StatoilHydro

# ENVIRONMENTAL STATEMENT
# ALFA SENTRAL
# SLEIPNER SATELLITES

StatoilHydro Document No: RE-SSAS-00010
DECC Reference No: D/4050/2009

## Standard Information Sheet

| | |
|---|---|
| **Project name:** | Alfa Sentral, Sleipner Satellites |
| **DTI Project reference:** | D/4050/2009 |
| **Type of project:** | Environmental statement under the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended) |
| **Undertaker Name:** | StatoilHydro ASA |
| **Address:** | Forusbeen 50<br>N-4035 Stavanger<br>Norway |
| **Licensees/Owners:** | PL046-Norway<br>StatoilHydro (operator): 62%<br>ExxonMobil: 10%<br>Total: 28%<br><br>P312-UK<br>ENI (operator): 45%<br>Talisman: 24%<br>First Oil Exploration: 31% |
| **Short description:** | This Environmental Statement (ES) presents the findings of StatoilHydro's assessment of the environmental consequences due to the construction of Alfa Sentral and the increased production at the Sleipner installations from the tie in of the Alfa Sentral field. |
| **Anticipated commencement of works:** | August 2010 |
| **Date and reference number of any earlier Statement related to this project:** | Not applicable |
| **Significant environmental impacts identified:** | None |
| **Statement Prepared By:** | StatoilHydro ASA |

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# 1 Non Technical Summary

## 1.1 Introduction

The Alfa Sentral field is a trans-boundary gas and condensate field with approximately 80% of the reserves on the Norwegian continental shelf and approximately 20% on the United Kingdom continental shelf. The field is located in Blocks 15/8 and 16/18a in the central North Sea, about 20 km vest of the Sleipner complex. Alfa Sentral is planned developed with a four slot sub sea template with 2 or 3 wells, and a 21 km pipeline connecting the wells to the Sleipner T platform (SLT). All processing will take place at SLT, and all infrastructures will be placed on the Norwegian side of the border line.

The gas in the Alfa Sentral field has a $CO_2$ content of about 20%, and will be routed through the $CO_2$-removal facilities at SLT. On the SLT the $CO_2$ content will be decreased from ca. 20% to ca. 5%. Separated $CO_2$ will be injected into the Utsira formation.

The Sleipner area includes the gas and condensate fields Sleipner East and Sleipner West, and the satellite fields Gungne, Loke and Alfa Nord. Condensate from Sleipner is transported through pipeline for treatment at Kårstø in South West Norway. The gas is mixed with gas from other fields and transported in the export pipelines Statpipe, Zeepipe and Europipe II to Emden and Zeebrugge.

The environmental and social impacts of the Norwegian part of the production from Alfa Sentral are already described in the Regional Impact Assessment (RIA) of the North Sea from 2006. The Norwegian Ministry of Petroleum and Energy has acknowledged that the Norwegian legal requirements for impact assessment are already fulfilled by the existing RIA-North Sea 2006, and that a new field specific impact assessment is not required (App. A & B).

This Environmental Statement (ES) presents the findings of StatoilHydro's assessment of the environmental consequences due to the construction of Alfa Sentral and the increased production at the Sleipner installations from the tie in of the Alfa Sentral field.

The submission of this ES is required under the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 as amended by the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) (Amendment) Regulations 2007. Department of Energy and Climate Change (DECC) has judged an ES of Alfa Sentral mandatory because the UK share of production exceeds the production threshold for activities that must be accompanied by an ES. This production threshold is set at 500 tonnes or more per day of oil or 500,000 cubic metres or more per day of gas.

The Offshore Petroleum Activities (Assessment of Environmental Effects) (Amendment) Regulations 2007 which implements the Public Participation Directive, requires that where production increases above the thresholds as detailed above, then an ES assessing the environmental impacts of the increased level of production is submitted.

Notwithstanding regulatory requirements, internal impact assessments are routinely carried out by StatoilHydro for all offshore development activities as a matter of company policy.

## 1.2 Operations Summary

The production on Sleipner has left plateau and is declining. The start up of Alfa Sentral will not provide any real increases in production, but will slow down the reduction in production and emissions. It is therefore considered that a development of the Alfa Sentral will not cause any significant changes of emissions to air compared to the forecast on which the Regional Environmental Impact Assessment (RIA) of the North Sea (2006) was based.

Start up of Alfa Sentral is scheduled in 2011 with peak production in 2012. The production period of the Alfa Sentral field is estimated to be approximately 7 years.

## 1.3 Environmental Management

StatoilHydro has established an environmental policy which supports the goals of zero harm to the environment and sustainable development. StatoilHydro's environmental policy has been adopted by the company's top management and applies to all the company's activities and to all employees.

The commitments that follow from the environmental policy are realised through StatoilHydro's establishment of mechanisms and systems for efficient implementation, measurement, control and improvement of all the activities and processes carried out by the company and its suppliers.

This system will also apply to Alfa Sentral. The impact assessment identifies mitigating measures and possible improvements that will be assessed in the further planning work. These measures will be followed up by the project on a running basis in the development and production phase.

The project will also try to identify new mitigating measures. This is part of the project's ordinary work relating to health, safety and the environment (HSE), and is in accordance with StatoilHydro's own guidelines for further development of the project

## 1.4 Environmental Sensitivities

Infrastructures, emissions to air and discharges to sea connected to the development of Alfa Sentral will take place on the Norwegian continental shelf in the North Sea. The proposed development is located in an area that is typical of the offshore regions of the central North Sea, where hydrographical, meteorological, geological and biological characteristics are relatively uniform over large areas. Users of the area are mainly those associated with oil and gas exploration and development, shipping and fishing. Table 1-1 provides a summary of the key features of the offshore environment in this area, and their seasonal patterns of activity or sensitivity.

***Table 1-1.*** *Seasonal environmental sensitivities in the influenced area.*

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Plankton**<br>The planktonic community is potentially sensitive to chemical releases into the sea. The planktonic community in the vicinity of the proposed activities is typical of the central North Sea and has the capacity to recover quickly because there is a continual exchange of individuals with surrounding waters. Any impacts associated with the proposed operations are likely to be small in comparison with natural variations. | | | | | | | | | | | |
| **Benthic Fauna**<br>Benthic communities in the area of the proposed activities are similar to those found throughout the surrounding area of the central North Sea and no rare species are known to occur in this area. Benthic faunal communities are vulnerable to physical and chemical disturbances to the sediment. | | | | | | | | | | | |
| **Fish**<br>Juvenile fish, in particular ecologically sensitive demersal spawning species such as sandeels, herring and Norway lobster, are vulnerable to any physical disturbance of their spawning and nursery grounds. Finfish and shellfish are vulnerable to pollution, such as oil and chemical discharges, especially during the egg, larval and juvenile stages of their lifecycle. The proposed activities lies within spawning grounds for cod, haddock, saithe and Norway pout. Most of these species are considered to be less sensitive because of their widespread distribution and extensive spawning areas. | | | | | | | | | | | |
| **Marine Mammals**<br>Harbour porpoise are the most commonly recorded cetacean in this area; numbers are greatest in July. Other species of cetaceans recorded in the area are killer whale, minke whale, white-beaked dolphin, white-sided dolphin and Risso's dolphin. Marine mammals are vulnerable to chemical discharges, acoustic disturbance from vessel operations, and injury from collisions with vessels. Marine mammals can easily avoid disturbed areas. | | | | | | | | | | | |
| **Seabirds**<br>Seabird populations are vulnerable to surface pollution, particularly oil. However, Alfa Sentral is a gas and condensate field and potential negative impacts on seabirds from the planned activities are therefore regarded to be low. | | | | | | | | | | | |
| **Fishing Activity**<br>Fishing activity is considered to be low in the eastern part of the influenced area and moderate to high in the western part around the template. | | | | | | | | | | | |
| **Conservation Areas and Species**<br>There are no protected areas that may be influenced by the planned development of Alfa Sentral. Based on generally available information and survey data from the pipeline route there are no reef habitats in the area of the proposed pipeline. Neither have any objects of cultural heritage importance been identified in the area. The harbour porpoise (mentioned above) is the only Annex II species known to occur in this region of the North Sea. | | | | | | | | | | | |

| **Key to Level of Sensitivity / Activity** | |
|---|---|
| | Very high |
| | High |
| | Moderate |
| | Low |

## 1.5 Evaluation of Potential Environmental Impacts

The proposed development has the potential to affect the environment in different ways. This may include physical disturbance of the seabed, and the creation of gaseous emissions, aqueous discharges and solid wastes. An evaluation of the relative significance of these potential environmental effects for the activities proposed in connection with the development of Alfa Sentral has been undertaken so that any potentially significant impacts can be assessed and mitigated. The evaluation takes account of the activity causing the impact or risk associated with the main project activities and the sensitivity of the location. Consideration was also given to the routine, non-routine and potential accidental/emergency events.

## 1.6 Assessment of Potential Significant Environmental Impacts

This assessment concludes that the development of Alfa Sentral will have only minor to negligible environmental impacts within the Norwegian continental shelf and negligible to none impacts on the UK continental shelf.

## 1.7 Mitigation Measures

The activities associated with the Alfa Sentral development will be conducted in accordance with StatoilHydro's environmental policy. A summary of the main commitments for the Alfa Sentral field development are as follows:

- Environmentally black (ref. chapter 5.1) chemicals will not be used. The use of red chemicals and yellow chemicals will be minimised. Chemical selection shall be based on best available technology (BAT) principles.
- Cuttings from drilling with oil based mud will not be released to sea, but either fluidized and injected into well or transported to shore for handling.
- The drilling programme will comply with StatoilHydro's Emergency Procedures and Oil Spill Contingency Plan.
- All subsea infrastructures will be made over-trawlable.
- All activities will be carried out in line with StatoilHydro's HSE policy and current Norwegian legislation.

Alfa Sentral will utilize available capacity in existing topside process facilities on SLT. No major modifications will be necessary, and the existing environmental standards and mitigating measures will apply also for the Alfa Sentral part of the production.

## 1.8 Conclusion

In overall terms, the proposed activities at the Alfa Sentral field and at the Sleipner complex are not expected to lead to environmentally significant effects. The Alfa Sentral field and the Sleipner complex are located in an area which is typical of the central North Sea in terms of habitats and marine life. None of the environmental receptors is assessed as being particularly sensitive to the type of activities proposed.

The activities associated with the Alfa Sentral development will be included in the Company's environmental measurement and monitoring programmes, which track performance against corporate targets for important emissions and discharges.

This assessment demonstrates that the planned drilling of the Alfa Sentral, the laying of the pipeline and subsequent increased production at the Sleipner complex will have no significant effects on environmental resources in the central North Sea. The controls on operations have been designed to ensure that robust environmental safeguards will be put in place and preventative measures have been designed to minimise any potential environmental risks. It is concluded that the Alfa Sentral activities could be implemented without significant adverse effects on the environment.

StatoilHydro believes that the measures that will be taken to minimise the environmental effects associated with the Alfa Sentral activities represent an appropriate balance between protecting the environment and securing the economic benefits of the planned production increase.

# 2 Introduction

Alfa Sentral is a gas and condensate field in the Sleipner License PL046 (block 15/8), where approximately 20% of the reserves are stretching into the British sector (P312, Block 16/18a). The field was discovered in 1983, but has been undeveloped in anticipation of the available capacity on the Sleipner installations. The $CO_2$ content of the gas is high (ca. 20%), and the gas is to be sent through $CO_2$ removal plant on the Sleipner T (SLT). If Alfa Sentral comes into production from 2011, it will be on decline when Gudrun comes on stream, and capacity conflict can be avoided.

Alfa Sentral is planned developed with a four slots template, 22 km of pipeline and tie in to the Sleipner T platform. All installations will be located on the Norwegian side; the distance from the template to the border line will be approximately 0.85 km.

StatoilHydro is the operator, with Norwegian partners ExxonMobil and Total, which are the same owners as in Sleipner. British partners are ENI (operator UK License area), Talisman and First Oil Exploration.

On the Norwegian continental shelf the environmental impacts are already described in the Regional Impact Assessment (RIA) of the North Sea from 2006. The Norwegian part of the production, emissions and discharges from the development of the Alfa Sentral field was included in this RIA. Norwegian authorities have agreed that the legally required impact assessment for the development of the Alfa Sentral field is fulfilled by the RIA, and any further impact assessments according to Norwegian legislation will not be required (App. A & B).

The Alfa Sentral 15/8 is mentioned in the Impact Assessment of the Sleipner West Field from 1991as one of several discoveries in the vicinity of Sleipner West. It was further stated that a production of Alfa Sentral naturally would be tied to the Sleipner West, and that the start up would depend on gas sales and the available processing capacity.

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The submission of this ES is required under the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 as amended by the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) (Amendment) Regulations 2007. Department of Energy and Climate Change (DECC) has judged an ES of Alfa Sentral mandatory because the UK share of production exceeds the production threshold for activities that must be accompanied by an ES. This production threshold is set at 500 tonnes or more per day of oil or 500,000 cubic metres or more per day of gas.

The Offshore Petroleum Activities (Assessment of Environmental Effects) (Amendment) Regulations 2007 which implements the Public Participation Directive, requires that where production increases above the thresholds as detailed above, then an ES assessing the environmental impacts of the increased level of production is submitted.

# 3 Project Description

## 3.1 Localization

Alfa Sentral gas and condensate field is located in PL046 Sleipner License in Norwegian block 15/8 (PL046 Sleipner Licence) and United Kingdom block 16/18a (P312). The field is located about 10 km southwest of Sleipner B platform and 20 km of the Sleipner field centre (*Figure 3-1*).

Water depth in the area is 110-120 m.

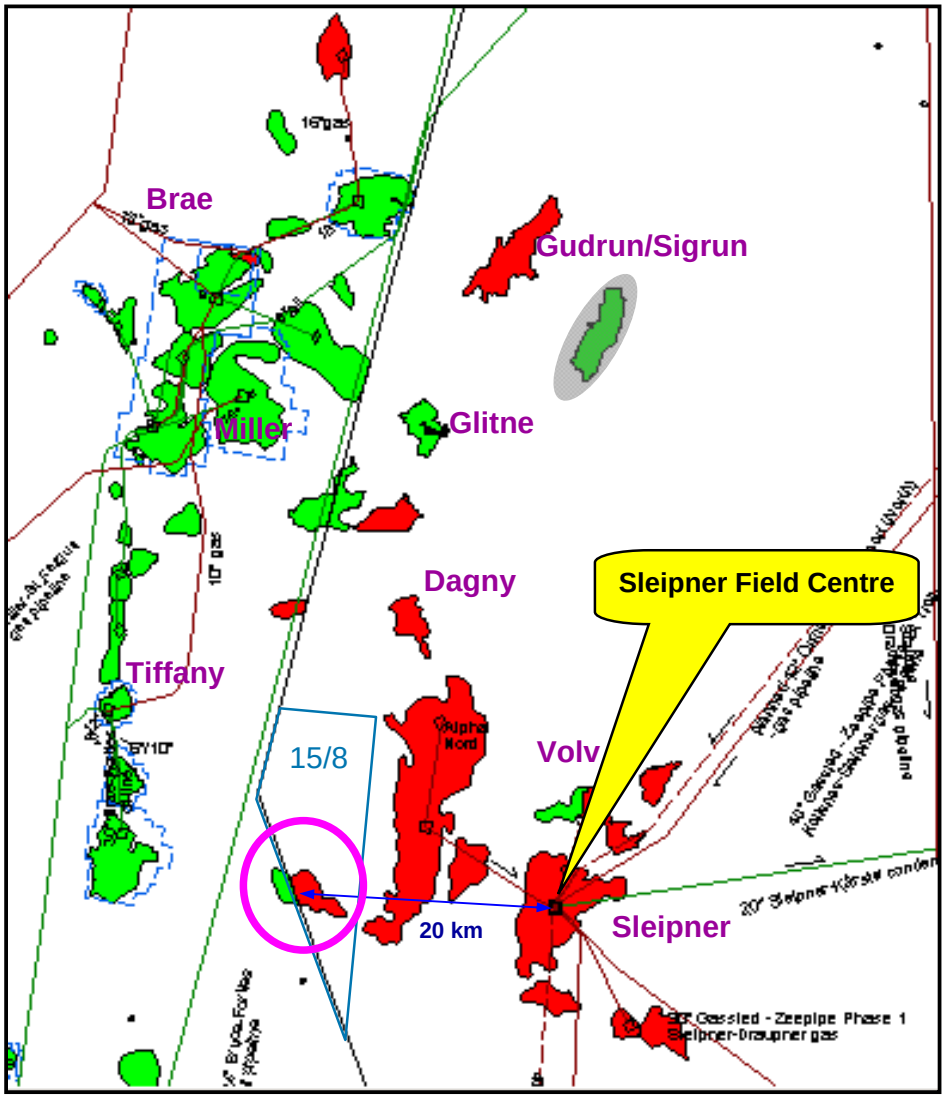


***Figure 3-1.*** *Location of the Alfa Sentral field in relation to the Sleipner field centre.*

## 3.2 Conditions on the Host Platform Sleipner T

The gas in Alfa Sentral has a $CO_2$ content of about 20%. It is therefore planned to route the gas through the $CO_2$-removal facilities at Sleipner T (SLT). On the SLT the $CO_2$ content will be decreased from 20% to ca. 5%. Separated $CO_2$ will be led into the Utsira formation, while the remainder will be mixed into the export gas. If Alfa Sentral comes into production from 2011, it will be on decline when Gudrun comes on stream. Capacity conflict can thus be avoided.

## 3.3 Existing Development and Infrastructure in the Sleipner Area

The Sleipner Area includes the gas and condensate fields Sleipner East and Sleipner West, and the satellite fields Gungne, Sigyn, Loke and Alfa Nord. Condensate from Sleipner is transported by pipeline for treatment at Kårstø. The gas is transported in the export pipelines Statpipe, Zeepipe and Europipe II to Emden and Zeebrugge.

**Sleipner East**
The Sleipner East Field is developed with an integrated process-, drilling- and living quarter platform; Sleipner A (SLA). In addition a riser platform is installed: Sleipner R, which ties the SLA to pipelines for gas transport, and a flare tower, Sleipner F. Two subsea templates are also installed, one for the production of the northern part of Sleipner East and one for the production of the Loke Deposit. In addition, three wells from Sigyn are tied to SLA.

The production on Sleipner East started in August 1993.

**Sleipner West**
Sleipner West is connected to the Sleipner East, and both fields are operated by the same operation organization.

Sleipner West is developed with a wellhead platform, Sleipner B, which is remotely controlled from the Sleipner A platform on the Sleipner East field, and a process facility, Sleipner T - which is connected with the Sleipner A with a walkway.

Untreated well stream from Sleipner West is transported in a 12 kilometre long pipeline to the Sleipner T platform. Gas and condensate from Sleipner West is processed on Sleipner T. $CO_2$ is separated from the gas in two 20 meter high towers on the Sleipner T platform. In the towers the $CO_2$ from the gas is absorbed into liquid amine and then separated from the amine in a recycle plant. From here, both gas and $CO_2$ is led to Sleipner A. Processed gas from Sleipner West goes to further export. $CO_2$ is injected in the Utsira formation via a separate injection well. Unstable condensate from Sleipner West and Sleipner East is mixed at Sleipner A, and is then transported to Kårstø for the processing of stable condensate and NGL products.

The production on Sleipner West started in August 1996.

The Alfa Nord segment was developed in 2004 with a template connected to the Sleipner T through an 18 kilometre long pipeline.

The Sleipner Area with existing infrastructure is shown in Figure 3-2 and Figure 3-3.

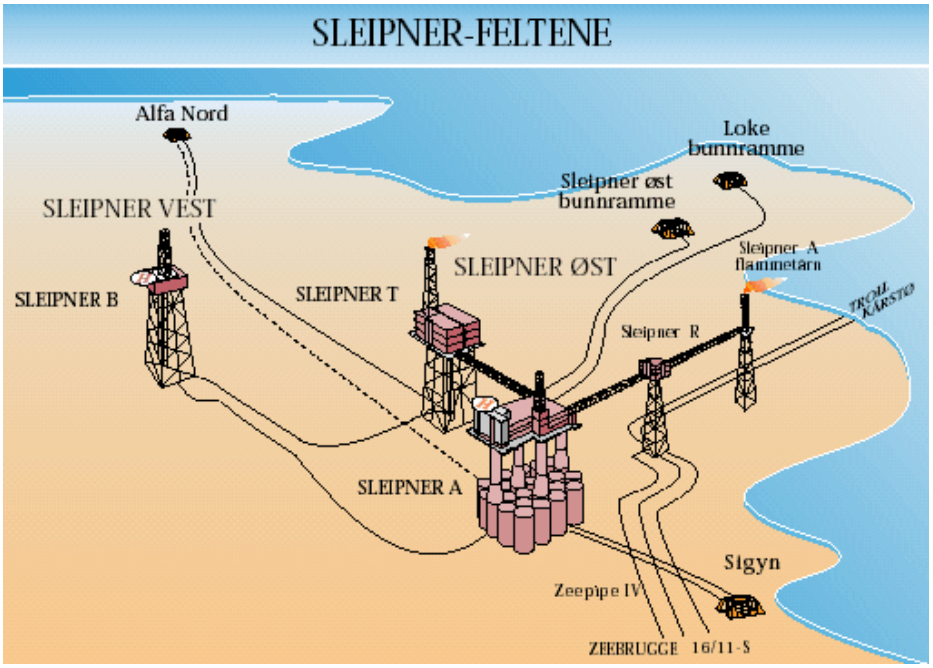


***Figure 3-2.*** *The Sleipner fields with existing infrastructure. The satellite field Gungne is not shown in the image.*

***Figure 3-3.*** *Figure 3.3. Photo showing the Sleipner A platform in front left with Sleipner T platform in the back.*

## 3.4 Ownership

Owner composition in percent and operator responsibilities are stated in the table below.

| * = Operator | Alfa Sentral | |
|---|---|---|
| | PL046 -Norway | P 312- UK |
| StatoilHydro* | 62 | |
| Total | 10 | |
| ExxonMobil | 28 | |
| ENI* | | 45 |
| First Oil Exploration | | 24 |
| Talisman | | 31 |

## 3.5 Resources and Development Solutions

### *3.5.1 General*

Alfa Sentral gas and condensate field was discovered in 1983. The field has been undeveloped in anticipation of the available capacity on the Sleipner installations. The gas is contained in the Upper and Lower Hugin and the Sleipner formations at a depth of about 3800 m below sea level.

All facilities, both subsea and topside, will be placed on the Norwegian continental shelf. There will be no infrastructure on the British side of the border line. With the exemption of 2-3 anchors from the drilling rig, and possibly vessels used during installation of subsea equipment, no physical activities are planned for on the British continental shelf.

The resources will be recovered by depletion of the reservoir. The plan entails the development of the field using a new template with four well slots. Initially it will be drilled two wells, with the possibility of a third well in the field when needed. The last well slot may be used for a nearby prospect.

In earlier phases of the project four different tie-in alternatives have been evaluated:

- Sleipner B (SLB)
- Hot Tap to the pipeline between SLB and Sleipner T (Base case)
- Direct tie in to Sleipner T (SLT)
- Sleipner A (SLA)

The selected alternative is a direct connection to the SLT, with an umbilical connected to the SLA (Figure 3-4). The umbilical shall provide for the transfer of hydraulics, production chemicals, MEG, electric power and signals to the subsea installation. The length of both pipeline and umbilical will be approximate 22 km. The umbilical will be placed in the same corridor as the pipeline. The pipeline will be protected by rockdumping and / or trenching. Protection by concrete coating only will be evaluated. The umbilical will be trenched and rock dumped where required. Alternative protection (rockdump only) will be evaluated.

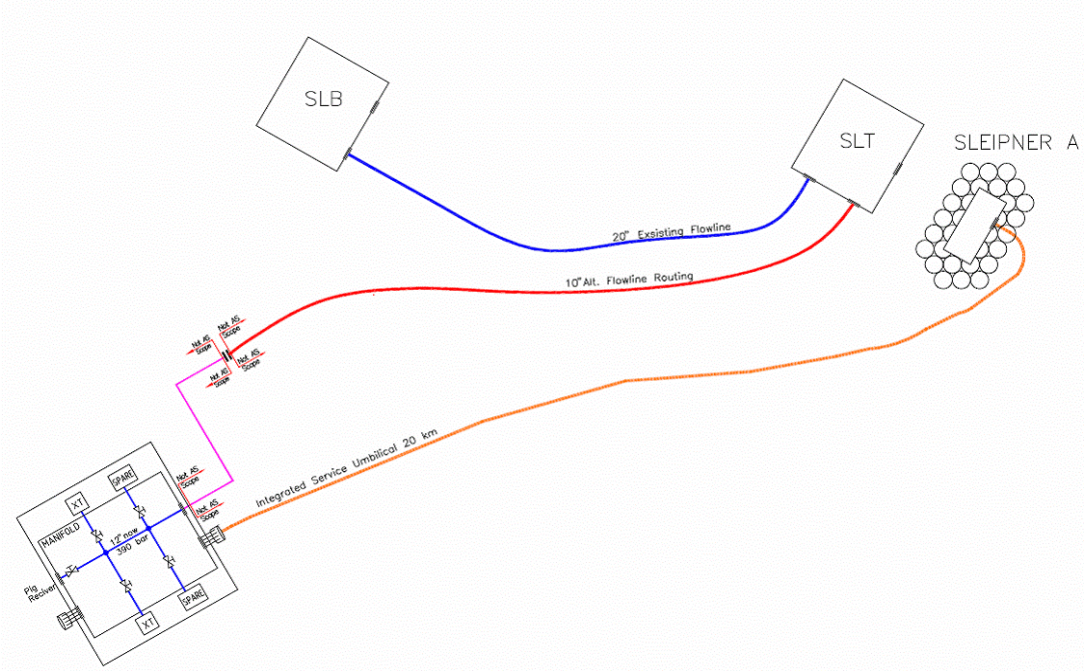


***Figure 3-4.*** *Alfa Sentral template with pipeline tie in to Sleipner T and umbilical to Sleipner A.*

### *3.5.2 Template Location*

Template location is based on a mid point between two proposed gas producers in the Alfa Sentral Field. The planned location of the template is given in the Table 3-1. Detailed location to be defined based upon site survey.

**Table 3-1.** *Planned location of template.*

| Projection: ED_1950_UTM_Zone_31N | | |
|---|---|---|
| Geographic | Lat: 58° 22’ 09,9” N | 01° 33’ 19,2” E |
| Projected | N: 6 470 895 m | E: 415 488 m |

### *3.5.3 Drilling*

Two wells (gas producers) are planned from a central template location, ref.Table 3-1, with both similar inclination and opposite azimuths. Gas producer GP1 has a well length of 4338 mMD (4300 mTVD) and GP2 4310 mMD (4272 mTVD). The wells will be built up below the conductor with 1-2 deg/ 30m to 8 degrees, and drilled to Total Depth; TD (base Sleipner formation).

The following hole sizes and casings are planned in the wells:

- 36” hole 30” casing set approx. 200 m TVDSS
- 26” hole 20” casing set below Utsira Fm. ~1200 m TVDSS
- 17 ½” hole 13 3/8” casing set below Heimal Fm. ~2800 m TVDSS
- 12 ¼” hole 9 5/8” casing set below Cromer Knoll/ Top of reservoir ~3600 m TVDSS

- 8 ½” hole (lower completion yet to be decided) to base Sleipner Fm. ~4300 m TVDSS

The Drilling Rig will be of a semisubmersible type. However, should availability and commercial issues dictate, there is a technical possibility to develop the Alfa Sentral using a Jack Up type drilling rig as well. A mooring layout map for drilling operations is given in Figure 3-5. Each line in the figure is 1500 m in length. Two or three anchors will probably be placed on the British side of the border line.

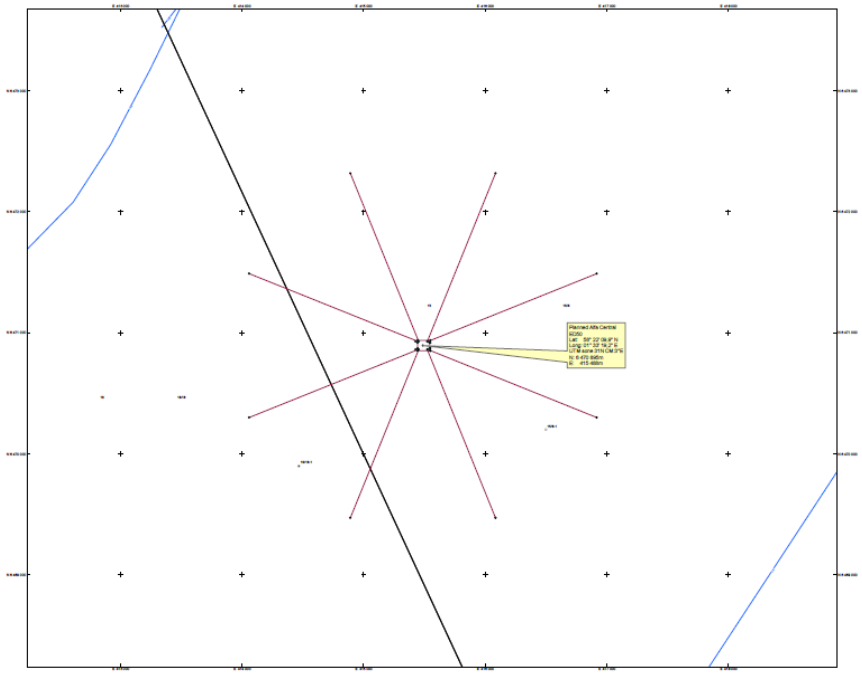

***Figure 3-5.*** *Mooring layout map for drilling operations at Alfa Sentral.*

Drilling fluids will be designed according to StatoilHydro governance documentation (WR0536 - Requirements to well fluids and related equipment). Most likely there will be used water based drilling fluids from sea floor down to 1200 m, and oil based drilling fluids further down. Cuttings from drilling with oil based mud will not be released to sea. Oily cuttings will either be fluidized and injected to well, or shipped to shore for proper handling.

Initial clean-up of the wells to the Sleipner T production facilities will be planned for, minimising the need for operating on a live well, with well stream to the drilling rig. However, back-up plans for flowing the wells to the drilling rig will be in place, should the initial clean-up through the subsea production equipment and pipelines be less desirable.

### *3.5.4 Sub Sea Production System*

The subsea production solution proposed for Alfa Sentral consists of one subsea structure with suction anchor or mud mats foundation, tied back to Sleipner T as host platform. The design life of the subsea production system is 20 years.

The subsea structure consists of a 4 well slots overtrawlable template, x-mass trees, manifold pipework and control system to facilitate production to the pipeline system. The control umbilical runs between Alfa Sentral and the Sleipner A platform. Chemical and hydraulic lines are distributed from the integrated control umbilical via single headers through the manifold to each well slot.

The pipeline system shall allow for pigging between the Alfa Sentral template and the Sleipner T platform.

The umbilical system shall be designed to transfer high pressure (HP) and low pressure (LP) control fluids, chemical injection fluids, annulus fluids, electrical power/signal and optical signals. The umbilical also contain a service line for well service and carriage of larger amounts of chemical fluids. The injection pressure shall meet the pressure at the injection point.

Primary communication with the subsea mounted control system shall be based on fibre communication with combined power and signal (CPS) as backup.

The system shall allow for MEG, scale, wax and asphaltene inhibitor injection. The injection pressure shall meet the pressure at the injection point.

Subsea hydraulic supplies are to be provided by a dedicated hydraulic power unit on the host platform topside, based on an open loop hydraulic system, whereby the discharged fluid is vented to sea.

### *3.5.5 Flow Assurance*

The hydrate control strategy is based on insulation pipeline to maintain a fluid temperature above the hydrate equilibrium temperature during normal production.

For a long planned shutdown the pipeline will be inhibited with MEG, and for a long unplanned shutdown the pipeline will be depressurised. Restart is performed by the compression method while injecting MEG until the temperature is above HET and rising. In the tail production continues MEG injection could be required.

Wax inhibitor will be required in the tail production due to a low temperature in the flowline. The Wax Appearance Temperature for the Alfa Sentral production is approximately 30°C.

Wax inhibitor at an injection rate of 200 ppm of the condensate production shall be included. New injection pump system for wax inhibitor should be installed. New storage capacity must be installed.

Scale inhibitor at an injection rate of 100 ppm of the water production shall be included. New injection pump system for scale inhibitor should be installed. New storage capacity must be installed.

Asphaltene inhibitor at an injection rate of 100 ppm of the condensate production shall be included. New injection pump system for asphaltene inhibitor should be installed. New storage capacity must be installed.

### *3.5.6 Pipeline*

Pipeline material alternatives are clad/lined material, Bubi pipe or stainless steel 13% Cr, 2.5% Mo, with a designed lifetime of 20 years. The internal diameter will be 10". The pipeline may be installed by reeling or S-lay. An anchored pipelay vessel may be used. At the Sleipner T platform the pipe will be pulled into an existing 20" J-tube on the West side of the platform.

A PLET, Pipeline End Terminator, will be installed at the end of the pipeline. A spool piece will be installed to connect the pipeline and template together. Protection will be installed to make the spool and termination over-trawlable.

### *3.5.7 Topside*

The main principle for Alfa Sentral tie-in to Sleipner is to use the existing processing and utility facilities. All process and utility systems shall be reviewed and need for modifications identified. A new riser will be pulled in and emergency valves and flow meter will be installed. The flow will be routed to the inlet separator and the gas further to the $CO_2$-removal facilities. The gas will then be exported to the Gasled system. The condensate will be exported to Kårstø, Norway.

## 3.6 Schedule

The internal decision-making process for the Alfa Sentral is as follows:

| | |
|---|---|
| DG1: | 18.6.2008 |
| DG2: | 03.3.2009 |
| DG3: | 18.6.2009 |
| Submission of PDO/FDP: | 26.6.2009 |

Abbreviations

DG: Decision Gate
PDO: Plan for Development and Operations (to Norwegian authorities)
FDP: Field Development Plan (to UK authorities)

Schedule of activities:

| | |
|---|---|
| Installation of template: | Third quarter 2010 |
| Drilling (two wells): | Fourth quarter 2010 |
| Installation of manifold: | First quarter 2011 |
| Laying of pipeline and umbilical: | Second quarter 2011 |
| Start-up production: | Third quarter 2011 |

# 4 Reserves and Production

## 4.1 Reserves

The reservoir of Alfa Sentral contains gas and condensate. The estimates of recoverable reserves are 2.9 billion $m^3$ (GSm3) sales gas, 1.7 million standard $m^3$ (MSm3) of condensate and 0.5 million tonnes of NGL (Table 4-1). In comparison, the recoverable reserves of the Sleipner West field were estimated to 133 $GSm^3$ sales of gas condensate and 48 $MSm^3$ (KU Sleipner West, 1991). Estimated reserves of the Alfa Sentral thus constitute ca. 2.0% and 3.1% of the previously estimated resources of gas and condensate from the Sleipner West.

Please notice that the estimates of recoverable reserves and production rates are uncertain.

***Table 4-1.*** *Estimates of recoverable reserves in the Alfa Sentral field per February 2009. "Expected" represents the amounts that have been used for the project economic calculations. "P90" is the estimated minimum amounts based within the 90% probability. P10 is a maximum estimate of 10% probability.*

| | **Condensate** ($MSm^3$) | **NGL** (Mill. tons) | **Gas** ($GSm^3$) |
|---|---|---|---|
| **Expected** | 1,7 | 0,5 | 2,9 |
| **P90** | 1,0 | 0,3 | 1,8 |
| **P10** | 2,5 | 0,7 | 4,1 |

## 4.2 Production

Scheduled start-up of the production from Alfa Sentral is autumn 2011, with peak production estimated in 2012. The production period is estimated to approximately 7 years. The expected production profile is shown in Table 4-2.

***Table 4-2.*** *Simulated production profile (updated per February 2009)*

| | Gas production | Condensate production | Water production |
|---|---|---|---|
| **Date** | **Mill Sm³/day** | **K Sm³/day** | **Sm³/day** |
| 01.okt.11 | 2.92 | 4.85 | 0.00 |
| 01.jan.12 | 3.63 | 4.85 | 0.00 |
| 01.apr.12 | 3.58 | 4.85 | 0.01 |
| 01.jul.12 | 3.74 | 4.85 | 0.83 |
| 01.okt.12 | 3.73 | 4.68 | 7.05 |
| 01.jan.13 | 3.24 | 3.97 | 151.45 |
| 01.apr.13 | 2.91 | 3.23 | 98.18 |
| 01.jul.13 | 2.43 | 2.67 | 0.02 |
| 01.okt.13 | 2.27 | 2.14 | 19.41 |
| 01.jan.14 | 1.94 | 1.77 | 25.69 |
| 01.apr.14 | 1.68 | 1.47 | 33.19 |
| 01.jul.14 | 1.33 | 1.15 | 77.54 |
| 01.okt.14 | 1.15 | 0.99 | 88.24 |
| 01.jan.15 | 1.01 | 0.84 | 87.93 |
| 01.apr.15 | 0.72 | 0.66 | 39.20 |
| 01.jul.15 | 0.64 | 0.59 | 36.09 |
| 01.okt.15 | 1.01 | 0.77 | 64.98 |
| 01.jan.16 | 0.87 | 0.71 | 66.64 |
| 01.apr.16 | 0.59 | 0.58 | 38.34 |
| 01.jul.16 | 0.54 | 0.54 | 38.70 |
| 01.okt.16 | 0.47 | 0.48 | 0.00 |
| 01.jan.17 | 0.52 | 0.51 | 0.00 |
| 01.apr.17 | 0.38 | 0.40 | 0.00 |
| 01.jul.17 | 0.43 | 0.44 | 0.00 |
| 01.okt.17 | 0.00 | 0.00 | 0.00 |
| 01.jan.18 | 0.34 | 0.38 | 0.00 |
| 01.apr.18 | 0.30 | 0.33 | 0.00 |
| 01.jul.18 | 0.33 | 0.38 | 0.00 |
| 01.okt.18 | 0.00 | 0.00 | 0.00 |
| 01.jan.19 | 0.30 | 0.33 | 0.00 |
| 1.apr.19 | 0.33 | 0.36 | 0.00 |

## 4.3 Production Increase on Sleipner

The production from the Sleipner West field has left plateau and is declining. The start up and tie in of Alfa Sentral will consequently not provide any real increase in production compared to the present conditions, but will slow down the reduction in production and emissions. Figure 4-1 shows the mean production forecast of Alfa Sentral based on a 50% probability together with the recent production forecast of the Sleipner West field. Figure 4-2 shows the high production forecast of Alfa Sentral based on a 10% probability.

The production levels for the whole Sleipner complex are shown in Figure 4-3. These production forecasts are based on the reports to the Revised National Budget 2006 (RNB 2006), which were used as baseline for the RIA-North Sea 2006.

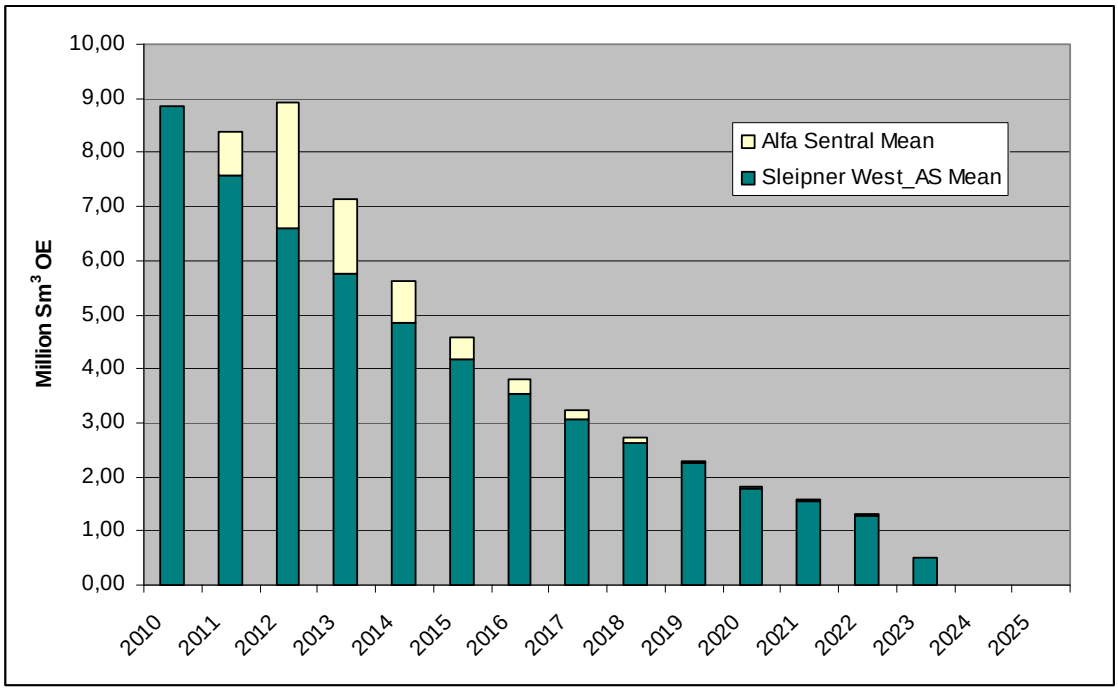


***Figure 4-1.*** *Recent production forecast of the Sleipner West field and the Alfa Sentral field presented as oil equivalents. The forecasts represent the mean estimated production of Alfa Sentral. The production forecast of Sleipner West is slightly reduced as compared to a production without the tie-in of Alfa Sentral.*

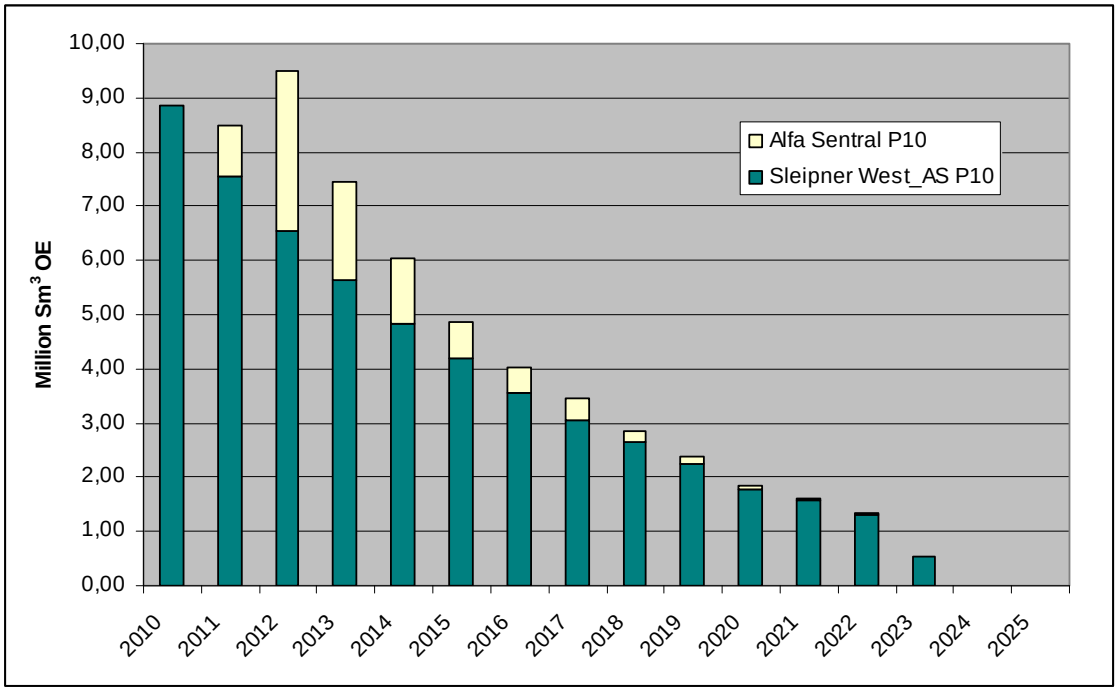


***Figure 4-2.*** *Recent production forecasts of the Sleipner West field and the Alfa Sentral field presented as oil equivalents. The forecasts represent the P10 estimate for Alfa Sentral production. The production forecast of Sleipner West is slightly reduced as compared to a production without the tie-in of Alfa Sentral.*

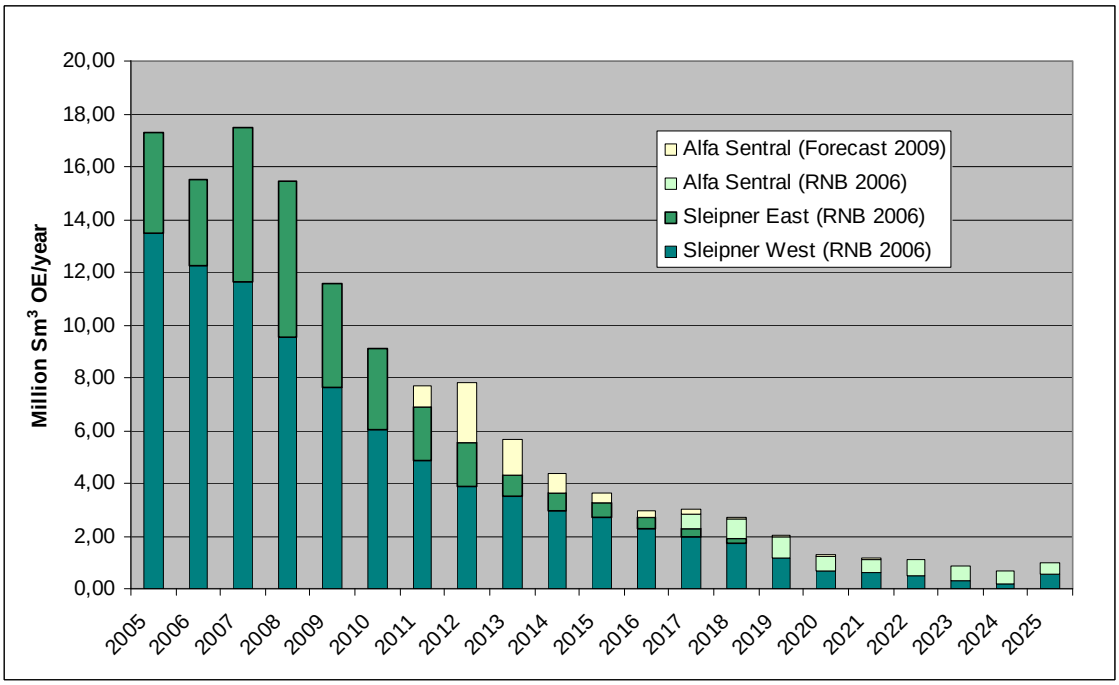


***Figure 4-3.*** *Production forecasts of Sleipner West, Sleipner East and Alfa Sentral converted into oil equivalents. Based on data from the RIA-North Sea 2006. For Alfa Sentral it is also shown an updated production forecast from 2009 (mean).*

## 4.4 Produced Water

Preliminary simulations indicate a total water production of 80-100 $m^3$/day from the Alfa Sentral field. In comparison, forecasted average water production at Sleipner West in 2011 was ca. 1100 $m^3$/day (RIA-North Sea 2006). For Sleipner East the forecast was ca. 550 $m^3$/day.

Table 4-3 below gives estimated produced water volumes for SLT and Alfa Sentral. A PE (Production Efficiency) factor of 92.1% has been used for Alfa Sentral estimates.

***Table 4-3.*** *Produced water volumes.*

| Produced water volumes [$Sm^3$] | | | |
|---|---|---|---|
| **Year** | **SLT excl. Alfa Sentral** | **Alfa Sentral** | **SLT incl. Alfa Sentral** |
| 2011 | 22 970 | 0 | 22 970 |
| 2012 | 19 840 | 663 | 20 503 |
| 2013 | 20 210 | 22 612 | 42 822 |
| 2014 | 20 350 | 18 881 | 39 231 |
| 2015 | 20 500 | 19 178 | 39 678 |
| 2016 | 21 110 | 12 075 | 33 185 |
| 2017 | 18 390 | 0 | 18 390 |
| 2018 | 14 180 | 0 | 14 180 |
| 2019 | 3 830 | 0 | 3 830 |
| **TOTAL** | 161 380 | 73 409 | 234 789 |

In 2009 Sleipner will initiate injection of produced water into the Utsira Formation. It is expected 90% injection. The water production from Alfa Sentral will be injected together with produced water from the Sleipner fields. Thus the discharge increase of produced water on Sleipner due to the tie in of Alfa Sentral will be insignificant.

Figure 4-4 shows the historical discharges (until 2007) and the expected amount of produced water for Sleipner East (including Sigyn) and Sleipner West with and without injection. Since 2005 it has been a marked increase in the amount of produced water on the Sleipner East. The reason for this is that the amount of produced water typically increases significantly as the wells get older. Sleipner East went off production plateau in late 2005. In periods with large amounts of produced water Cetco filter has been used (Zero discharge report 2008 Sleipner field).

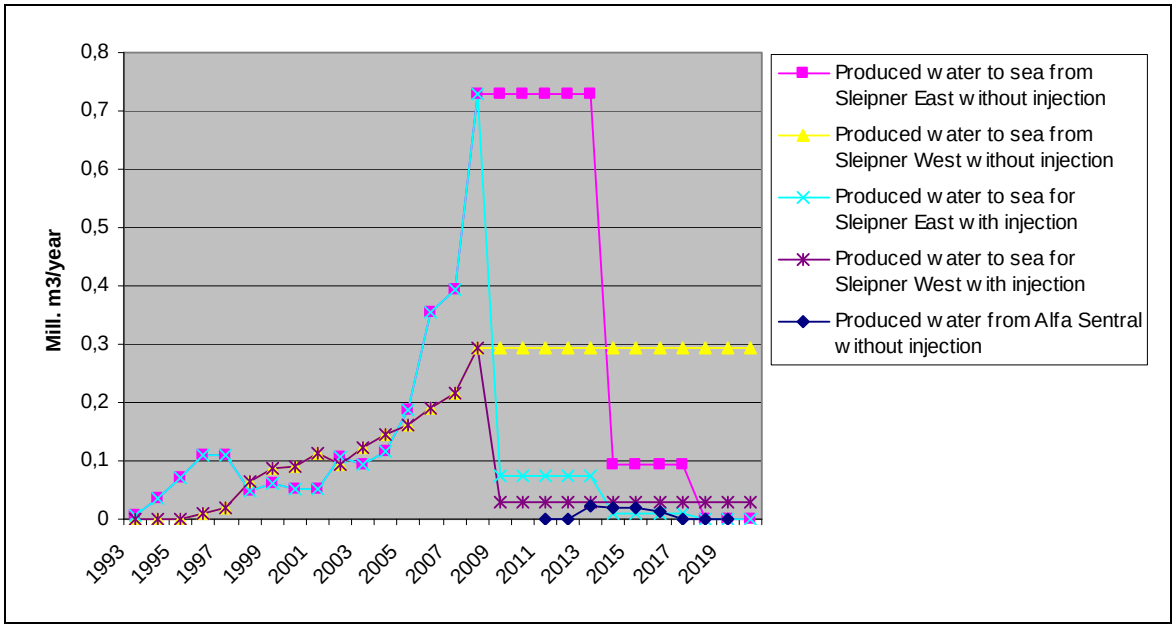


***Figure 4-4.*** *Historical and anticipated discharge of produced water for the Sleipner field, with and without injection. It is estimated 90% injection from 2009. Source: Zero discharge report 2008 Sleipner field.*

# 5 Measures to Minimize Environmental Impacts

## 5.1 Chemicals

According to Norwegian legislation, chemicals used in the petroleum industry on the Norwegian continental shelf shall be categorised into 4 different categories based on ecological toxicity:

- Green (PLONOR): Chemicals on the OSPAR's PLONOR list, regarded to cause no or negligible negative impact on the environment
- Black: Chemicals that normally are not allowed into the environment
- Red: Chemicals presenting a potential environmental risk, and thereby should be replaced
- Yellow: All other chemicals in use which are not covered by the other categories.

In connection with the development of Alfa Sentral no chemicals categorised as black will be used. The use of red chemicals and yellow chemicals impacting EIF (Environmental Impact Factor) will be minimised. Chemical selection will be based on best available technology (BAT) principles.

Due to low biodegradability of the dye component, the control fluid currently used at the Sleipner installations is classified as environmentally red by the Norwegian Pollution Directorate (SFT). Alfa Sentral is investigating the possibility of using a yellow control fluid from another manufacturer, however this might cause some logistics problems at Sleipner.

## 5.2 Drill Cuttings, Oily Drainage Water and Produced Water

Cuttings from drilling with water based drilling fluid will be discharged to sea. Cuttings from drilling with oil based mud will either be fluidized and injected into well or transported to shore for proper handling.

Oily drainage water shall be injected or discharged to the sea. If drainage water is discharged to the sea, the oil in water concentration shall be below 30 mg/l.

Produced water will be handled together with Sleipner A produced water and injected to the Utsira formation. A minimum of 90% regularity is expected.

## 5.3 Subsea Infrastructure

All subsea infrastructures will be made over-trawlable according to current Norwegian regulations and internal StatoilHydro requirements. It is will be no subsea installations on the British side of the border line.

## 5.4 Pipeline Installation

Chemicals used to prevent fouling, and the dyes used for pressure testing and leakage search will be environmentally friendly, only green and yellow chemicals will be used. The pipeline will be protected by trenching and later covered by with rock/gravel. The umbilical will be trenched and rock dumped where required. Alternative protection with rock dump only may be evaluated.

# 6 Environmental Aspects in the Influenced Area

Environmental aspects in the influenced area on the Norwegian continental shelf are described in the Regional Impact Assessment of the North Sea (RIA-North Sea) from 2006. As well as describing the environmental conditions of the North Sea, the RIA also describes present and planned development and production in the North Sea region, and assesses potential and significant environmental impacts. After a period of public consultations the RIA-North Sea was approved by the Ministry of Petroleum and Energy in 2007. The whole document with subject reports in Norwegian language is available at: http://www.statoilhydro.com

The assessed area is represented by an activity area, as well as an area that could be affected by activities in this activity area. Together, this is referred to as the influenced area. The extent of the influenced area will vary between different types of activities. Most of the information in the present chapter is collected from the RIA-North Sea 2006. Where other sources are used this is referred in the text. RIA-North Sea is covering the sea areas between Norway's southern continental shelf boundary and 62 ° N. For some subjects this area is divided into four sub regions: North, Middle, Southeast and Southwest. Sleipner and Alfa Sentral are located in the sub region referred to as "Central" (Figure 6-1).

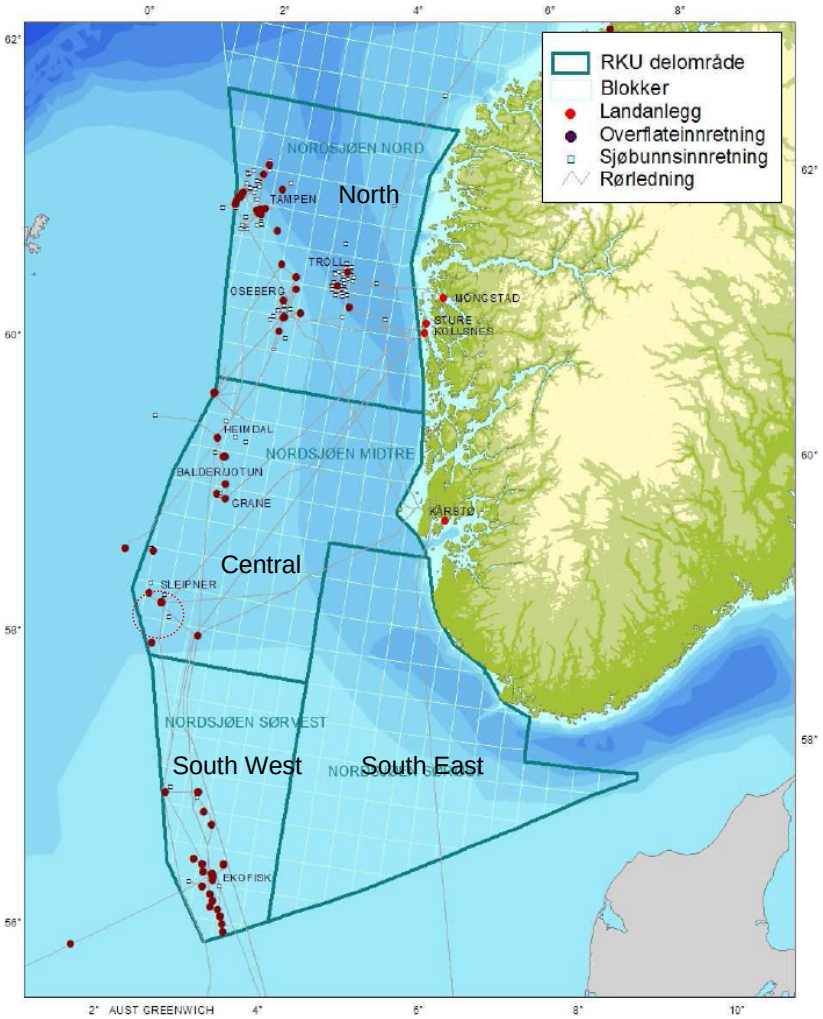


***Figure 6-1.*** *Activity area for RIA-North Sea. The Sleipner marked by a red circle is located in the sub region referred to as Central.*

In UK the Strategic Environmental Assessment (SEA) is the process of appraisal through which environmental protection and sustainable development may be considered, and factored into national and local decisions regarding Government (and other) plans and programmes – such as oil and gas licensing rounds. On UK continental shelf the area that potentially can be influenced by the development of Alfa Sentral lies within the SEA region 2 (Figure 6-2). SEA2, whose area includes the majority of existing oil and gas fields in the North Sea, was completed in December 2001.

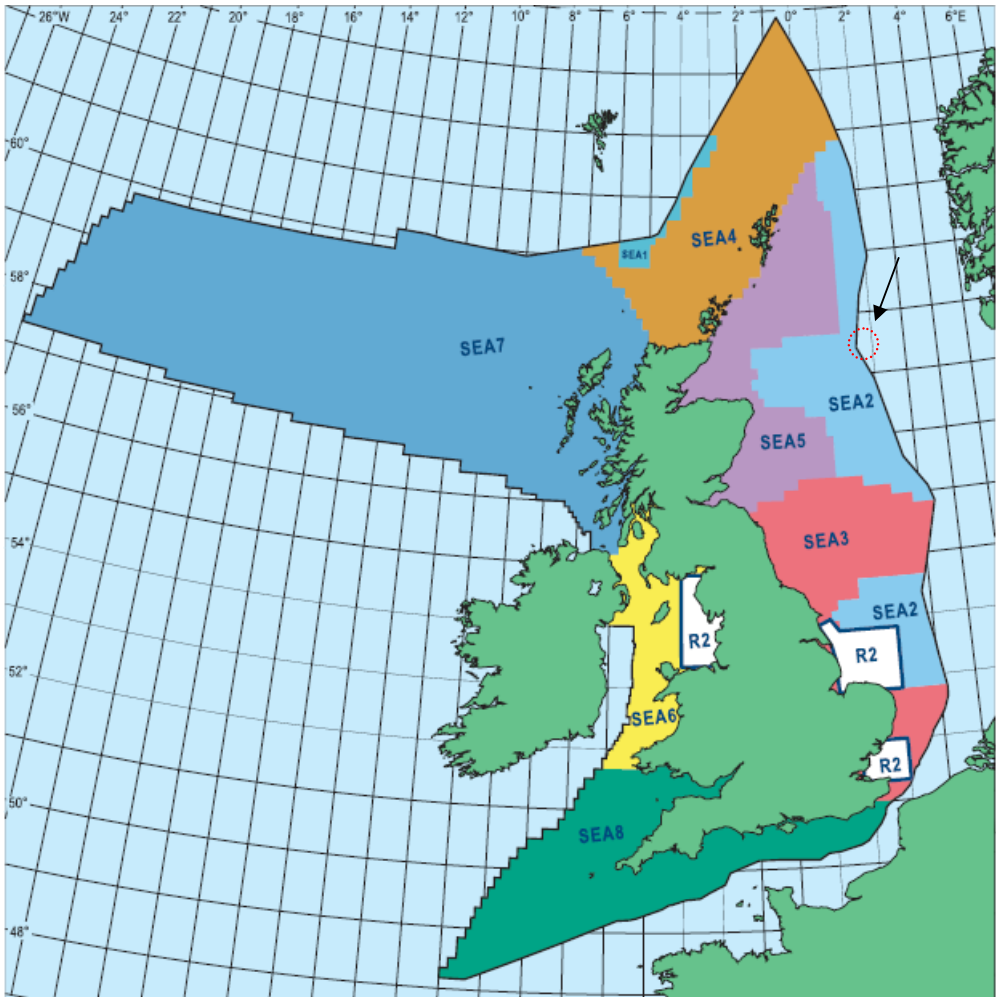


***Figure 6-2**. Regions covered by the Strategic Environmental Assessment (SEA). The area potentially influenced by Alfa Sentral on the UK continental shelf lies within the SEA2 region.*

## 6.1 Environmental Conditions and Natural Resources

### *6.1.1 Physical Conditions*

The North Sea is a shallow sea compared to the Norwegian Sea and the Barents Sea. Two-thirds of the North Sea is shallower than 100 m. The deepest part is the Trough near the Norwegian Coast, which has depths of more than 700 m (in the Skagerrak), and that extends from the Skagerrak and up along the west coast. Depth of the Norwegian Trench is at 270 m (outside Jæren), while it is deeper, both further north and further south (Figure 6-3). Depth conditions are important for circulation, since the topography to a major extent govern the water mass movement.

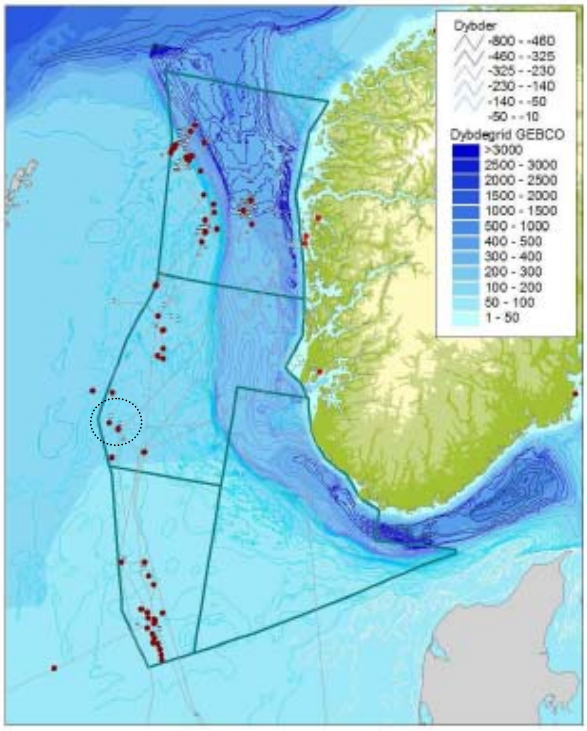


***Figure 6-3.*** *Water depths in the North Sea. The Sleipner area is marked with a dotted circle.*

The North Sea and Skagerrak is a meeting place for Atlantic water and freshwater, which initially have different properties with respect to specific gravity, salinity and temperature. The water in the North Sea moves mainly against the clock, it turns into the Skagerrak and then continues north as part of the Norwegian coastal current (Figure 6-4). Variations in the currents have great impact on the ecosystem in the North Sea. In the winter vertical circulation is high in most areas, which implies very low difference in water mass properties between the upper and lower layers. In summer, the warming of upper water layer causes a clear temperature leap at 20-50 m depth.

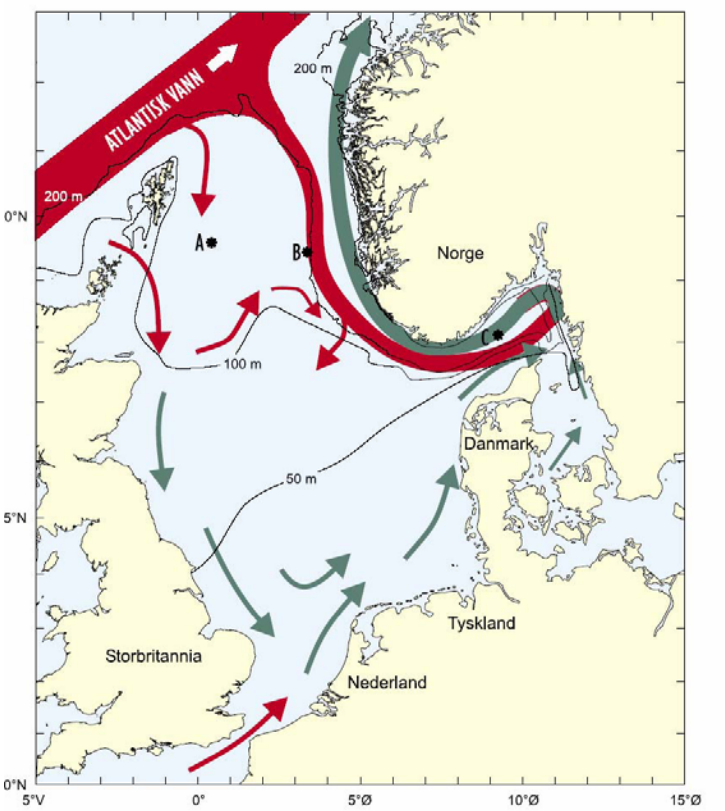


***Figure 6-4.*** *The most important features of the circulation patterns and depth conditions in the North Sea and Skagerrak. Red arrows: Atlantic water. Green arrows: coastal waters.*

### *6.1.2 Human Influence*

The ecosystem of the North Sea is significantly influenced by human activity. There is much traffic and the area has many activities such as a large fishery, development of oil and gas, take out of sand and gravel and dumping of sludge. Around the North Sea lie densely populated and highly industrialized states, with the consequence that the eco system is influenced by pollutions from construction, agriculture and industry. Pollutions largely originate from the rivers that flow into the North Sea. The North Sea is also affected by the inflow from the Baltic Sea.

### *6.1.3 Plankton*

The planktonic community is composed of a range of microscopic plants (phytoplankton) and animals (zooplankton) that drift with the oceanic currents. These organisms form the basis of marine ecosystem food chains and many species of larger animals such as fish, birds and cetaceans, are dependent upon them. The distribution of plankton, therefore, directly influences the movement and distribution of other marine species.

The most common phytoplankton groups are the diatoms, dinoflagellates and the smaller flagellates. Together they are responsible for most of the primary production in the North Sea. The most abundant group of zooplankton is the copepods, dominated by *Calanus* spp. The larger zooplankton (or megaplankton) includes the euphausiids (krill), thaliacea (salps and doloids), siphonophores and medusae (jellyfish). Blooms of salps and doloids produce large

swarms of individuals in late summer to October, which deplete food sources for other herbivorous plankton. Krill is abundant throughout the North Sea and is a primary food source for fish and whales (DTI 2001).

Plankton communities in the vicinity of Sleipner and the Alfa Sentral field are expected to be typical of those of the central North Sea.

### *6.1.4 Benthic Communities*

Seabed sediments are utilised as a habitat and nutrient source by organisms living either in, on or in close association with the seabed. The distribution of benthic fauna is influenced by water depth and sediment type. Other important factors include the influence of different water masses and the food supply to the benthos. Fluctuations in benthic populations may also be caused by natural spatial or temporal variations in the environment, as well as by pollution-induced effects. For example, the typical infaunal community response to organic disturbance is a reduction in species richness and diversity, usually accompanied by an increase in the density of species which are able to exploit disturbed environments.

Benthic communities in the vicinity of Sleipner and the Alfa Sentral field are expected to be typical of those of the central North Sea.

Regional Environmental- and Baseline Surveys are conducted every third year on the Norwegian continental shelf. These surveys make analyses of the sediments and of the benthic communities. Alfa Sentral is located in the Region II and will be included in the 2009 survey program, which takes place in late May or early June.

Pockmarks are depressions or craters in the seabed. In the North Sea they range from less than 0.5 m to approximately 20 m in depth and from 1 m to more than 1 km long (Hovland & Judd, 1988). The North Sea pockmarks are typically roughly circular or ellipsoidal at the top and cone-shaped in cross-section, although they may also be irregular in cross-section, with the long axis being typically parallel to the bottom current direction. It is generally believed that pockmarks are formed by the expulsion of fluid, either gas or water through seafloor sediments. Most pockmarks are relict features, but a few continue to leak natural gas and may contain carbonate structures.

The leaking of hydrocarbons in pockmarks leads to local enrichment of organic material, which in turn gives the foundation for increased local production. Such enrichment of nourishment has been connected to the presence of cold water corrals (Hovland & Mortensen 1999).

There are no known pockmarks in the Alfa Sentral field. The closest registered pockmarks are in the UK sector; the 20 m deep "Scanner" pockmark in block 15/25 and the “Braemar” pockmarks in block 16/3.

No coral reefs have been found in the open waters of the North Sea. Thus, it is not likely that any coral reefs will be affected by the Alfa Sentral.

### *6.1.5 Fish*

Fish constitute the largest part of the living resources in the North Sea. The pelagic component is dominated by herring and sprat, which are located in the North Sea all year. Mackerel (*Scomber scomrus)* and horse mackerel (*Trachurus trachurus*) are mainly present in summer when they enter the North Sea from the south and northwest. The dominant gadoid fishes are

cod (*Gadus morrhua*), haddock (*Melangrammus aeglefinus*), whiting (*Merlangius merlangus*) and saithe (*Pollachius virens*), while the most important flat fishes are plaice (*Pleuronectes platessa*), American plaice (*Hippoglossoides platessoides*), dab (*Limanda limanda*), common sole (*Solea solea*) and lemon sole (*Microstomus kitt*). The most important prey fishes are great sandeel (*Hyperoplus lanceolatus*), herring (*Clupea harengus*), sprat (*Sprattus sprattus*) and Norway pout (*Trisopterus esmarkii*). The total amount of fish in the North Sea has varied between 11 and 15 million tonnes in the last 20 years. In addition to the variation in total biomass, there is a variation in the relative distribution of biomass between species.

Several vulnerable fish species that previously were quite common in the North Sea have completely disappeared (e.g. tuna), or become very rare (e.g. halibut). Most cartilaginous fish are on a low population level. Spiny dogfish was previously common in the North Sea, but now the biomass is only about 5% of the original population size. Most ray species are also at a low level and have disappeared from large parts of the North Sea. These problems are mostly related to high fishing pressure, but also the ongoing temperature increase cause many southern species to move their territory northward.

Of commercially important fish species, Norway pout and mackerel spawn in the regions around Sleipner. The Sleipner Area is centrally located in the North Sea, and current conditions, implies that the eggs and larvae of other fish species can drift into the area. This applies, for instance, for saithe and haddock, which spawn north of Sleipner.

Juvenile fish, in particular ecologically sensitive demersal spawning species such as sandeels, herring and Norway lobster (*Nephrops norwegicus*), are vulnerable to any physical disturbance of their spawning and nursery grounds that may be caused by operations to install the template and the pipeline. The proposed activities lies within spawning grounds for cod, haddock, saithe and Norway pout. Most of these species are considered to be less sensitive because of their widespread distribution and extensive spawning areas. However, this region of the North Sea constitutes an important area for cod spawning activity.

### *6.1.6 Seabirds*

Internationally important numbers of seabirds breed on the coastal margin of the North Sea, and rely on the offshore North Sea for their food supply and habitat.

Pelagic diving seabirds might be found in the influenced area during both summer and winter, but the areas around Sleipner and Alfa Sentral are not characterised by any greater significance than any other open sea areas. High seabird vulnerability in this area is identified in November and February (Figure 6-5).

Seabird vulnerability to surface pollution varies throughout the year with peaks in late summer, following breeding when the birds disperse into the North Sea, and during the winter months with the arrival of over wintering birds. In general, seabird vulnerability is highest in inshore waters. (DTI 2001a).

Seabirds populations are vulnerable to surface pollution, particularly oil. Guillemot, razorbill and puffin are at their most vulnerable to oil pollution in their moulting season, when they become flightless and spend a large amount of time on the water surface. As the Alfa Sentral is a gas and condensate field the potential impact on seabirds is regarded as very low on an individual level and negligible on a population level.

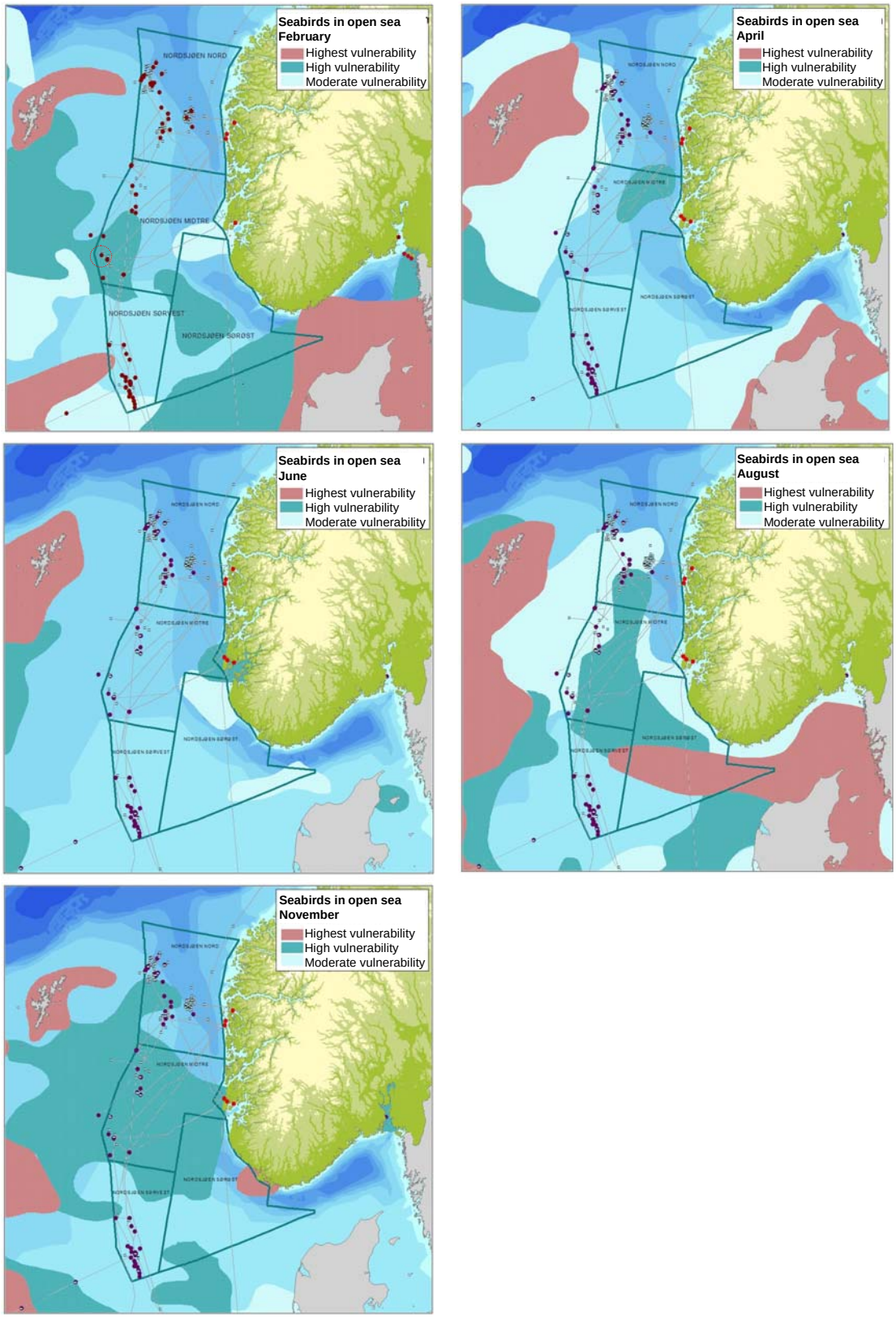


***Figure 6-5.*** *Areas in the open sea of relative importance to seabirds in different months of the year (Source: RIA-North Sea 2006). The area of Alfa Sentral and Sleipner is indicated by a red circle in the first map.*

## 6.2 Marine Animals

The waters of the North Sea support a wide variety of marine mammals, with internationally important numbers of grey and common seals. A wide range of cetaceans has been sighted in the North Sea, the most common being the harbour porpoise, minke whale and white beaked dolphin. Bottlenose dolphins from the nearshore population of the Moray Firth are rarely seen far offshore (DTI 2001a).

Marine mammals are vulnerable to chemical discharges, acoustic disturbance from vessel operations and injury from collisions with vessels. The effects of noise on marine mammals range from mild irritation through impairment of foraging behaviour to hearing loss, and in extreme cases injury or death (DTI 2001b). Although there is no evidence to show that vessel noise adversely affects seals or small cetaceans, there are indications that large whales may avoid areas of intense activity (DTI 2001a).

## 6.3 Protected areas

There are no proposed marine protected areas that may be affected by the development of Alfa Sentral.

## 6.4 Fishing Areas

Data regarding fisheries are excerpted from the Fisheries Assessment Report, a baseline report to the RIA-North Sea. Alfa Sentral is located within the fishery location 42-14 (Figure 6-6). In the Sleipner Area the majority of fishery activities take place in the eastern parts. In the western parts, where the installations are situated, there is moderate trawl fishing for saithe. Tracking data of foreign vessels show some activity in the far west of the Sleipner Area (Main area 42).

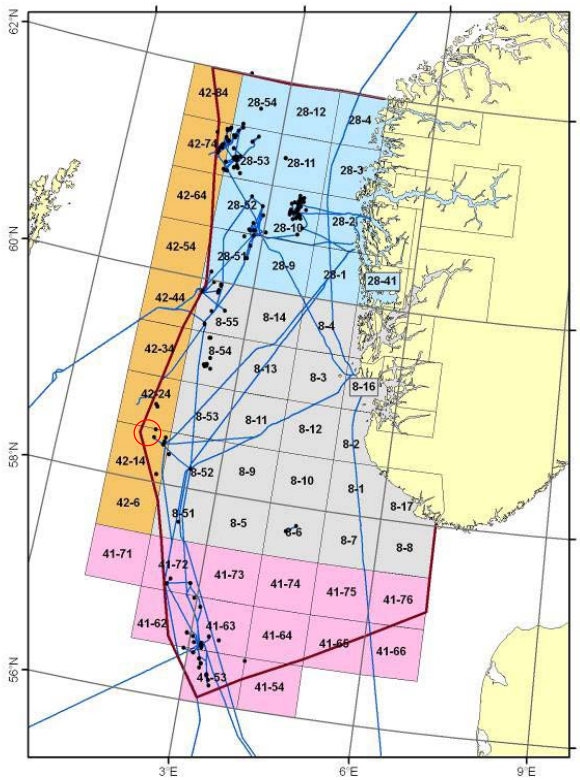


***Figure 6-6.*** *Main areas and locations for the reporting of fish catches (Standards of ICES and Norwegian Directorate of Fisheries).*

*The fishing areas are shown in different colours. Each single square represents one Fishing location. Alfa Sentral is situated in the fishing location 42-14 (orange).*

*The area of Sleipner and Alfa Sentral is marked by a red circle. Petroleum installations are marked by black spots, and main pipelines are marked by blue lines.*

Catch data from 2000, 2002 and 2004 show that within the Main areas (Figure 6-6) in the Norwegian sector there is mainly Norwegian fishing activity. Norwegian catches constituted 68-78% of the total catch, while the Danish and British catches represented 15-21% and 6-10%, respectively. In the main area 8 (coloured gray in Figure 6-6) the majority of the catch was taken by bottom trawl and seine net, each with a share of more than 40%. In the west, in area 42 where Alfa Sentral is located, more diverse fishing gear is being used. About 47% of the catch is here taken with float trawl, while bottom trawl constituted ca. 26% and seine net ca. 12%.

Tracking data from the area around the Alfa Sentral suggest that the fishing activity here primarily consists of foreign vessels, mainly British and some Danish. In connection with the communication to the Norwegian Directorate of Fisheries and the fishery organizations, a separate tracking map with data on fishing activity in this area has been prepared (App. C).

## 6.5 Cultural Heritage and Relicts of the Past

There are no registered cultural relicts in the Alfa Sentral Area. Generally two types of cultural heritage can occur on the Norwegian Shelf: findings from the Stone Age and the discoveries of shipwrecks. In the REIA-North Sea it is assumed a depth limit for the possible discovery of the Stone Age relicts of about 140 m. Alfa Sentral is located at 110-120 m depth, and it is thus a theoretical potential for discoveries from the Stone Age

## 6.6 Environmental sensitivities

A summary of the key features of the offshore environment in the influenced area, and their seasonal patterns of activity or sensitivity is given in Table 6-1 below.

***Table 6-1.*** *Seasonal environmental sensitivities in the influenced area.*

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Plankton**<br>The planktonic community is potentially sensitive to chemical releases into the sea. The planktonic community in the vicinity of the proposed activities is typical of the central North Sea and has the capacity to recover quickly because there is a continual exchange of individuals with surrounding waters. Any impacts associated with the proposed operations are likely to be small in comparison with natural variations. | | | | | | | | | | | |
| **Benthic Fauna**<br>Benthic communities in the area of the proposed activities are similar to those found throughout the surrounding area of the central North Sea and no rare species are known to occur in this area. Benthic faunal communities are vulnerable to physical and chemical disturbances to the sediment. | | | | | | | | | | | |
| **Fish**<br>Juvenile fish, in particular ecologically sensitive demersal spawning species such as sandeels, herring and Norway lobster, are vulnerable to any physical disturbance of their spawning and nursery grounds. Finfish and shellfish are vulnerable to pollution, such as oil and chemical discharges, especially during the egg, larval and juvenile stages of their lifecycle. The proposed activities lies within spawning grounds for cod, haddock, saithe and Norway pout. Most of these species are considered to be less sensitive because of their widespread distribution and extensive spawning areas. | | | | | | | | | | | |
| **Marine Mammals**<br>Harbour porpoise are the most commonly recorded cetacean in this area; numbers are greatest in July. Other species of cetaceans recorded in the area are killer whale, minke whale, white-beaked dolphin, white-sided dolphin and Risso's dolphin. Marine mammals are vulnerable to chemical discharges, acoustic disturbance from vessel operations, and injury from collisions with vessels. Marine mammals can easily avoid disturbed areas. | | | | | | | | | | | |
| **Seabirds**<br>Seabird populations are vulnerable to surface pollution, particularly oil. However, Alfa Sentral is a gas and condensate field and potential negative impacts on seabirds from the planned activities are therefore regarded to be low. | | | | | | | | | | | |
| **Fishing Activity**<br>Fishing activity is considered to be low in the eastern part of the influenced area and moderate to high in the western part around the template. | | | | | | | | | | | |
| **Conservation Areas and Species**<br>There are no protected areas that may be influenced by the planned development of Alfa Sentral. Based on generally available information and survey data from the pipeline route there are no reef habitats in the area of the proposed pipeline. Neither have any objects of cultural heritage importance been identified in the area. The harbour porpoise (mentioned above) is the only Annex II species known to occur in this region of the North Sea. | | | | | | | | | | | |

| **Key to Level of Sensitivity / Activity** | |
|---|---|
| | Very high |
| | High |
| | Moderate |
| | Low |

# 7 Potential Environmental Impacts

This section gives a budget for emissions to air, discharges to sea, physical impacts on seafloor and physical presence of subsea infrastructure as caused by the development of Alfa Sentral. The potential environmental impacts are described. Accidental events are also considered.

In general the development of Alfa Sentral will result in only minor potential environmental impacts. During the construction phase there will be activities from vessels and drilling close to the UK border. During the production phase all emissions to air will come from the existing Sleipner complex. Produced water from Alfa Sentral will be sent for injection together with the produced water from the Sleipner fields.

## 7.1 Emissions to Air

Sleipner has left production plateau and the processing of the stream from Alfa Sentral will consequently use this free capacity on the Sleipner complex. This implies that Alfa Sentral will not cause any increase of emissions to air from Sleipner compared to the present conditions.

The gas from the Alfa Sentral has a high content of $CO_2$ (ca. 20%). Most of the $CO_2$-content will be separated and injected into the Utsira Formation. The rest concentration of $CO_2$ will under normal conditions be ca. 5%. The gas from Alfa Sentral will be blended into the Sleipner gas (SLB, Alfa North and Alfa Sentral) before it is exported to Gassled, and further on to the consumers. No $CO_2$ extracted from the gas stream will be vented to air.

The following activities will cause emissions to air:
- Drilling and well operations
- Marine operations (installation of template, pipeline, etc.)
- Operation/processing on Sleipner
- Injection of $CO_2$ and produced water
- Transport of gas and condensate

For drilling and completion, a separate, floating drilling rig will be used, and emissions to air will occur from this. The drilling will give emissions of $CO_2$ and NOX, as well as smaller amounts of $SO_2$ from diesel engines on the rig. A potential need for testing and cleaning of the wells may also give some emissions to air.

Marine operations in connection with the installation of subsea equipment and pipeline laying and cables will give emissions of $CO_2$, NOX and $SO_2$ from diesel engines on ships.

In the operational phase, all emissions to air occur from the Sleipner installations. The main components that are released into the air are $CO_2$, NOx, $CH_4$, and $N_2O$ nmVOC. The emissions of these gases come from the following sources:

- Gas turbines (without low-NOx technology)
- Diesel engines (fire water pumps and emergency generators etc.)
- Diffuse emissions from processing
- Emissions from flaring

Processing, injection and transport require energy, which in turn will lead to emissions. It is especially the export of gas and condensate, which require energy. There will be no need for

installation of new power production or process equipment at Sleipner as a result of the development of the Alfa Sentral.

There are a total of 11 turbines on the Sleipner Installations. Sleipner A has 3 Dual Fuel (DF) LM2500 generator drivers, of which one is prepared for low-NOx (DLE). Sleipner A has 5 Single Fuel (SF) LM2500 PE compressor drivers. Sleipner T has 3 SF LM2500 PE compressor drivers which all are prepared for low-NOx. At present none of the turbines have low-NOx technology. SFT (Norwegian Pollution Directorate) stated in the current Frame Discharge Permit for Sleipner that they consider the technology used in the energy plants on the Sleipner Field as satisfactory in relation to BAT.

The development of Alfa Sentral will utilize a part of the processing capacity and export capacity, and thus contribute to the total emissions from the Sleipner installations.

It is estimated that Alfa Sentral will represent a maximum electric load of 3400 kW (in 2012). Total load on the Sleipner plants is currently 54 440 kW.

Potential environmental impacts of the emissions to air are summarized in table 7-1.

***Table 7-1:*** *Potential Environmental Impacts of Atmospheric Emissions*

| **Type of Emission** | **Environmental Impact** |
|---|---|
| Carbon Dioxide ($CO_2$) | A Greenhouse Gas (GHG) with potential climate effects |
| Methane ($CH_4$) | Contributes to Low-level ozone production, along with other hydrocarbons and NOx. A Greenhouse Gas (GHG) with potential climate effects |
| Carbon Monoxide (CO) | Can be oxidised to $CO_2$, a GHG, but is primarily a local air pollutant that can be toxic at high concentrations. |
| Oxides of Nitrogen (NO and $NO_2$) | Contributes to acid deposition, fertilizing of soil, and may also contribute to ozone formation when mixed with volatile organic compounds in sunlight. |
| Oxides of Sulphur (SOx) | Contributes to acid deposition and toxic gas. |
| Nitrous Oxide ($N_2O$) | A Greenhouse Gas (GHG) with potential climate effects |
| Volatile Organic Compounds (VOC) | May promote the formation of photochemical oxidants (ozone) |

## 7.2 Emissions to Air – Environmental Budget Sleipner

This chapter presents the estimated emissions to air from the Sleipner complex due to the tie-in and production of Alfa Sentral. All data in connection with the environmental budget are excerpted from the Environmental Report “Alfa Sentral tie-in to Sleipner” (Aker Solutions 2009).

Main sources of emissions to air from Alfa Sentral are:

- Turbines driving generators (power generation)
- Turbines driving compressors (compressor work)
- Flaring

Note that the total loads on pre compressor and export compressor are assumed to be constant 20 MW due to the operation philosophy for existing facilities, independent of tie-in of Alfa Sentral. Hence, tie-in of Alfa Sentral does not results in an increase in total emissions to air from SLT associated with changes in the pre compressor and export compressor loads. However, tie-in of Alfa Sentral changes the fuel gas composition and thus the Lower Heating Value (LHV), which gives higher fuel gas consumption to be able to generate the 20 MW required power.

Hence, there will be a small increase in total emissions to air from the pre compressor and export compressor following Alfa Sentral tie-in.

Emissions to air from the above combustion processes include $CO_2$, $NO_x$, $CH_4$ and nmVOC.

Note that for power generation, only emissions related to main power generation are included in this budget. Emissions to air in connection with emergency power, fire water generators etc. are not included in the budget due to a relatively low contribution to the overall emissions.

## 7.3 Emissions to air in connection with power generation

Emissions to air associated with power generation (main power) are based on expected electrical load figures. Tie-in of Alfa Sentral to SLT will give an increase in the electrical load mainly from:

- Two recompression trains on SLT, each consisting of two recompressors with one common electrical driver
- Condensate pipeline pumps

SLA has three 20 MW turbine driven generators to produce the required power. In addition SLT has two Pelton generators, producing a maximum of 4.5 MW, that run on energy released from the amine plant, i.e. there are no emissions from fuel gas combustion related to energy production from the Pelton generators. The profits from this emission-free energy production have not been accounted for in this budget.

Turbine fuel gas consumption in connection with generating the required power is calculated from the formula:

$$Fuel\ gas\ consumption = \frac{Operational\ time\left[days\ /\ year\right] \times Electric\ load\left[MW\right]}{Lower\ heating\ value\left[MJ\ /\ Sm^3\right] \times Turbine\ power\ efficiency}$$

The operational time of the turbines, i.e. number of days running per year, depends on the availability of the turbines and generators. For simplicity it is assumed that the availability of the turbines/generators is 92.1 % (Production Efficiency value for Sleipner West) as the electric load is weighted towards the production profile. The operational time of the generators is thus 336 days per year with full load.

The dual fuel turbines run on diesel mainly during revision stops. As the power consumption on SLT during revision stops is low, emissions from diesel combustion is omitted from the budget.

A Lower Heating Value of 43.2 MJ/$Sm^3$ has been used for SLA fuel gas with 3.1 mol% $CO_2$ content, based in HYSYS simulations.

Turbine power efficiency is assumed to be 35 %.

The fuel gas consumption is used to calculate the emissions of $CO_2$, $NO_x$, $CH_4$ and nmVOC. Total increase in emissions to air from power generation due Alfa Sentral is calculated to 45.2 ktonnes $CO_2$ equivalents with an average of 5.0 ktonnes per year during the operational lifetime.

## 7.4 Emissions to air in connection with compressor work

Emissions to air associated with turbine driven compressors are based on expected compressor load figures for:

- Pre compressor
- Export compressor
- $CO_2$-injection compressors

The compressor loads are simulated in HYSYS only for production year 2011, i.e. assumptions have been made for production years 2012-2019:

- Total loads on pre compressor and export compressor are assumed to be constant 20 MW per year due to the operation philosophy for existing facilities, independent of Alfa Sentral tie-in. Hence, tie-in of Alfa Sentral does not results in an increase in total emissions to air from SLT associated with changes in the pre compressor and export compressor loads. However, tie-in of Alfa Sentral changes the fuel gas composition and thus the Lower Heating Value of the fuel gas. A decrease in LHV, from 37.1 MJ/$Sm^3$ to 36.4 MJ/$Sm^3$, due to $CO_2$ rich Alfa Sentral gas, gives higher fuel gas consumption to be able to generate the 20 MW required power. Hence, there will be a small increase in total emissions to air from the pre compressor and export compressor following Alfa Sentral tie-in.
- For the $CO_2$-injection compressors, loads are based on a $CO_2$ design rate of 109.32 kW/tonnes $CO_2$ produced, ref. system P&IDs. $CO_2$ production for SLT and Alfa Sentral is weighted towards the production profile for SLT and Alfa Sentral respectively.

Turbine fuel gas consumption and related emissions to air for the compressor work is calculated following the same method as for power generation, ref. chapter 2.1.

The regularity for the compressors is assumed to be 92.1%, giving an average operational time of 336 days per year.

A lower heating value of 37.1 MJ/$Sm^3$ has been used for existing SLT fuel gas with 3 mol% $CO_2$ content, based in HYSYS simulations. A Lower Heating Value of 36.4 MJ/$Sm^3$ has been used for SLT fuel gas when Alfa Sentral is tied-in, due to higher $CO_2$ content in the Alfa Sentral gas (5 mol%).

Increase in total emissions to air from compressor work due to Alfa Sentral are calculated to 80 ktonnes $CO_2$ equivalents with an average of 8.9 ktonnes per year during the operational lifetime.

## 7.5 Emissions to air from flaring

Emissions to air from flaring are based on an estimate of flare volumes for Alfa Sentral during the operational lifetime. Flare volumes for Alfa Sentral are estimated by using historical flare volumes for SLT from 2004 to 2007 scaled to reflect the production profile for Alfa Sentral.

Total emissions from Alfa Sentral flaring are calculated to 6.7 ktonnes $CO_2$ equivalents with an average of 0.7 ktonnes per year during the operational lifetime.

## 7.6 Total emissions to air

Table 7-2 below shows total emissions to air from power generation, compressor work and flaring:

- *"SLT excl. Alfa Sentral"*-column in the table shows emissions to air at SLT if Alfa Sentral is not tied-in to Sleipner.
- *"Alfa Sentral"*-column in the table shows increased emissions to air at SLT following Alfa Sentral tie-in.
- *"SLT incl. Alfa Sentral"*-column shows total emissions to air at SLT with Alfa Sentral tied-in to Sleipner.

Production period is assumed from October 2011 until July 2019.

*Table 7-2 Total emissions to air*

| Year | Total emissions to air [ton] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $CO_2$ | | | $NO_x$ | | | $CH_4$ | | | nmVOC | | |
| | SLT excl. Alfa Sentral | Alfa Sentral | SLT incl. Alfa Sentral | SLT excl. Alfa Sentral | Alfa Sentral | SLT incl. Alfa Sentral | SLT excl. Alfa Sentral | Alfa Sentral | SLT incl. Alfa Sentral | SLT excl. Alfa Sentral | Alfa Sentral | SLT incl. Alfa Sentral |
| 2011 | 97 211 | 6 778 | 103 989 | 429 | 24 | 454 | 35 | 2 | 37 | 9 | 1 | 10 |
| 2012 | 370 865 | 33 256 | 404 121 | 1 641 | 124 | 1 765 | 135 | 10 | 145 | 36 | 3 | 38 |
| 2013 | 347 332 | 23 296 | 370 628 | 1 539 | 82 | 1 621 | 127 | 7 | 133 | 33 | 2 | 35 |
| 2014 | 326 232 | 16 015 | 342 247 | 1 449 | 52 | 1 501 | 119 | 4 | 124 | 31 | 1 | 33 |
| 2015 | 312 257 | 14 650 | 326 907 | 1 389 | 48 | 1 437 | 114 | 4 | 118 | 30 | 1 | 31 |
| 2016 | 301 570 | 11 349 | 312 920 | 1 343 | 34 | 1 377 | 110 | 3 | 113 | 29 | 1 | 30 |
| 2017 | 290 061 | 10 822 | 300 883 | 1 294 | 33 | 1 327 | 106 | 3 | 109 | 28 | 1 | 29 |
| 2018 | 277 182 | 10 063 | 287 245 | 1 239 | 30 | 1 268 | 102 | 2 | 104 | 27 | 1 | 27 |
| 2019 | 132 837 | 4 943 | 137 779 | 595 | 15 | 609 | 49 | 1 | 50 | 13 | 0 | 13 |
| **Total** | **2 455 547** | **131 172** | **2 586 719** | **10 918** | **442** | **11 360** | **898** | **37** | **934** | **237** | **10** | **246** |
| **Average** | **272 839** | **14 575** | **287 413** | **1 213** | **49** | **1 262** | **100** | **4** | **104** | **26** | **1** | **27** |

## 7.7 Discharges to Sea

Development and operation of Alfa Sentral will cause discharges to sea, normally consisting of:

- Discharge from drilling and well operations (water based drilling fluid and cuttings)
- Discharge from testing and cleaning of wells (to rig or to SLT)
- Discharge from the preparation of pipelines
- Control fluid, from the operations of valves on subsea installations

There might be a minor increase of other operational discharges from Sleipner T and Sleipner A, caused by increased processing:

- Cooling
- MEG in connection with possible shut-down

The environmental impact associated with discharges from the drilling will largely be restricted to the direct effect on benthic animals as a result of the physical coverage of bottom sediments. The main ingredients in water based drilling fluid are not considered toxic, but the particles may have some physical effect on the planktonic organisms and the benthic animal society. Such

consequences are local. It is planned to use non oil drilling fluids down to 1200 m below the seabed. From 1200 m oil based drilling fluid will be used. Cuttings from oil based mud will not be released to the sea, but either fluidized and injected into the well or shipped to shore for proper handling.

In connection with the preparation and tie in of pipelines, there will be a discharge of the chemicals used to prevent fouling, and the dyes used for pressure testing and leakage detection. The discharge is expected to provide only local effects within a limited time period. MEG will be injected into the wells at shut downs, and a mixture of MEG and water will be discharged to sea. These discharges comprise only limited quantities which are not expected to cause any significant impact on the environment. Chemicals most likely to be used are oxygen scavenger OR-13 (green), fluorescent Dye RX-9022 (yellow) and monoethylene glycol MEG (green).

The control system of Alfa Sentral will be an open hydraulic system with discharges to sea. Currently a control fluid which is classified as environmentally red is being used at the Sleipner installations. Sleipner is continuously trying to find a more environmentally friendly alternative to this fluid, but at present, there are no concrete plans for replacement. The control system of Alfa Sentral is to be designed in such a way that it is prepared for the use of “yellow” control fluids. Whether it will be feasible to use two different control fluids on the Sleipner Installations, is to be decided in dialogue with the Sleipner Operation.

Based on the experience from a similar subsea installation (Alfa North) a yearly discharge of approximately 1 cube of control fluid is expected.

Sleipner will take action to reinject produced water from year 2009. It is estimated approximately 90% injection. Accordingly the discharge of produced water from the Sleipner complex when Alfa Sentral is on flow will be insignificant compared to the present situation on Sleipner.

Summing up, no significant environmental impacts are expected from the planned discharges to sea from the development of Alfa Sentral.

## 7.8 Discharges to Sea – Environmental Budget Sleipner

This chapter presents the estimated discharges to sea from the Sleipner complex due to the tie-in and production of Alfa Sentral. The data are excerpted from the Environmental Report “Alfa Sentral tie-in to Sleipner” (Aker Solutions 2009).

Produced water from Sleipner West well stream will be re-injected. For this study it is assumed an injection regularity of 90%, i.e. 10% of produced water will be discharged to sea. Refer to chapter 4.4 for produced water profile.

Produced water discharged to sea will contain small amounts of oil and scale inhibitor. The following average concentrations, based on 2007 and 2008 historical production data, are assumed for this study:

- Oil in produced water: 6.57 mg/l
- Scale inhibitor in produced water: 85.01 mg/l

For Alfa Sentral scale inhibitor, it is assumed that the amount of chemicals injected will be recovered in the production stream.

Calculations of discharges to sea are given in Table 7-4 below.

***Table 7-4.*** *Total discharges to sea*

| Year | Discharges to sea | | | | | |
|---|---|---|---|---|---|---|
| | Oil [tons] | | | Scale inhibitor [tons] | | |
| | SLT excl. Alfa Sentral | Alfa Sentral | SLT incl. Alfa Sentral | SLT excl. Alfa Sentral | Alfa Sentral | SLT incl. Alfa Sentral |
| 2011 | 0.02 | 0.00 | 0.02 | 0.2 | 0.0 | 0.2 |
| 2012 | 0.01 | 0.00 | 0.01 | 0.2 | 0.0 | 0.2 |
| 2013 | 0.01 | 0.01 | 0.03 | 0.2 | 0.6 | 0.7 |
| 2014 | 0.01 | 0.01 | 0.03 | 0.2 | 0.5 | 0.6 |
| 2015 | 0.01 | 0.01 | 0.03 | 0.2 | 0.5 | 0.6 |
| 2016 | 0.01 | 0.01 | 0.02 | 0.2 | 0.3 | 0.5 |
| 2017 | 0.01 | 0.00 | 0.01 | 0.2 | 0.0 | 0.2 |
| 2018 | 0.01 | 0.00 | 0.01 | 0.1 | 0.0 | 0.1 |
| 2019 | 0.00 | 0.00 | 0.00 | 0.0 | 0.0 | 0.0 |
| **Total** | **0.11** | **0.05** | **0.15** | **1.4** | **1.8** | **3.2** |
| **Average** | **0.01** | **0.01** | **0.02** | **0.2** | **0.2** | **0.4** |

## 7.9 Waste Handling

The primary aim regarding waste handling during Alfa Sentral operations is to minimise the amounts of waste and to maximize the degree of reprocessing, reuse or recirculation, as generation of different types of waste in connection with operations and maintenance is unavoidable.

Alfa Sentral is expected to generate a small increase in waste production, which will be handled by the existing waste segregation system on Sleipner. An environmental station is located in M12 on SLT main deck, where segregation of the different types of waste is possible, including hazardous waste. On SLA there are several environmental stations, with the main station for segregation of hazardous waste located in M21 Weather Deck.

During the installation phase there might be need for extended waste disposal capacity. In this case, skips will be ordered for waste handling as deemed necessary and located in laydown areas on lower and upper mezzanine decks or weather deck.

Produced sand shall either be handled as hazardous waste or cleaned and discharged to sea according to Norwegian regulations. Furthermore, according to the Activities regulations, sand shall not be discharged to sea if the oil content is more than ten grams per kilogram of dry matter. Sand from Alfa Sentral will be trapped in Alfa Nord sand trap and drained to drip tray. The rest of the sand will be sedimented in inlet separator G-20-VA01. There is no sand jetting system in G-20-VA01, hence trapped sand has to be dug out for disposal during revision stops. Sand production from Alfa Sentral is expected to be low.

## 7.10 Physical Impacts and Presence of Subsea Infrastructure

Physical impacts will be related to installation of template, drilling of two wells and installation of 21 km of pipeline. Physical presence caused by the development of Alfa Sentral includes the template and 21 km of pipeline and umbilical.

Fisheries
Field activities connected to drilling, and installation of subsea facilities and pipelines, can potentially lead to greater disadvantages for the execution of fishing than the actual production phase. Activities as mentioned can imply a temporary area occupation that moves with the ongoing work. Since these activities take place within a limited time period, they are not expected to cause any significant loss of catch.

Exclusion from areas of sea by the presence of rigs or installations could result in effects on commercial fishing, as could the presence of snagging hazards associated with pipelines or debris. However, the small scale of the Alfa Sentral infrastructures implies that this is unlikely to cause significant economic impacts. Template and pipeline will be overtrawlable.

Corals
Cold water corals are sensitive to physical interference. However, no cold water coral reefs have been found in the open waters of the North Sea. The likelihood of corals being affected by the planned activities is therefore minimal.

Cultural Heritage and Relicts from the Past
Activities affecting the seabed may cause direct or indirect impact on cultural heritage and relicts from the past. This relates mainly to activities such as the placement of wells / subsea templates and the laying of pipelines.

Investigations of the pathways and anchoring corridors for templates and pipelines will reveal possible discoveries of cultural relics. If cultural relics are found in the impact area, the cultural heritage authorities will be contacted and further handling of the discoveries will be clarified.

## 7.11 Accidental Emissions and Discharges

Accidental emissions and discharges may occur due to accidents in the following categories:

- Blow-outs from field installations during operation or when drilling
- Accidental emissions from drilling rig
- Leaks from pipelines
- Leaks from subsea installations
- Leaks from processing

The most severe environmental impacts are generally associated with acute accidental discharges of oil and the subsequent damages of seabirds. For gas / condensate fields the potential impacts from possible acute discharges are considerably less severe.

Alfa Sentral is included in the resent update of the Environmental Risk Analysis for the Sleipner Field (DNV 2009). The analysis is based on the discharge frequency for activities on the installations Sleipner A, Sleipner B, Sigyn, Alfa Nord and Alfa Sentral. Environmental risks in connection with blowouts have been analysed for a selection of seabirds and marine mammals. Because the fields are localized far from shore and the specific oil type from these fields will have only a short lifespan on the sea, the influenced area do not include the coastline. The results from the analysis show comparatively low population loss as a consequence of possible blowouts, and an environmental risk with a maximum impact of 0.4% of StatoilHydros field specific acceptance criteria.

# 8 Assessment of Environmental Impacts

This section evaluates the relative significance of the potential environmental impacts that might arise as a result of the construction and production of Alfa Sentral. Its purpose is to identify those potential impacts that might cause significant effects, so that they can be more fully assessed and mitigated as necessary. Potential effects are evaluated in terms of the environmental impact or risk of the activity and the sensitivity of the location (where applicable).

As mentioned in the introduction chapter, the Norwegian Ministry of Petroleum and Energy has acknowledged that the Norwegian legal requirements for environmental impact assessment already are fulfilled by the existing RIA-North Sea 2006. To facilitate the evaluation of consequences for UK stakeholders the area which has been assessed is divided into Norwegian continental shelf and UK continental shelf.

## 8.1 Norwegian Continental Shelf

### *8.1.1 Emissions to Air*

Potential environmental effects of acid gas and greenhouse emissions are, respectively, regional and global in nature. In general, local environmental effects of atmospheric emissions are not expected to be significant in view of the high atmospheric dispersion associated with offshore locations. Du to comparatively low emissions from both the construction and production of Alfa Sentral, the incremental contribution to regional and global effects will not be significant.

### *8.1.2 Discharges to Sea*

As no toxic chemicals or oil based mud will be released to sea, the environmental impact associated with discharges from the drilling will be restricted to the direct effect on benthic animals as a result of the physical coverage of bottom sediments. The main ingredients in water based drilling fluid are not considered toxic, but the particles may have some physical effect on the planktonic organisms and the benthic animal society. Such consequences are local, within a range of maximum 100 m from the drilling location (RIA-Nort Sea 2006). Calculations on dispersion of particles from the Norwegian Sea show that small particles from the drilling may sediment far from the actual drilling location (Frost & Rye 2002). The amount of particles that sediment is, however, minor and no environmental effects are expected from the drilling of the two wells.

In connection with the preparation and tie in of pipelines, there will be a discharge of the chemicals used to prevent fouling, and the dyes used for pressure testing and leakage search. The chemicals at use have low environmental risk, and the discharge is expected to provide only local impacts within a limited time period. Those organisms that would be at risk include planktonic organisms (i.e. those drifting in the near-seabed currents), epibenthic organisms (e.g. demersal fish and shellfish) and sediment dwelling filter feeders.

Due to the planned re-injection of produced water, the discharges to sea from the Sleipner complex will be reduced by approximately 90% compared to the present situation. The

proportion from the production of Alfa Sentral will be low and environmental impacts are expected to be insignificant.

During operation there will be a small discharge of control fluid to sea from the template. It is estimated a yearly discharge of approximately 1 $m^3$ of control fluid per year. As a consequence of low toxicity and very low amount of discharge, the environmentally impact is regarded as negligible.

### *8.1.3 Physical Impacts*

Installation of template, drilling of wells and laying the pipeline and creating the rock-dumps will disturb the seabed sediments, and benthic organisms living in or on these sediments. The total footprint from these structures will, however, be small in relation to the area of undisturbed benthic habitat, and the overall ecological impact will be very small.

The pipeline, pipeline crossings and rock dump areas will create new habitats for benthic organisms that live on hard surfaces. Such organisms typically include tubeworms, barnacles, hydroids, tunicates and bryozoans, which are commonly found on submerged rocky outcrops, boulders and offshore structures. These structures could also provide habitats for crevice-dwelling fish (e.g. ling) and crustaceans (e.g. squat lobsters and crabs). The overall ecological benefit would be negligible, however, because these structures will have a small surface area.

A very small number of demersal and pelagic fish might be temporarily disturbed by the pipe-laying operations. After the pipe has been installed, however, it is anticipated that a variety of fish species would be found along its entire length, making use of the shelter provided by this new structure on the seabed.

Subsea installations, pipelines and cables will be made as to minimize negative impact on trawling activity. Loss of area due to the subsea installations are not expected to cause any significant catch reductions. Even though pipelines and template will be overtrawlable, trawling vessels may want to avoid crossing them, and thus they could represent some operational disadvantages.

For the other fisheries in the area it is assumed that the development of Alfa Sentral will not lead to any disadvantages during the production phase.

There may be encounters with shipwrecks during installations. However, the Alfa Sentral project will only cause a very limited intervention in the seabed.

## 8.2 United Kingdom Continental Shelf

The chief water movements are influxes of Atlantic water through the Fair Isle Channel (between Orkney and Shetland) and to the east of Shetland, and a major outflow through the Norwegian Trough. Water circulation in the North Sea is anticlockwise, with an eddy forming over the Fladen Ground.

Meteorological Office wind data for the north, central and southern areas of the North Sea from the period 1854-1994 show the occurrence of winds from all directions, although dominated by winds from south-south-west and south (DTI 2001a).

The prevailing winds and the residual water circulation will more likely result in the trans-boundary transport of discharges to water (including particulates) and atmospheric emissions from the UK continental shelf to the Norwegian continental shelf than the other way around.

### *8.2.1 Emissions to Air*

There will be no emissions to air on the UK continental shelf. The atmospheric emissions caused by the construction and production of Alfa Sentral are negligible both compared to the present emissions on the Sleipner complex and compared to the overall emissions in the North Sea. Incremental contribution to regional and global effects will not be significant.

### *8.2.2 Discharges to Sea*

All planned discharges and possible accidental spills will take place on the Norwegian continental shelf. As low to negligible environmental impacts are expected on the Norwegian side, any impacts on the UK side will be negligible to none existent.

Environmental effects caused by discharges from drilling will be limited to the immediate proximity of the wells. As the wells will be located approximately 850 m from the UK border no environmental impacts are expected on UK continental shelf.

Flooding, strength and integrity testing are routine part of pipeline installation, during which permitted discharge of chemicals to the marine environment will take place. The discharge will take place in Norwegian waters, most likely close to the template location approximately 850 m from the border line. There might be a local impact in the immediate vicinity of the discharge point, however, no impacts are expected in UK waters.

Small amounts of control fluid will be discharged to sea at the template. As the amounts of fluid discharged will be limited and the toxicity of the chemicals is low, no environmental impacts in UK waters are expected from these discharges.

The discharge of produced water from the Alfa Sentral will be low and the outlet is located approximately 20 km from UK border. No environmental impacts are expected in UK waters.

### *8.2.3 Physical Impacts*

There will be no subsea infrastructure on the UK continental shelf. During drilling operations eight anchors will be used to secure the rig. Two or three of these anchors might end up on the UK side of the border line.

Depending on the nature of the seabed, anchors can create mounds up to 1m high, and anchor chains lying on, and sweeping over, the sediments can create gouges and scour marks. On a clay seabed, such anchor mounds can potentially become an obstruction when mobile fishing gear is used on the seabed.

Anchor mounds and scours also have the potential to cause disruption to benthic communities. The deployment and retrieval of anchors would cause some direct impact of invertebrates living on and in the sediments, and some physical disturbance of their environment as a result both of the ploughing of sediments and of the covering of sediments by disturbed material. The magnitude of this disturbance will, however, be very low. In all cases, the disturbed sediments would be clean, and recolonisation from adjacent undisturbed communities would begin very

quickly after the disturbance is ceased. The area of seabed that could be physically disturbed by such operations would be very small in relation to the adjacent areas of comparable seabed.

# 9 Conclusions

In overall terms, the proposed activities at the Alfa Sentral field and at the Sleipner complex are not expected to lead to environmentally significant effects. The Alfa Sentral field and the Sleipner complex are located in an area with habitats and marine life typical for the central North Sea. None of the environmental receptors is assessed as being particularly sensitive to the type of activities proposed.

The activities associated with the Alfa Sentral development will be included in the Company's environmental measurement and monitoring programmes, which track performance against corporate targets for important emissions and discharges.

This assessment demonstrates that the planned drilling of the Alfa Sentral, the laying of the pipeline and subsequent increased production at the Sleipner complex will have no significant effects on environmental resources in the central North Sea. The controls on operations have been designed to ensure that robust environmental safeguards will be put in place and preventative measures have been designed to minimise any potential environmental risks. It is concluded that the Alfa Sentral activities could be implemented without significant adverse effects on the environment.

There will be no subsea infrastructure, discharges to sea or emissions to air on the UK side of the border line. The only expected effects on UK continental shelf are the potential physical impact from the anchoring of the drilling rig. Mounds from anchors have a potential to become an obstruction when mobile fishing gear is used on seabed. However, no environmental impacts are expected from the anchoring.

StatoilHydro believes that the measures that will be taken to minimise the environmental effects associated with the Alfa Sentral activities represent an appropriate balance between protecting the environment and securing the economic benefits of the planned production increase.

# 10 References

Aker Solution 2009. StatoilHydro. Alfa Sentral tie-in to Sleipner. Environmental Report. Appendix 17.3.3.

DNV 2009. Miljørisikoanalyse for Sleipnerfeltet. Det Norske Veritas. Report number: 2009-0176.

DTI 2001a. *Strategic Environmental Assessment of the Mature Areas of the Offshore North Sea SEA2*. Report to the Department of Trade and Industry. Consultation Document, September 2001.

DTI 2001b. Background Information on Marine Mammals Relevant To SEA2. Technical Report TR_006. Produced by Sea Mammal Research Unit, August 2001.

Evans, PR (1973). Avian resources of the North Sea. In Goldberg ED (ed) North Sea Science. NATO North Sea Science Conference, Aviemore, Scotland 15-20 November 1971, MIT Press.

Frost, T. K. & Rye, H. 2002. Regulære utslipp til sjø – spredningsog miljørisikoberegninger. Statoil Report RIA Norwegian Sea.

Hovland, M. & Judd, A. G. 1988. Seabed pockmarks and seepages. pp. 293. London: Graham and Trotman.

RIA-North Sea 2006. Oppdatering av regional konseskvensutredning for petroleumsvirksomhet i Nordsjøen. Sammenstillingsrapport. OLF.

Tasker ML, Webb A, Hall AJ, Pienkowski MW and Langslow DR (1987). Seabirds in the North Sea. Final report of phase 2 of the Nature Conservancy Council Seabirds at Sea Project. November 1983-October 1986. Nature Conservancy Council.

Zero discharge report 2008 Sleipner field. Internal StatoilHydro report in Norwegian language.

# Appendix A: Application for Consent to Fulfilled Assessment Requirements

| Vår dato | Vår referanse | Vår saksbehandler |
|---|---|---|
| 2009-02-19 | AU-SSAS-00003 | Svein Dam Einan |
| Deres dato | Deres referanse | |

StatoilHydro

Ministry of Petroleum and Energy

Postboks 8148 Dep
0033 OSLO

COPY per 18.3.2009

Original letter in Norwegian language

**PL046 Sleipner License – Application for consent to fulfilled assessment obligation for Alfa Sentral, Sleipner satellites**

We refer to the meeting between the Ministry of Petroleum and Energy and StatoilHydro 19th November 2008, as well as communication via e-mail and phone.

On behalf of the license owners StatoilHydro is planning to develop the reserves of Alpha Sentral, a satellite field to Sleipner West. It is the license owner's opinion that the development of these reserves has minor environmental impact, and that potential impacts already are sufficiently assessed in the existing Regional Impact Assessment (REIA) of the North Sea from 2006.

The license owners therefore want to apply the Ministry for consent that the development of Alfa Sentral is covered by the existing Impact Assessment, and thereby that the legal requirements for impact assessment are already fulfilled by existing REIA. The documentation of impacts of development and operation is presented in the Attachment 1. A short summary is given below.

**Introduction**
Alpha Sentral is a gas and condensate field in the Sleipner License PL046 (block 15 / 8), where approximately 20% of the reserves are stretching into the British sector (P312, Block 16/18a).

The field was discovered in 1983, but has been undeveloped in anticipation of the available capacity on the Sleipner Installations. The $CO_2$ content of gas is high (ca. 20%), and the gas is to be sent through $CO_2$ removal plant on the Sleipner T (SLT). The capacity of the SLT is currently sufficient to take the gas from the Alpha Sentral, but the capacity will be limited if the gas from Gudrun also is sent to the SLT. If Alfa Sentral can come in production from 2011, it will be on decline when Gudrun comes on stream and capacity conflict can thereby be avoided.

StatoilHydro is operator together with the Norwegian partners ExxonMobil and Total, which are the same license owners as in Sleipner. British partners are ENI (operator), Talisman and First Oil Exploration.

**Project description**
The gas is contained in the Upper and Lower Hugin and the Sleipner formations at a depth of about 3800 m below sea level. Recoverable reserves expected are 2.6 $GSm^3$ gas, 1.5 $MSm^3$ condensate and 0.5 million tonnes of NGL.

A four slot template will be installed on the Alfa Sentral Field. Initially there will be drilled two wells, with the possibility of a third well in the field when needed. The last well slot can be used for a nearby exploration prospect. The template will be tied in to the Sleipner T platform. The umbilical will be connected to the Sleipner A platform. Pipeline and umbilical will have a length of approximately 21 km, and mainly be laid in the same corridor.

StatoilHydro

**Investments**
The project has an investment frame of 4.7 billion NOK (2008).

**Anticipated emissions to air**
The production on Sleipner has left plateau and is declining. The start up of Alfa Sentral will not provide any real increases in production, but will make the reduction in production and emissions. It is therefore considered that a development of Alfa Sentral will not cause any significant changes of emissions to air in relation to the numbers that are included in the REIA of the North Sea from 2006.

**Anticipated discharges to sea**
In 2009 Sleipner will take action to reinject produced water to the Utsira Formation. Water production from Alfa Sentral will be treated the same way. The discharge of produced water to sea will therefore be insignificant.

**Power consumption**
Alpha Sentral is a small project with low power requirements. Total load is estimated at maximum 1.8 MW, and the average power consumption is likely to be considerably lower. The power consumption will mainly be in connection with processing, injection and transport, and take place on the platforms Sleipner T and Sleipner A. The development of Alfa Sentral will not release the need to install any new equipment for power production or processing at the Sleipner platforms.

**Contact with British authorities**
A substantial part of the reserves (ca. 20%) of the Alfa Sentral Field are located on the British side of the borderline. There will, however, be no subsea infrastructure in the UK license area. It will be made contact with UK authorities (DECC) to clarify whether an UK Environmental Statement is required.

**Fulfilled assessment obligation**
Alfa Sentral is included in the prediction basis for the REIA for the North Sea from 2006. It is our judgement that the project thereby already has fulfilled the legal requirements of an impact assessment, and it should not be necessary with a separate EIA-process for Alfa Sentral. It is concluded that the project will cause only minor impacts on the external environment and on the fishing activities. These arguments are further described in the document "PL046 Alfa Sentral. Documentation of consequences of development and operation" (attached).

**Conclusion**
Based on the arguments above and the attached documentation, StatoilHydro will ask the Ministry to consider whether the assessment requirement for the Alpha Sentral already has been fulfilled by existing Impact Assessment.

Best regards
StatoilHydro ASA

Svein Olav Høyland
Project Manager

Attachments: 1

## Appendix B: Consent to Fulfilled Assessment Requirements

Copy of original letter from the Norwegian Department of Petroleum and Energy

MOTT. 27.03.2009

DET KONGELIGE
OLJE- OG ENERGIDEPARTEMENT

StatoilHydro ASA
Svein Olav Høyland
Forusbeen 50
4035 STAVANGER

| Deres ref | Vår ref | Dato |
|---|---|---|
| | 09/00430-3 | 23.3.2009 |

**PL046 Sleipner lisensen - Søknad om godkjenning av oppfylt utredningsplikt for Alfa Sentral, Sleipner satellitter**

Det vises til brev fra StatoilHydro ASA av 19. Februar 2009 hvor StatoilHydro ASA på vegne av rettighetshaverne i utvinningstillatelse PL046 søker om godkjenning av oppfylt utredningsplikt for Alfa Sentral, Sleipner satellitter.

Olje- og energidepartementet har forelagt søknaden for Oljedirektoratet.

Med bakgrunn i søknaden fra StatoilHydro ASA med vedlagte dokumentasjon, finner Olje- og energidepartementet at utredningsplikten for Alfa Sentral er oppfylt.

Med hilsen

Egil Meisingset (e.f.)
Underdirektør

Nils Anders Nordlien
Rådgiver

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|---|---|---|---|---|
| Postboks 8148 Dep | Einar Gerhardsens plass 1 | 22 24 90 90 | | Nils Anders Nordlien |
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| http://www.oed.dep.no/ | | 977 161 630 | 22 24 66 27 | |

Translation of the letter from Department of Petroleum and Energy:

**PL046 Sleipner license - Request for consent that the impact assessment requirements has been fulfilled, Alpha Sentral, Sleipner Satellites**

With reference to the letter from StatoilHydro ASA 19Th. February 2009 where StatoilHydro ASA on behalf of the licensees in production license PL046 is requesting a consent to the fulfilled impact assessment requirements for Alpha Sentral, Sleipner Satellites.

The Ministry of Petroleum and Energy has submitted the application for the Norwegian Petroleum Directorate.

Based on the application from StatoilHydro ASA, including the attached documentation, the Ministry of Petroleum and Energy has given consent that the legal requirements of environmental assessment for the Alpha Sentral are fulfilled.

Sincerely,

Egil Meisingset (e.f.)
Director

Nils Anders Nordlien
Adviser

## Appendix C: Map of Fishing Activity