellow fraction discharge and in addition 1 - 2 kg yellow fraction of Halad-350L, CFR-8L and SCR-100L. The discharge also includes NF-6 which contains vegetable oil (about 100 kg yellow fraction), Musol with 1,44 tonnes and SEM 8 (500 kg yellow fraction).

No red chemicals are planned discharged from the cementing operations.

Planned discharge of rig chemicals

Rig chemicals that are planned discharged to sea are jacking grease (Statoil Multidope) with approximately 800 kg for each jacking. The chemical has 68,1 % red fraction and 100 % discharge to sea is used as a discharge factor, and in addition approx. 7 750 kg rig cleaning chemical Cleanrig HP which is a chemical with 12,4 % yellow fraction. Hydraulic fluid is not planned discharged.

Planned discharge of testing chemical

A Drill Stem Tests (DST) is planned which could involve (if conducted) the discharge of 14 tonnes yellow fraction.

1.7.5 Summary of acute spill scenarios and operational discharges

A summary of the potential spill scenarios and operational discharges during the drilling operations is shown in Table 5.

Table 5. Summary of scenario statistics – acute spills to sea and operational discharges.

Scenario no.	Description	Frequency (per year)	Discharge quantity (m ³)	Risk Index #1 ²	Fraction
S 1	Topside oil blow-out through drillpipe	2,5 x 10 ⁻⁵	4 114	0,1	0,004%
S 2	Topside oil blow-out through annulus	1,8 x 10 ⁻⁴	4 114	0,7	0,03 %
S 3	Topside oil blow-out through open hole	2,5 x 10 ⁻⁵	4 114	1,1	0,004 %
S 4	Topside oil well release	2,4 x 10 ⁻⁴	3	0,001	0,00003 %
S 5	Diesel spill from rig	0,86	1	0,9	0,03 %
S 6	OBM spill from rig	0,86	1	0,9	0,03 %
S 7	WBM spill from rig	0,86	50	36,6	1,4 %
S 8	Hydraulic oil spill from rig	0,43	1	0,4	0,02 %
S 9	Operational discharge of drilling mud	1	2 267	2 267	88,3 %
S 10	Operational discharge of drill cuttings	1	200	200	7,8 %
S 11	Operational discharge of cement	1	59	59	2,3 %
S 12	Operational discharge of jacking grease	1	0,5	0,5	0,02 %
S 13	Operational discharge of rig cleaning agent	1	3,6	3,6	0,04 %
S 14	Operation discharge of testing chemicals	1	0,06	0,06	0,002 %

The risk index based on frequency and discharge quantity (water free) summarises as follows:

- Blow-outs and well releases (#1-4): 0,04 %
- Acute minor spills (#5-8): 1,5 %
- Operational discharges (#9-14): 98,5 %

1.8 Fluid characteristics and weathering properties

1.8.1 Crude oil

The overall weighted blow-out rate is calculated to 150 m³/day, and the maximum 278 m³/day. The density of the Orange oil has been set to approximately 834 kg/m³ (slight expected variations between the wells). This is similar to a typical Ekofisk light crude with density 820 - 850 kg/m³. If released to sea it is expected to form stable oil emulsions with maximum water content of 70-80% dependent on the temperature and weather conditions.

The evaporation rate after 24 hours on the sea surface will be in the range 30-40% (summer temperatures) to 30-35% (winter temperatures). The pour point temperature is expected to be in the range -5 to -10°C and it is not considered that the oil may cause problems for traditional oil skimmers. The wax content may be in the range 5-7 weight%.

1.8.2 Diesel

Diesel has a density of approx. 0,84 tons/m³, containing hydrocarbon fractions with boiling point in the range 165-360°C. Upon discharge to sea it will float on the surface and practically not disperse into water at all. However, the evaporation rate will be high, and the diesel will be almost completely evaporated within a few days. No diesel spill will reach the Norwegian coast.

² Corrected for water content when calculating the risk index (frequency x discharge quantity (m³)).

A spill of 1 m³ will cover an area of maximum 2-15 km² under the assumption of a slick that forms 70% “sheen” (0,05-0,3 µm), 20% “rainbow” (0,3-5,0 µm) and 10% “metallic” (5,0-50 µm) (ref. BONN BAOAC colour code), not taking into consideration evaporation or downmixing. The maximum extent of a slick will be 0,2-1,6 km² using the Bonn colour codes.

1.8.3 Hydraulic oil

The hydraulic oils being used on Mærsk Guardian are Erifon Pilot Line Fluid (red chemical) and Pelagic 50 (yellow chemical). These hydraulic oils consist of highly refined mineral oils and additives. The density is 0,87-0,88 tons/m³. The water solubility is negligible and when spilt it will float on the sea surface. A spill of 1 m³ will form a slick comparable to a diesel spill. No hydraulic oil is planned discharged.

Some components in hydraulic oils are not readily biodegradable, and may accumulate in marine organisms, but it is not toxic to marine organisms (LC₅₀ >100 mg/l).

1.8.4 Oil based mud

Oil-based mud is a mixture of barite, mineral oil, and chemical additives. Oil-based mud is used for deeper well sections, and in cases where the well is drilled at an angle (directional drilling), where there is an increased likelihood for a drill pipe to stick. Oil-based mud has more negative environmental effects compared to water based mud.

Oil based mud will have a density of approx. 1,3 tons/m³. The base oil component is a mineral oil such as Clairsol NS from Halliburton, with density 0,83 tons/m³, containing hydrocarbon fractions with boiling point in the range 260-290°C, and consists of light petroleum hydrogen treated distillates. It is a colourless to yellow fluid which is insoluble in water. The biodegradability of the product is good and it is not toxic to marine organisms, but it may bioaccumulate. The product has yellow environmental classification.

In addition to base oil it will contain barite and smaller amounts of other chemicals, hereof some chemicals additives with red environmental classification (Carbogel 1 and Magma Gel SE).

A portion of the OBM will initially sink until sufficiently diluted, while the petroleum components will form a very thin slick on the surface.

1.8.5 Water based mud

All WBM components are PLONOR (Pose Little or No Risk to the environment). The main constituents are barite (2000 tonnes discharge), bentonite (134 tonnes discharge) and KCl-brine (425 tonnes discharge). The discharge will occur to sea from the drilling rig. The mud is heavier than sea water so initially the mud will sink until sufficiently diluted. It will not form any slick on the surface. The discharged WBM consists of many chemicals but each component is PLONOR and also the mixture of chemicals is considered to pose little or no risk to marine organisms.

1.8.6 Cementing chemicals

Discharged cementing chemicals consist mainly of PLONOR chemicals, and with only a small fraction of yellow chemicals. The yellow constituents have been listed in chapter 1.7.4 and consist mainly of Tuned Light XL (which contains 10 – 30 % Fly ash and a total planned

discharge of 62 tonnes of which 12 tonnes is the yellow fraction). Tuned Light is not toxic ($LC_{50} > 1000$ mg/l).

No red chemicals from the cementing operations are planned discharged.

1.8.7 Rig chemicals

Jacking grease

Statoil Multidope contains approx. 68% grease components with red environmental classification (thickener system/synthetic ester), in addition to approx. 25% PLONOR component (Mica and calcium carbonate) and 6% yellow component (titanium dioxide). Most of the constituents are not toxic ($LC_{50} > 700$ -1000 mg/l), while the grease part are moderately toxic (EC_{50} 72h for algae is 26 mg/l). The bioaccumulation potential has been analysed, but the OSPAR test methods are not applicable for the heavy grease components of the products, and based on an assessment of the chemical the accumulation potential has been set to 0 (ref. CHEMS/KPD centre). The biodegradability (BOD_{28days}) is 3% for the grease part, which forms the basis for the red classification. The product does not contain heavy metals and do not have tainting properties.

The jacking grease is applied on the legs during positioning of the rig (jacking up/down). The grease is discharged to sea during an extended period of time in small portions.

Rig washing chemical

Cleanrig HP is a water based cleaning agent, with density approx. 1,1 tons/m³. It is clear yellow water soluble fluid, with pH 12,5-13,5. The fraction of PLONOR chemicals are >85%, while the remaining has yellow environmental classification. The yellow compounds are toxic to marine organisms ($LC_{50} < 10$ mg/l). However, they are readily biodegradable (BOD_{28} 64-78%) and will not bioaccumulate in marine organisms. The consumption of rig wash chemicals will be approx. 1 m³/week during the drilling operation. The discharged chemical will rapidly dissolve in sea water and be diluted to non-toxic levels, causing minimal environmental effects.

Testing chemicals

Only yellow chemicals are planned used and discharged during the test. A total of 14 tonnes yellow fraction is planned discharged.

1.9 Area of influence

The fluid characteristics and weathering properties for the Orange oil are presented in chapter 1.8. Oil drift simulations have been carried out for comparable oil types and spill scenarios for installations in the Ekofisk region (Jødestøl, K.A., 2004). An area of influence was defined based on blow-out rates of 2.200 m³/day (Figure 7). It was concluded for the Ekofisk region, that the area of influence did include neither the Norwegian nor the Danish coast. The area of influence was defined as the area with more than 5% probability for entering of more than 1 tonne of oil within a 10x10km area. The area of influence covered an offshore area of approx. 120 000 km² (approx. 340 km x 350 km). Fastest drift times for oil slicks in open waters was calculated to approx. 35 km/day. The drift time until most of the oil would be weathered and disappear at the borders of the area of influence would be in the range 6-10 days.

For Orange it has been evaluated that an area of influence would be maximum 180 km from the drilling location, as marked in Figure 7, not reaching the Norwegian coast within a probability of 5%. This area covers an area of approx. 100.000 km².

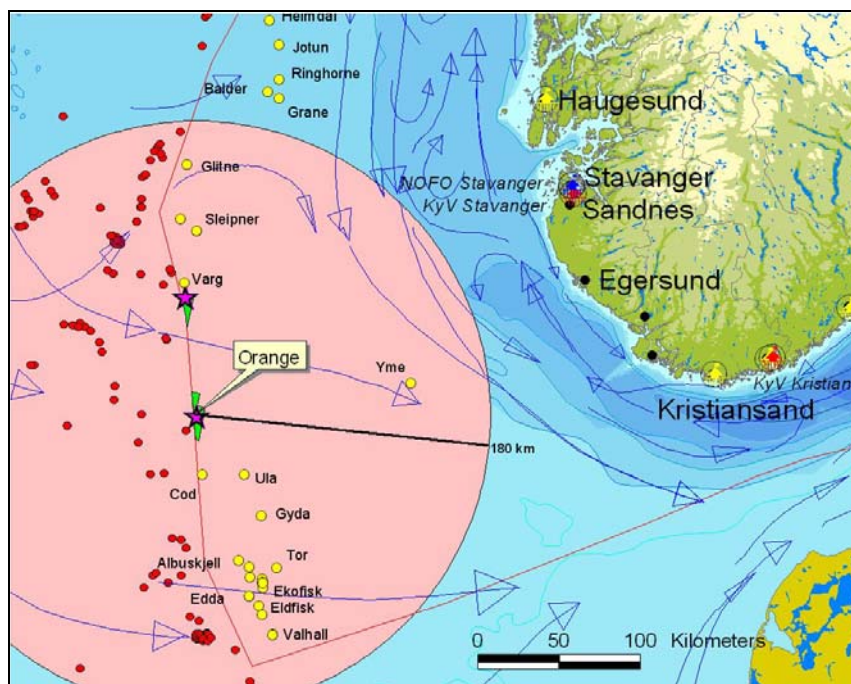


Figure 7. Area of influence (pink area) for a potential blow-out from the Orange position. Blue arrows are ocean currents.

The maximum blow-out rate at Orange is calculated to 278 m³/day. This is a very low blow-out rate compared to estimates for other installations and drilling activities, and only a fraction of the blow-out rates in the simulations referred to above. As a result of evaporation and mixing into the sea, the area of influence for an oil spill from Orange will cover a more limited area than the oil spills in the mentioned simulations for the Ekofisk area. It may thus be concluded that the area of influence for an oil spill from Orange will include neither the Norwegian nor the Danish coast.

2 ENVIRONMENTAL DESCRIPTION

2.1 Water masses

The exploration well is located west of the Norwegian trench, close to the UK border and northeast of the Cod (N) field and at approximately 83 m depth. The area is dominated by Atlantic water masses. The direction of the currents in the drilling location is mainly from west. During winter the water masses are mixed from surface to bottom.

The temperature of the water masses (at 10 m depth) is typically 8-9°C in May (Figure 8). During summer there will be a pronounced stratification of the water masses, with a 20-40 m surface layer of water with high temperature (14-18°C) and a colder bottom layer with somewhat colder water (approx. 10°C).

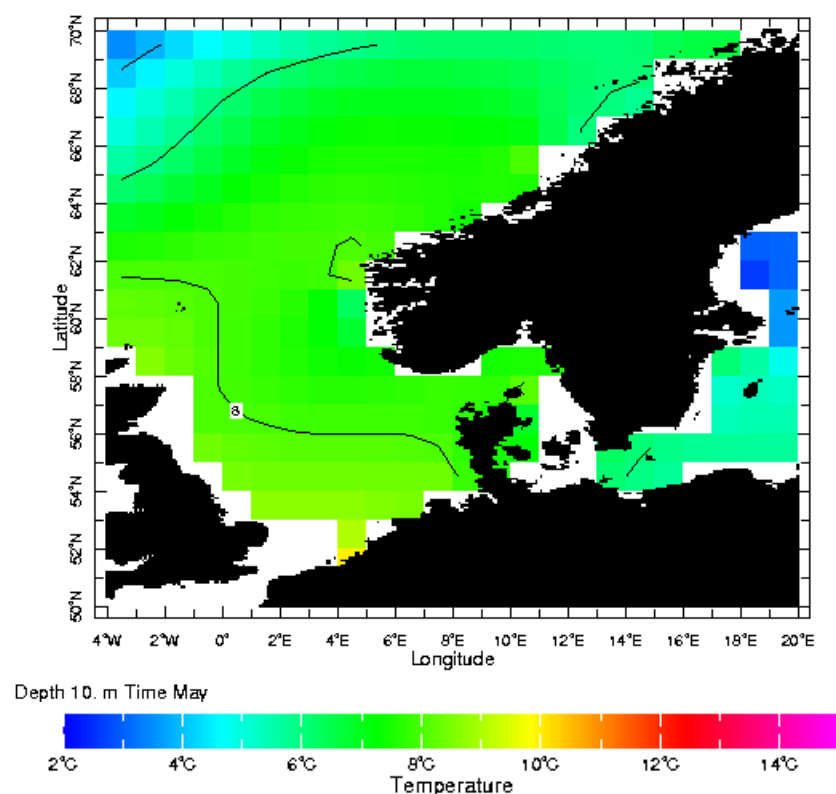


Figure 8. Water temperatures (at 10 m depth) in the North Sea area in May. Data from Levitus94 web database (<http://iridl.ldeo.columbia.edu/SOURCES/LEVITUS94/MONTHLY/.temp/>).

2.2 Weather statistics

Weather data from Sleipner for May-July (1995-2005) has been used to indicate wind and wave statistics for the area for the period May-June-July.

Distribution statistics of wind velocity is given in Figure 9.

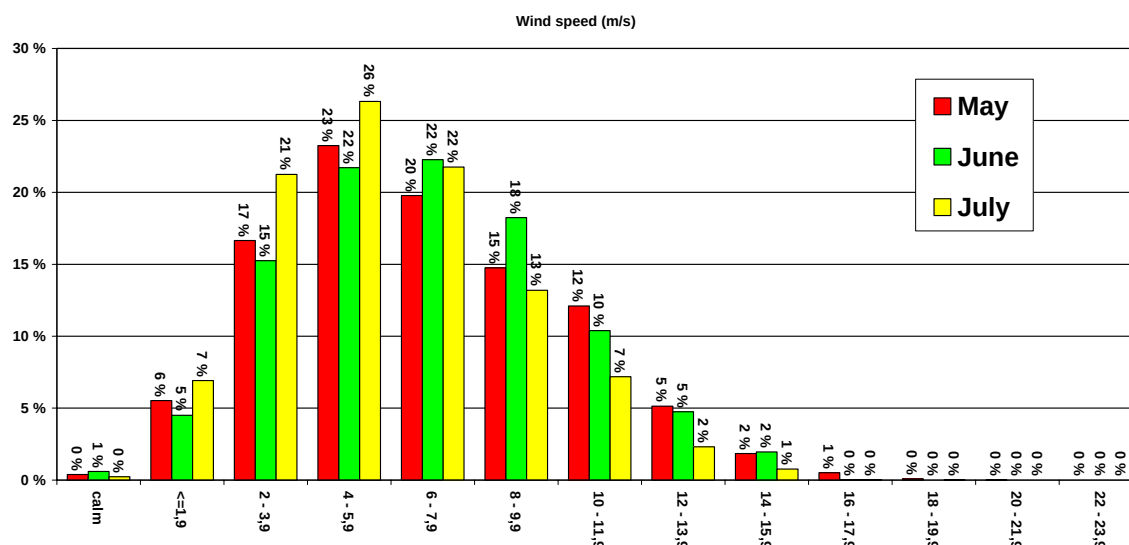


Figure 9. Wind speed statistics from Sleipner (1995-2005).

The average wind speeds in the three months and period in whole is:

- May 6,8 m/s
- June 6,8 m/s
- July 5,9 m/s
- Total 6,5 m/s

Wind direction statistics if given in Figure 10.

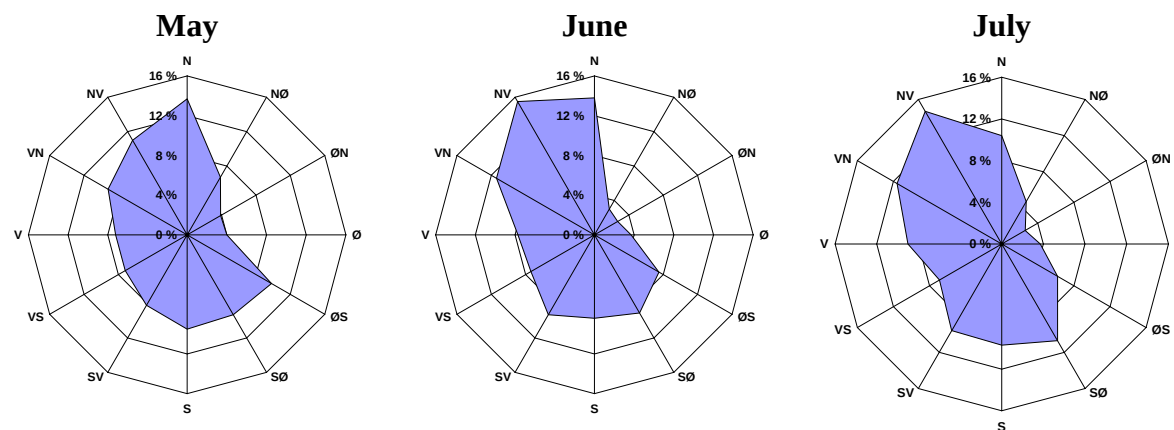


Figure 10. Wind direction statistics from Sleipner (1995-2005).

Main wind directions are from Northwest and Southeast in May-July, and most predominantly from Northwest. The statistics implies that the probability for drift of an oil slick towards the Norwegian coastal areas in this period is very low.

The distribution statistics of significant wave height is given in Figure 11.

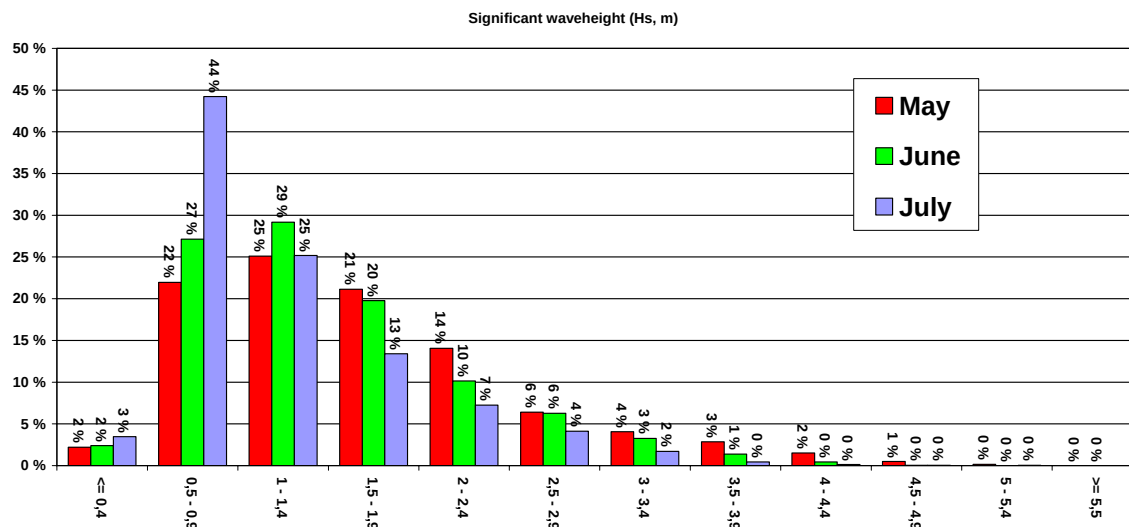


Figure 11. Wave height (Hs) statistics from Sleipner (1995-2005).

The average significant wave heights in the three months are:

- May 1,6 m
- June 1,4 m
- July 1,2 m
- Total 1,4 m

With respect to efficient operation of mechanical oil equipment, which requires a wave height less than approx. 4 m, the significant wave height is less than this for more than 99% of the time in the months May-July.

2.3 Sediments

The sea bottom is dominated by loose sand with patches of coarser material, probably shell or gravel banks. The area is not a deposition area and the sea depth is between 80 - 90 m.

The benthic fauna in the open sea areas consist mainly of animals and bacteria that are dependent on food supply from the upper waters. The benthic fauna consist normally of species rich communities dominated by polychaetes. However, there are large occurrences of mussels, crustaceans and echinoderms (e.g. brittle stars). These animals are characterised by relatively high reproduction rate and multi-annual life cycle. The biomass decreases normally with the depth and consist of an average of 20 g/m² for deep water societies. The fauna form an important food source to benthic fish species like haddock and plaice.

2.4 Cold water corals

There are no registrations of cold water corals (*Lophelia* communities) in the area of the drilling location, the closest one being close to Bømlo in the county of Hordaland.

2.5 Seabirds

The vulnerability of seabirds has been thoroughly assessed (Anker-Nilssen 1994, Fauchald et al 2006, AMBIO 2006). The seabirds at highest risk include pelagic diving seabirds such as Guillemot, Puffin, Razorbill, Little Auk, and coastal diving seabirds such as Eider, Cormorant, Shag, Long-tailed Duck, Common Scooter, Velvet Scooter, Black Guillemot, Red-throated Diver, Black-throated Diver, Grebes. "

Because there is less than 5 % probability that an accidental oil spill will reach the coast, a stranding scenario has not been included.

The species that have the strongest connection to the open sea include members of several families, most notably auks, gulls, petrels and gannets. Some of these birds come only ashore to breed and even in the breeding season many of them spend the majority of their time feeding at sea, often tens of kilometres away from their colonies. Inshore birds include seaduck, divers, cormorants and terns, as well as some gull species and one auk (black guillemot). These birds normally occur within sight of land although they may move further offshore, especially in areas of shallow waters. Although some breed in substantial numbers, the North Sea is of greatest importance to most inshore species in autumn and winter. (Carter *et al.* 1993).

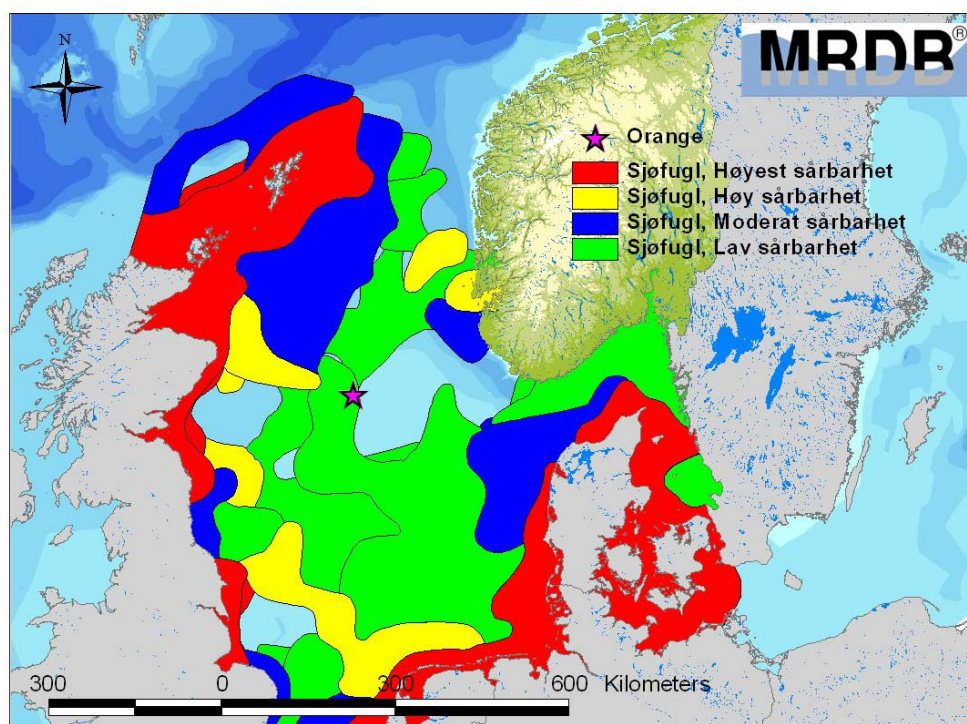


Figure 12. Vulnerable sea bird areas in the North Sea in the breeding period. Red areas = highest vulnerability, yellow areas = high vulnerability, blue areas = moderate vulnerability, green area = low vulnerability (MRDB@2006).

Birds that feed on inter-tidal areas such as sand and mud flats are the most coastal bird species. The North Sea is particularly suited to these species because of its large tidal amplitude and relatively mild climate, which prevent mud flats freezing for most of the winter. The North Sea is mainly a staging post for some species of birds on passage between breeding grounds to the north and wintering areas further south. Other species spend the winter along North Sea coasts.

Areas with vulnerable seabird occurrences in April-June in the North Sea are presented in Figure 12. This figure demonstrates that the drilling location to a very little extent will affect areas with high vulnerability for sea birds to oil spills at open sea.

2.6 Sea mammals

There are several species of whale and seals in the area of influence of the drilling location. Common whale species are Porpoise, Killer whale, Sperm whale and Minke whale but these are not considered vulnerable to oil spills or chemical spills or operational discharges from the drilling operation.

Common seal species are the Harbour seal (“steinkobbe”) and the Grey seal (“havert/gråsel”). Grey seals occur mainly in the outer parts of the coast of Norway and UK, and give birth on very exposed skerries in the period September-December. In this period the new born are vulnerable to oil pollution. Because there is less than 5 % probability that an accidental oil spill will reach the coast, grey seals are not considered at risk from potential spills from the drilling location.

Harbour seals occur more frequently in the inner parts of the coastal zone, including fjords. The whelping period is in the summer time (June-July), and neither adults nor youngster are considered vulnerable with respect to oil or other spills from the drilling location in the Winter period.

Otters are not considered at risk from potential spills from the drilling location.

2.7 Fish resources

For fish species it is proven that eggs and larvae may be very vulnerable to oil pollution in the waters, while larvae larger than ca. 2 cm are vulnerable to a lesser extent. In the North Sea the spawning products are spread over larger areas and time periods than in Norwegian areas further north. It is primarily the zone closest to the spawning areas that may have the largest potential to harmful effects to fish stocks (Havforskningsinstituttet 2006). Recently hatched saithe larvae are especial vulnerable to oil pollution. Eggs and larvae of cod are also quite vulnerable; however larvae of herring in laboratory tests have proven less vulnerable.

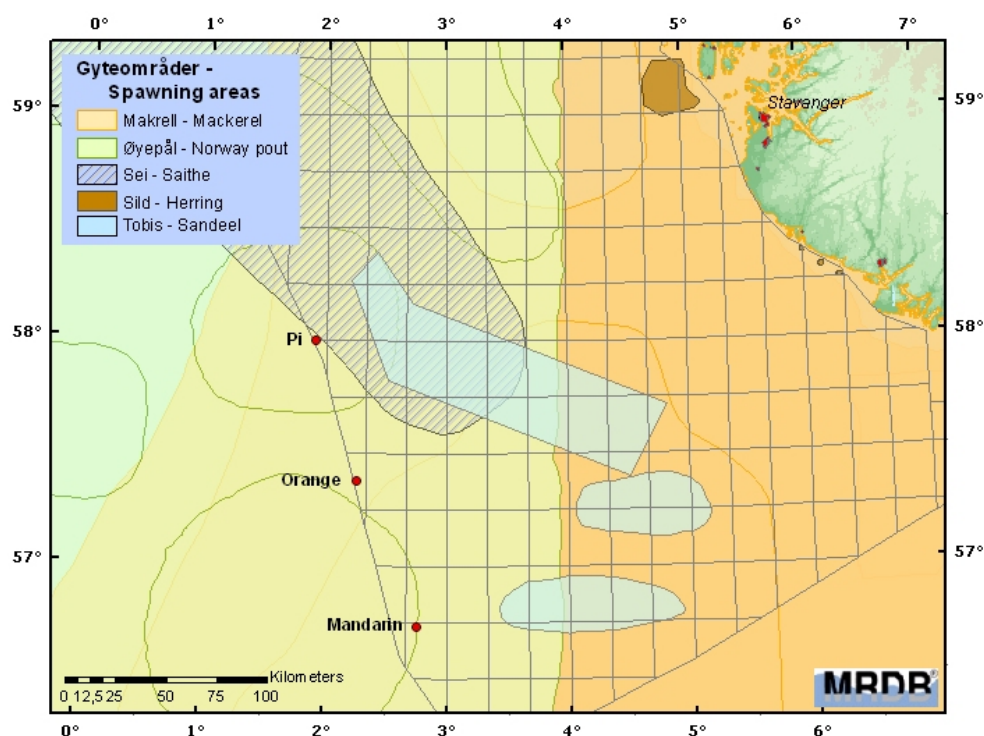


Figure 13. Spawning areas for commercial important fish species in the North Sea (Ref. MRDB®2006).

Many commercially important fish species spawn and have their breeding areas in the North Sea. Spawning areas for species important for the Norwegian fishery in the North Sea are presented in Figure 13. Spawning areas for species important for the Norwegian fishery in the North Sea are presented in Figure 13. The Orange drilling location is located within the spawning areas for Norway pout and mackerel. The peak spawning periods for these species are presented in Table 6. As the drilling according to the plans will start in May, only mackerel, which spawns in June - July has the potential of being impacted.

Table 6. Spawning periods for species spawning in area surrounding the drilling location. (Havforskningsinstituttet 1991).

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Norway pout												
Mackerel												
Saithe												
Sandeel												

In its 2006-report on marine resources and environment the Institute of Marine Research describes a weak recruitment over the last 3 – 4 years to the stocks of sandeel, Norway pout, cod and to a certain degree herring in the North Sea (Havforskningsinstituttet 2006b). This development is mainly due to changes in physical and biological conditions, but the cod and sandeel stocks also suffer from overexploitation. According to the Institute the cod fishery in the North Sea should have stopped several years ago. Furthermore, illegal landings and dumping of catches makes it difficult to estimate the species' size, especially mackerel and cod.

The fishery for reduction to fish meal and oil is mainly based on sandeel, Norway pout and blue whiting. Due to a high percentage of fats and good quality of the meal, sandeel is the most sought after species. Fishmeal and oil are important as food in the fish farming industry. Sandeel

plays an important role in the marine ecosystem as it is important as food for several fish species and whale. For the time being the sandeel stock is very weak. The sandeel fishery is closed, and will only be reopened if a planned research fishery shows an increased stock. The Norway pout stock is at a historically low level, combined with a risk for low recruitment. The fishery for Norway pout was closed in 2005, and remained closed in 2006. The blue whiting stock seems to be inside safe biological limits. All year classes after 1995 are strong, or very strong, compared to the recruitment in the period 1991 - 1994.

The most important species in the purse seine fishery are herring and mackerel. The herring stock is harvested inside safe biological limits. But the three latest year classes are the weakest since the stock collapsed in the 1970-ies. This weak recruitment calls for a special attention to secure the stock in the coming years. The north-east Atlantic mackerel stock has been decreasing since 1998. The catch level is much higher, perhaps the double, of the reported catches. This leads to a very high uncertainty on the real stock level.

In the whitefish trawl fishery with bottom (otter) trawl the main catches are a mix of cod, haddock and whiting. The trawl fishery for reduction purposes and the beam trawl fishery for flatfish both cause a high mortality for the youngest year classes of these species. The spawning stock for North Sea cod is at a historical low level, and the harvesting is not within sustainable limits. ICES have recommended a full stop in the cod fishery. The spawning stock of saithe is in good condition, and the mortality is inside safe biological limits.

2.8 Fishing activity

It has been collected data on the trawl and purse seine catches in the area surrounding the exploration well from the Directorate of Fisheries. The trawl and purse seine catches in the area surrounding the exploration well are presented in Table 7. The table shows that no whitefish trawling has been conducted in this specific area in recent years. According to the Directorate of Fisheries it was earlier an important foreign, mainly Scotch, fishery in the area. The foreign fishery has decreased in recent years, and is today limited to a sporadic British trawl fishery and a sporadic Danish fishery with Danish seine (Kolle 2005).

Table 7. Norwegian catches in the area surrounding the exploration well. The locations include areas in the UK sector. Catch in 1000 tonnes live weight (The Directorate of Fisheries/Fiskeridirektoratet).

Trawl catches	Block 7/7 to 7/12 Location 4172			Total Norwegian catches in the North Sea ³⁾		
Year	-97	-00	-04	-97	-00	-04
Trawl catches:						
- consumption ¹⁾	-	-	-	36,5	23,5	47,9
- reduction ²⁾	2,1	0,3	0		252,1	161,0
Purse seine		-	0,3		231,0	263,5

1) The main part of the trawl catch for consumption is saithe.

2) The main part of the trawl catch for reduction in/near the Ekofisk area is sandeel.

3) Catch in statistical areas 08, 28, 41 and 42, corresponding to the North Sea between 53°30'N and 62°N, and east of 4°W.

On the North Sea banks sandeel is the most important species in the trawl fishery for reduction purposes. Some sandeel catches are reported in the fishery statistics location where the exploration well is located. These catches will be related to the northeast corner of this statistical location (block 7/7 to 7/12), been close to the sandeel areas further northeast. Possibly some of

these catches are misreported in this specific location. No regular sandeel fishery is conducted near the exploration well.

In fisheries with purse seine or mid-water (pelagic) trawl for herring and mackerel the fishing areas will depend on both the stocks migration and regulations conducted by the authorities, both varying from year to year. As a result, these fisheries are generally considered as not affected by drilling activities. According to the fishery statistics it was caught 300 tonnes herring in 2004 in the location corresponding to block 7/7 to 7/12. This confirms that this area has not been important for purse seine fishery in recent years.

2.9 SMO areas - important coastal areas

The concept of SMO (“spesielt miljøfølsomme områder”) has been developed by SFT and DN (SFT & DN1999). Based on the most recent scientific data on occurrences of natural resources, the criteria developed provides a tool for identification of the areas and resources that are considered to be the most sensitive to oil pollution incidents. Hence the SMO data provides a prioritization of the mapping and description of resources in the previous sections.

There are no SMO areas registered within the area of influence for spills from the drilling location. Accidental spills from the exploration drilling are not expected to reach the coast, and will not affect SMO areas for sea birds and marine mammals.

NOFO Planverk also described important areas for high priority during combat actions (Figure 14). These areas are locations with high occurrences of environmentally prioritised locations and which are important for designing of oil spill contingency systems (NOFO Planverk, <http://planverk.nofo.no>). Accidental spills from the exploration drilling are not expected to affect any of these areas.

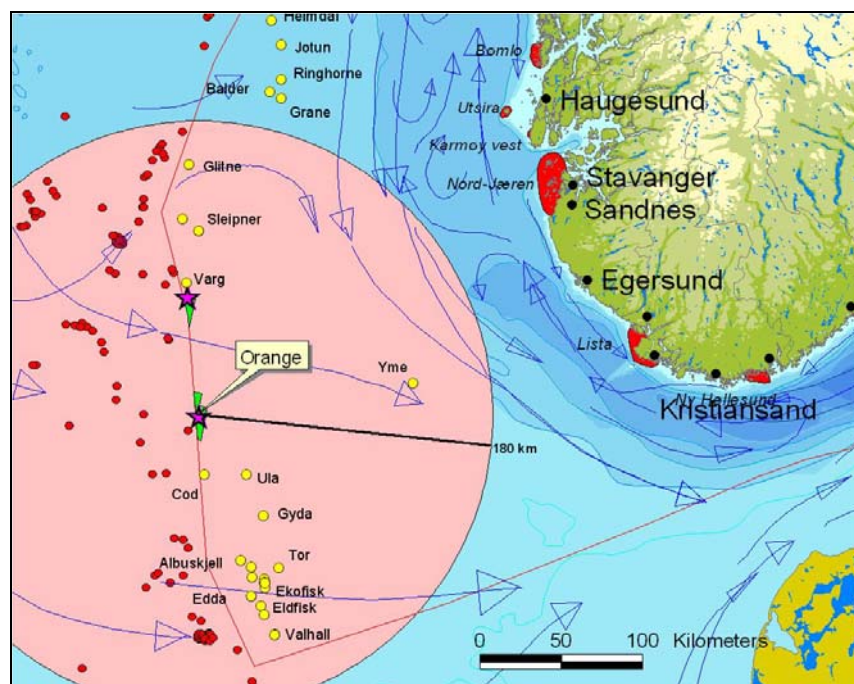


Figure 14. NOFO Planverk's important coastal areas.

The coastal areas of Norway, and particularly in the southern parts, are widely used for recreational and outdoor activities. Oil pollution can potentially cause extensive inconvenience

to a large number of people, particularly in the spring and summer, and to a lesser extent in autumn and winter months. Particularly valuable areas for recreational activities are listed as “secured” (“sikrede”) area, but no such areas are within the area of influence for the well.

2.10 Background pollution

The background pollution level must be described as basis for assessment of potential effects of oil spills or other discharges (ref. the Management Regulations §16).

A comprehensive quality status report describes the pollution status and input to the North Sea and Skagerrak area (OSPAR 2000).

Inputs of heavy metals occurs both from rivers (e.g. 36-64 tonnes/year cadmium and approx. 1000 tonnes/year lead) and from the atmosphere (e.g. 15 tonnes/year cadmium and approx 1500 tonnes/year lead).

The “natural” background levels (BRC) and ecological assessment criteria ³ (EAC) in sea water of some priority heavy metals are:

	BRC	EAC	Factor above EAC
• Cadmium (Cd)	5 – 25 ng/l	0,01 – 0,1 ng/l	50 – 2500 x
• Mercury (Hg)	0,1 – 0,5 ng/l	0,005 – 0,05 ng/l	2 – 100 x
• Lead (Pb)	5 – 20 ng/l	0,5 – 5 ng/l	1 – 40 x
• Copper (Cu)	50 – 360 ng/l	0,005 – 0,05 ng/l	1000 – 72000 x

For both cadmium and copper the levels are alarming high. However, it has not been reported negative effects on marine organisms in the open waters of the North Sea.

Other pollutants such as polychlorinated biphenyls (PCB) that are persistent and bioaccumulate, can be found in all biota in the North Sea, but the levels are not as alarming high as in arctic areas. Because of the prohibition to use PCB the levels are generally being reduced.

Other synthetic pollutants (such as dioxins, furans, hexachlorbenzene, pesticides) mainly represent a problem in some coastal and fjord areas.

PAH (polyaromatic hydrocarbons) are discharged to the North Sea from offshore installations, oil spills and ship transport. The ranges of background/reference concentrations (BRC) and Ecological assessment criteria of PAHs in the surface sediments for the northern North Sea and Skagerrak has been reported by OSPAR (2000):

	BRC	EAC	Factor above EAC
• Benzo(a)pyrene	8,8 – 112 µg/kg dw	0,1 – 1 µg/kg dw	9 – 1120 x
• Fluoranthene	14 – 160 µg/kg dw	0,5 – 5 µg/kg dw	3 – 320 x
• Benzo(b+k)fluoranthene	46 – 434 µg/kg dw	-	-
• Pyrene	11 – 128 µg/kg dw	0,05 – 0,5 µg/kg dw	22 – 2560 x

PAH have very low water solubility and will tend to bind to particulate material and sediment in fall-out areas such as the Norwegian trench. The levels of PAH in sea water are either at the BRC level or lower. Although the levels of PAH are high, the risk of negative effects on marine organisms are reasonable low due to the fact that most organisms have well-developed enzymatic or other means for metabolising and excretion and of PAH compounds.

³ EAC is defined as the concentration level of a substance above which concern is indicated.

Other sources of discharge of petroleum hydrocarbons are riverine inputs from the countries surrounding the North Sea and also produced water discharges from offshore installations.

The total volume of discharged produced water in the Norwegian sector was 177 million m³ in 2005, an increase of 53% since 2000 (OLF 2006). None of the major contributors are in the near vicinity of the drilling location.

The overall conclusion is that it is not considered that the vulnerability of marine organisms in the water column is affected because of background/reference concentrations of natural and man-made pollutants. With respect to discharges that contain persistent substances that may bioaccumulate and that mainly will end up in marine sediments, it is reasons to believe that the background concentrations may be affecting the vulnerability of sediment organisms. This aspect is therefore relevant to consider with respect to operational discharges of drilling cuttings which mainly will deposit on the sea bottom.

3 ENVIRONMENTAL RISK ANALYSIS

3.1 Impact assessment

When petroleum hydrocarbons are discharged to sea a number of weathering processes will start, such as evaporation, downmixing, dilution, emulsification. The rate of the processes depends particularly on oil characteristics and weather conditions. Eventually, relatively stable oil-in-water emulsions will form, with 60-80% water content. Usually, such an emulsion slick will be distributed on the sea with approx. 90% of the oil quantity on 10% of the slick area. After some time on the sea surface, downmixing rates will be very slow.

The environmental effects of oil are numerous, and depend on the combination of oil type and quantity, weather conditions, and the presence of vulnerable resources.

The potential effects of oil in Norwegian offshore/onshore areas have been assessed during a large number of studies and assessments. An important basis is the factual reports to the updated "Regional Konsekvensutredning for Nordsjøen 2006" (Regional Impact Assessment for the North Sea), "Regional Konsekvensutredning for Nordsjøen 1999", but also the oil spill impact review by SFT (1993).

Important factors for assessment of environmental impact of spills and operational discharges:

1. Recovery time; estimated time from discharge to the environment (biological resources) are recovered (comparable to pre-spill situation taking into account natural variation).
2. Number of environmental and economical resources affected: seabirds, sea mammals, fish, phytoplankton, zooplankton, shoreline habitats (littoral zone and beaches), coral reefs, seabed fauna and sediments, fisheries, aquaculture, tourism, water resources, ports and marinas, other industrial activity.
3. Ecological/conservation value/interest of affected resources.
4. The size of affected areas in open sea and in the coastal zone.
5. The degradability of the pollution (biological and/or mechanical/chemical) indicates the duration of potential effects.
6. The quantity of pollution on shorelines.
7. The size of areas with harmful concentrations of pollution in water masses (e.g. oil concentrations > 30-50 µg/l).
8. The size of areas on the sea bed with harmful concentrations or amounts of pollution (e.g. persistent substances that can bioaccumulate).
9. Transfer of effects to other parts of the ecosystems or new generations, e.g. bioaccumulation of pollutants with potential harmful effects on reproduction on survival, particular in relation to key species in the ecosystem.
10. The significance for fisheries expressed as number of the affected vessels in combination with level of importance of the fisheries (local, regional etc).
11. The significance for aquaculture expressed as the number of affected fish/shellfish farms affected.
12. The significance for the recreational/outdoor life expressed as the "value" of affected areas based on whether they are secured as recreational areas ("sikrede friluftsområder").
13. The significance for ports and marinas expressed as the number of vessels/boats potentially affected (effects such as cleaning of vessels).
14. Additional workload in the company related to investigations, correspondence and communication with authorities, follow-up and planning of mitigation and restoration measures.
15. The effect on the company reputation caused by the incident or planned operational discharges. Pre-planning and risk reducing measures, and contingency measures as well as management and follow-up of incidents may affect the company's reputation among authorities and the public in general.
16. Economic costs in relation to spill combat and mitigation, fines and compensation, investigations and research activities etc. Not included internal costs, administration etc.

Classification and weighting of the impact parameters are shown in the Impact Matrix (Table 8).

Table 8. Impact matrix.

Nr.	Impact category Impact parameters	0	1	2	3	4	5	Weighting factors
1	Recovery time (year)	Not detectable	< 1 month	< 1 year	1- 3 year	3-10 year	> 10 year	15 %
2	Number of resources	None	1-2	< 5	< 10	< 15	> 15	5 %
3	Conservation Value of affected resources / areas	None	Local	Regional	County	National	International	5 %
4	Size of affected area on sea surface (km ²)	< 0,1	< 0,5	< 5	< 50	< 150	> 150	5 %
5	Fluid degradability (weathering properties)	Not relevant	Very fast (hours)	Fast (days)	Moderate (weeks)	Slow (months)	Very slow (months-years)	10 %
6	Shoreline quantity (tonnes)	<1	<10	<100	<1000	<5000	>5000	5 %
7	Area with harmful water concentrations (km ²)	< 0,1	< 0,5	< 5	< 50	< 150	> 150	5 %
8	Area with harmful sediment concentrations/amounts (km ²)	None	< 0,1	< 0,15	< 0,3	< 0,6	> 0,6	5%
9	Transfer of effects (to new generations etc)	None	No	-	Uncertain	-	Yes	10 %
10	Importance for fisheries	None affected	Locally, few vessels	Locally, many vessels	Regionally, few vessels	Regionally, many vessels	Nationally	5 %
11	Importance for aquaculture	None affected	<5 farms affected	5-10 farms	10-20 farms	20-50 farms	>50 farms affected	5%
12	Importance for outdoor life (secured areas regional/county level)	None affected	1-2 secured areas affected	3-5	6-10	11-20	>20	5%
13	Importance for harbours and marinas (boats)	None affected	Only few boats affected	Many boats, locally	Many boats in the municipality	Many boats, regionally	Many boats, county level	2,5%
14	Additional administrative effort/work in the company	Insignificant	Little extra work, short duration	Moderate extra work, short duration	Moderate extra work, long duration	Considerable extra work, short duration	Considerable extra work, long duration	2,5%
15	Company reputation	No effect	Small effect	Moderate effect	Considerable, short duration	Considerable, long duration	Serious effect	10%
16	Economic costs, mill. NOK	< 0,05	< 0,5	< 2,5	< 5	< 10	>10 mill. NOK	5 %

The impact matrix has been used for assessment of the spills and operational discharge presented in chapter 2.7. The results from the impact classification are shown in appendix and Figure 15. The average impact values (AIV) in Figure 15 is calculated by multiplying each impact value (for the 16 impact parameters) with its weighting factor (the sum of all weighting factors is 100%), and then summarising the values:

$$AIV = \sum_{i=1}^{16} (impactvalue)_i \times (weightingfactor)$$

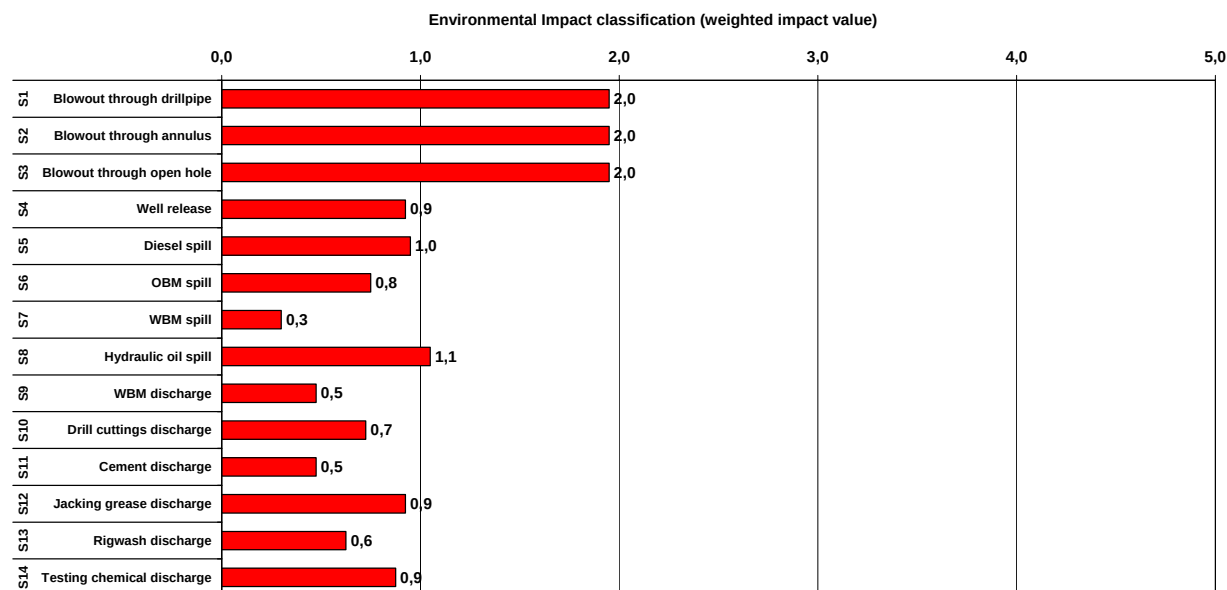


Figure 15. Results from the impact classification for acute spills and operational discharges.

The blow-out scenarios (S1-S3) are the most serious incidents with respect to potential environmental impact. A blow-out through open hole will cause the largest impacts, because of a larger discharge quantity. Well release (S4) will not cause serious environmental impact.

Among the minor spill incidents the diesel (S5) and hydraulic oil (S8) spills are considered to cause equal impact (both 1 m³ spills), while the OBM spill (S6) will have somewhat lower impact due to faster weathering and biodegradation.

The operational discharges generally cause insignificant environmental effects. Although large differences in discharge quantities, the operational discharges are considered to be associated with the same consequence levels.

3.2 Activity specific environmental risk

The environmental risk expressed on basis of recovery time of more than 1 month (not including the category not detectable) is only relevant to consider for the blow-out scenarios (S1-S3). Only these scenarios have a potential to cause significant effects on a population or community level and hence are relevant to consider with respect to environmental risk acceptance criteria.

The total blow-out frequency is $2,3 \times 10^{-4}$. In addition to the damage probability distribution, a hit probability factor has to be taken into account. For Orange it is only seabirds that may be impacted in the magnitude as described wrt recovery time, and the assessed recovery of 1-3 years represents a reasonable worst case. Seabirds in this area, however, are widely and patchy distributed, and only occur in the area in shorter time periods, mainly when seeking food or resting on the sea surface before returning to the breeding areas/colonies. A hit probability of 10-20% is considered to represent a conservative estimate for Orange.

This results in a damage frequency for the three blowout scenarios S1-S3 of $5,1 \times 10^{-6}$, $3,6 \times 10^{-5}$ and $5,1 \times 10^{-6}$, respectively, for the damage category moderate, according to BG acceptance criteria for environmental risk (see Table 2).

Hence, the environmental risk level for the blowout scenarios are 1%, 14% and 2%, respectively, for the three scenarios, which shows that the risk level is very low according to BG acceptance criteria.

In addition to the evaluation of environmental impact based on recovery time, the environmental risk has been assessed and ranked for identified spill and operational discharge scenarios based on totally 16 impact parameters.

The Risk Index is calculated by dividing the Average Impact value (AIV) with the logarithmic value of the Frequency of occurrence value (F). The results are shown in Figure 16.

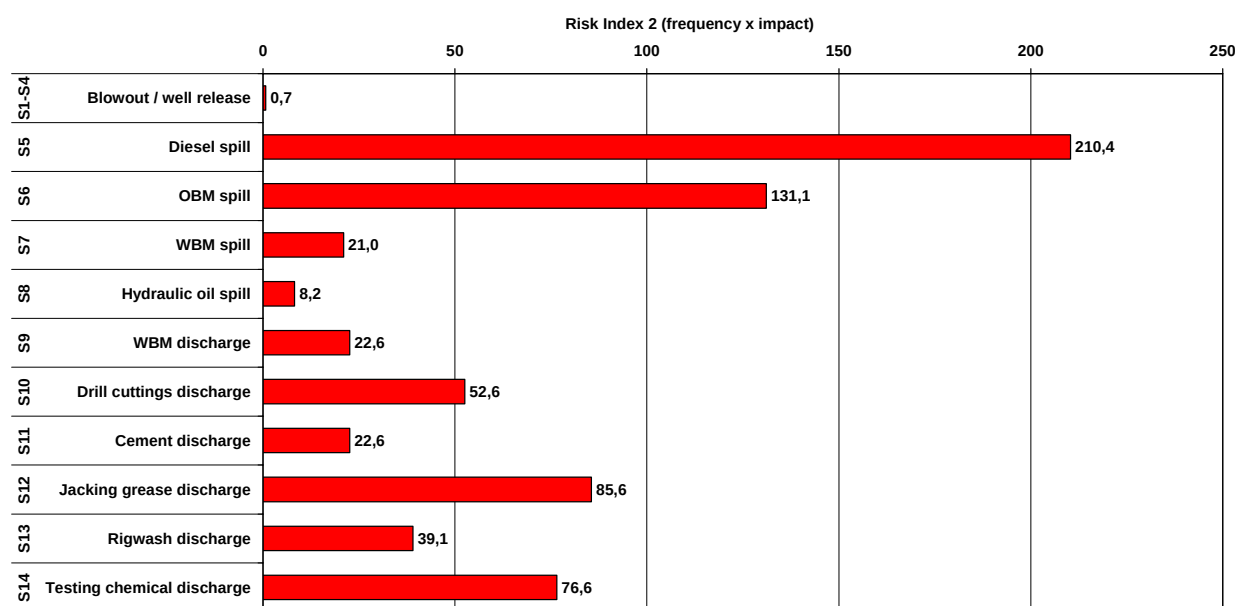


Figure 16. Ranking of environmental risk for 14 spill and operational discharge scenarios (the three blow-out scenarios and the well release scenario have been summarised) for the Orange exploration well based on the Risk Index (Frequency of occurrence x Impact classification).

Compared to the impact classification (Figure 15) this provides a completely different picture. The diesel spill is ranked as the highest risk scenario for the drilling operation, followed by the OBM spill scenario. Among the operational discharges, the discharge of jacking grease is assessed to be the largest contributor, with the discharge of testing chemicals second. However, the overall picture is a very low environmental risk level for the drilling operation.

3.3 Regional environmental risk

In the area there are other installations nearby, and there is a potential for other drilling activity planned at the same time in the close vicinity. The Orange well is located north of the Cod/Ula area (approximately 40 km north). The installations in the Ekofisk area are more than 100 km south of the well.

All installations, including the exploration drilling operation, contribute to the risk for oil pollution from this region. Compared to the total number of installations and other activities in the Ekofisk region, the contribution from the drilling operations during the period that the operation will take place, is considered marginal. The activity specific environmental risk should

therefore form a sufficient basis for identifying risk reducing measures including oil spill contingency systems.

3.4 The effect of risk reducing measures

During the detailed planning phase and the subsequent management of the drilling operation, risk reducing measures will be identified and implemented based on the results of the environmental risk analysis. Risk reducing measures may be either probability reducing or impact reducing.

In the following sections it is indicated which types of measures that are relevant and that are being or will be considered:

Risk item	Description of measures
Use of jacking grease	Jacking grease is classified as environmentally red substance and substitution plans will be established for this product. It will be sought to establish a wider co-operation among other operators that also plan to use Jack-up rigs in the future in order to develop and test possible alternative jacking grease products.
Diesel spills	The procedures and operational logistics for handling of diesel on the drilling rig will be audited and verified, and an awareness campaign will be considered to ensure best operational practice.
Use of rig wash detergent	The procedures and operational logistics for use of the rig wash detergent Cleanrig HP on the drilling rig will be audited and verified. Routines will be described in the HSE Plan for the drilling operation to ensure minimization of the use of chemicals.
OBM spills	Procedures for transport and handling of both new and used oil based drilling mud will be established, with requirements for inspection and closing of all drains that could result in OBM being routed to sea.
Use of drilling mud and cementing chemicals	Routines will be established and described in the HSE Plan to ensure minimal use of chemicals, and re-use if possible. Several chemicals are described in substitution plans and work is ongoing to find replacement chemicals with less environmental effect potential.
Major oil spills	Such incidents represent a low environmental risk for the drilling operation because of the low probability and low environmental sensitivity in the area. The main risk reducing measure will be an oil spill contingency system. This is addressed in a separate oil spill contingency analysis. Solutions and the organisational aspects and procedures will be described in an oil spill contingency plan which will be linked to the NOFO Master Plan ("Regionale Planverk").

4 Conclusions

BG Norge plans to drill the exploration well 7/7-4 Orange using the jack-up rig Maersk Guardian, starting in June 2007. The drilling will be conducted using water based mud (WBM) in the upper sections and oil based mud (OBM) in the lowest section. Only chemicals from the upper sections will be discharged.

No black chemicals will be used but the operation plan for use of five red chemicals, three of these are included in the rig chemicals (Statoil multidope, Bestolife 3010 Ultra and Bestolife 2010 NM Ultra) and will partly be discharged, while the latter two red chemicals (Carbogel 1 and Magma-Gel SE) are used in OBM and will not be discharged. Total discharge of red chemicals is estimated to be less than 1 tonne.

The calculated maximum blow-out rate is 278 m³/day which is a low day rate. If a blow-out should occur, the potential for stranding is estimated to << 5 %.

Based on the BG Norge Environmental Risk Assessment, the highest risks are from accidental diesel spills and accidental spill of OBM. The environmental risk from blow-outs is far below the BG Norge acceptance criteria.

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6 Appendix – Environmental impact classification

Appendix Table 9 shows the results from the Environmental Impact classification of the 14 spills and operational discharge scenarios included in the risk analysis.

Table 9. Impact matrix and classification of impacts of scenarios for exploration drilling of ORANGE.

No.	Impact category	0	1	2	3	4	5	Weighting Factors	Scenario													
									1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Recovery time (year)	Not detect.	< 1 month	< 1 year	1- 3 year	3-10 year	> 10 year	10 %	3	3	3	1	1	1	0	1	1	1	0	1	0	1
2	Number of resources	None	1-2	< 5	< 10	< 15	> 15	5 %	3	3	3	1	1	1	2	1	2	2	2	1	2	2
3	Conservation Value of affected resources / areas	None	Local	Regional	County	National	International	5 %	2	2	2	2	2	2	1	2	2	1	1	1	2	2
4	Size of affected area on sea surface (km ²)	< 0,1	< 0,5	< 5	< 50	< 150	> 150	10 %	5	5	5	1	0	0	0	0	0	0	0	0	0	0
5	Fluid degradability (weathering properties)	-	Very fast (hours)	Fast (days)	Moderate (weeks)	Slow (months)	Very slow (months-years)	10 %	3	3	3	2	4	2	0	4	0	0	0	4	3	3
6	Shoreline quantity (tonnes)	<1	<10	<100	<1000	<5000	>5000	5 %	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	Area with harmful water concentrations (km ²)	< 0,1	< 0,5	< 5	< 50	< 150	> 150	5 %	3	3	3	0	0	0	0	0	0	0	0	0	0	0
8	Area with harmful sediment conc./amounts	None	< 0,1 km ²	< 0,15	< 0,3	< 0,6	> 0,6	5%	0	0	0	0	0	0	0	0	0	3	1	0	0	0
9	Transfer of effects (to new generations etc)	None	No	-	Uncertain	-	Yes	10 %	1	1	1	1	1	1	0	1	0	1	1	1	0	1
10	Importance for fisheries	None affected	Locally, few vessels	Locally, many vessels	Regionally, few vessels	Regionally, many vessels	Nationally	5 %	1	1	1	0	0	0	0	0	0	1	1	0	0	0
11	Importance for aquaculture	None affected	<5 farms affected	5-10 farms	10-20 farms	20-50 farms	>50 farms affected	5 %	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Importance for outdoor life (secured areas regional/county level)	None affected	1-2 secured areas affected	3-5	6-10	11-20	>20	5 %	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	Importance for harbours and marinas (boats)	None affected	Only few boats affected	Many boats, locally	Many boats in the municipality	Many boats, regionally	Many boats, county level	2,5 %	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	Additional administrative effort/work in the company	Insignificant	Little extra work, short duration	Moderate extra work, short dur.	Moderate extra work, long duration	Considerable extra work, short dur.	Considerable extra work, long duration	2,5 %	4	4	4	3	2	2	2	2	1	1	1	3	1	1
15	Company reputation	No effect	Small effect	Moderate effect	Considerable, short duration	Considerable, long duration	Serious effect	10 %	3	3	3	2	1	1	1	2	1	1	1	1	1	1
16	Economic costs, mill. NOK	< 0,05	< 0,5	< 2,5	< 5	< 10	>10 mill. NOK	5 %	0	0	0	0	0	0	0	0	0	0	0	0	0	0