Fact sheet from
OLF The Norwegian Oil Industry Association

Barriers against spills

The goal of the oil and gas industry is that their activities shall not harm the environment. Therefore, the industry has developed technological solutions that meet stringent environmental requirements. The history of the Norwegian Shelf shows about 40 years of petroleum activity without significant damage to the environment. In addition to this, the likelihood of major spills is continually decreasing as new technology and improved procedures are put to use. Nevertheless, we cannot guarantee that an accident will never happen. That is why the oil industry is always working to reinforce oil spill preparedness.

This fact sheet addresses barriers that prevent spills during exploration for oil, as well as the emergency response resources that can be brought to bear if an oil spill should occur.

Thorough preparatory work

When drilling an exploration well, we are penetrating a potential oil reservoir for the first time. If the reservoir is turned loose, it often has sufficient pressure to cause an uncontrolled flow of large amounts of oil to the surface. This is called a blow-out. Blow-outs dominate the environmental risk associated with exploration drilling, and the oil industry is very aware of the danger this represents. The exploration activity on the Norwegian Shelf is well equipped to prevent such an incident.

Barriers are a key concept in the industry's work to minimize the risk of oil spills and harm to the environment. The main principle is that at least two independent barriers shall prevent leakage from all potential spill incidents. This means physical barriers, or other measures designed to:

1. Reduce the danger of spills
2. Limit the volume of oil, if a spill should occur
3. Prevent or limit the harmful effects of a spill

There have never been blow-outs during exploration drilling on the Norwegian Shelf, but planning and emergency preparedness during the exploration phase are characterized by consideration for this risk.

Unlike certain locations in the North Sea and the Norwegian Sea, the reservoirs in the Barents Sea do not have high pressure. This means that an uncontrolled blow-out is unlikely.

Source: The Norwegian Petroleum Directorate.

Before drilling an exploration well, we need high-quality knowledge about the formations under the seabed. Seismic surveys provide valuable information about the reservoir and help contribute to a safe drilling operation. If the seismic surveys provide a basis for exploration drilling, the operator hires a drilling rig. The rig must be adapted to the specific assignment and the special environmental conditions that apply to the area in question. Environmental surveys are conducted prior to exploration drilling in environmentally sensitive areas.

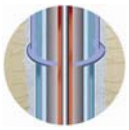
All oil activities require permission from the authorities before the activity can commence. In order to obtain permission to drill an exploration well, the industry must submit an application well in advance of the planned start date, describing what they are drilling for and how the drilling will take place. Environmental risk and emergency preparedness analyses must be submitted, together with a description of which barriers have been set up to prevent spills, and which measures will be implemented in the event that a spill should occur. These plans and measures form the basis for the authorities' permits, issued by the Petroleum Safety Authority Norway (PSA) and the Norwegian Pollution Control Authority (SFT). Both the application from the oil companies for permission for exploration drilling and the permit issued by the authorities are open for public inspection.

The drilling mud keeps the pressure in the reservoir under control, and prevents oil and gas from penetrating into the well.

Edge that collects rainwater and possible oil spillage, preventing it from running into the sea.

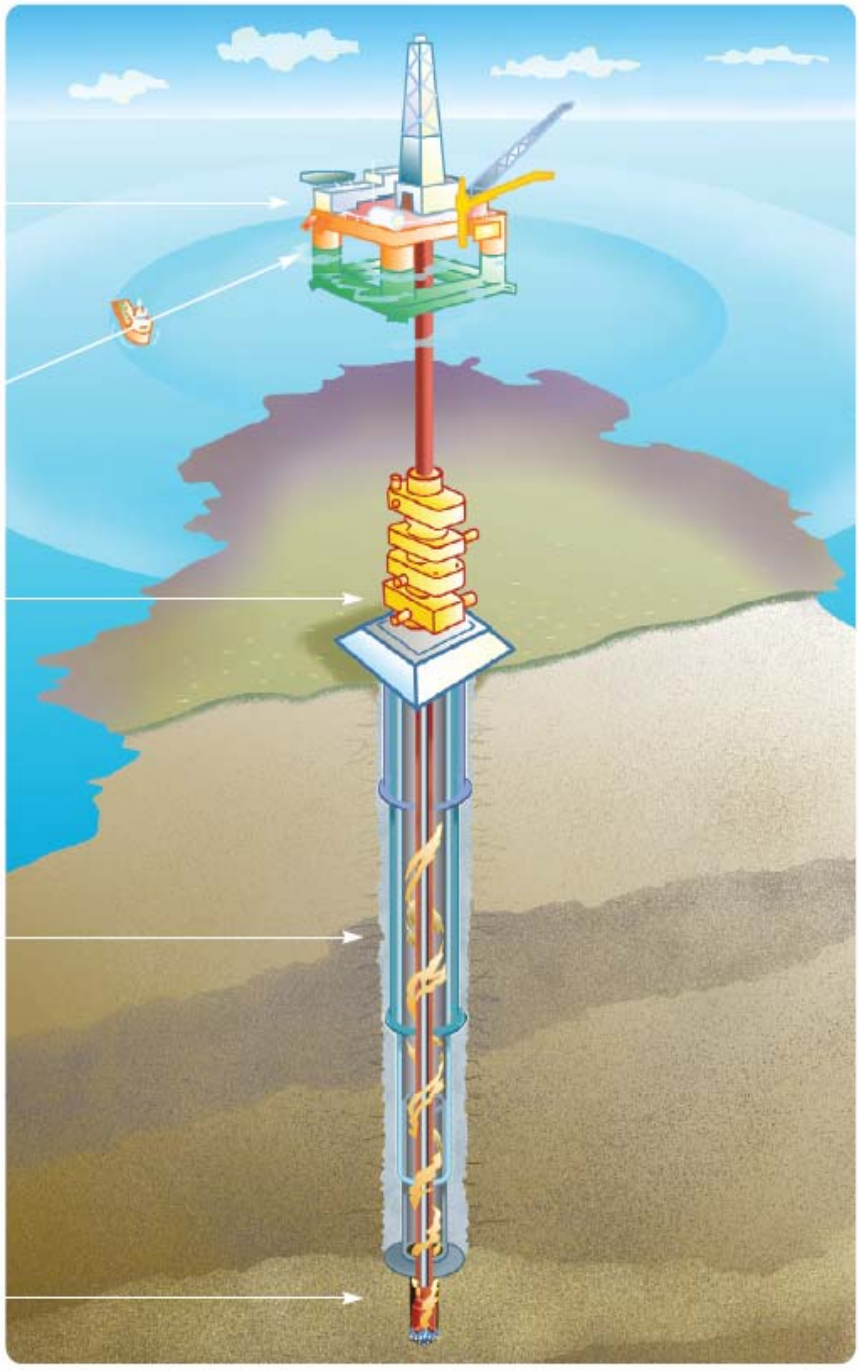
Double valves on systems that could cause leakage.

Blow-out preventers (BOPs) close and prevent the flow of oil and gas up to the rig, if there is an unexpected change in the well pressure.



Steel casing isolates any small liquid deposits from the well and keeps the wall of the well stable. The casing acts as an anchor point for the BOP, helping to prevent an uncontrolled flow of oil and gas up to the surface.

Drilling mud is pumped down through the drillstring, keeping the pressure in the reservoir under control and preventing oil and gas from penetrating into the well.



Safe exploration

There are two independent barriers against blow-outs during exploration drilling: drilling mud and a so-called Blow-Out Preventer (BOP).

Drilling mud is a mixture of water, clay and weighting substances. During drilling, mud is pumped down through the drillstring. The drilling mud has several important functions. It lubricates and cools the drill bit, helps prevent the wall of the borehole from collapsing and it transports cuttings out of the hole and up to the rig. However, the most important function in this context is that the mud keeps the pressure in the reservoir under control and prevents oil and gas from penetrating into the well. Choosing the correct type and weight of mud is a key element when planning a drilling operation.

The BOP is fastened in the steel casing which is cemented down in the well. The BOP makes it possible to physically shut in the well. It is primarily activated in the event of well kicks, i.e. when reservoir fluid has penetrated into the well. This may be caused by the pressure in the well being too low in relation to the pressure in the reservoir. To maintain control over the well, it is important to ensure that the mud in the well has sufficient weight. The crews of drilling rigs hold well control drills several times each month.

Limits volume

If, despite these precautions, a blow-out should occur, there are two factors that limit how much oil is discharged: the strength of the oil flow and how long the blow-out lasts.

A blow-out means that the BOP has failed. However, in most cases, the BOP will help limit the spill. Firstly, one or more of the valves will probably be nearly or partially closed. This will contribute to reduced flow out of the well. If the BOP does not close, this may be due to failure of the control systems. If this can be repaired, the blow-out can be stopped fairly quickly by simply closing the BOP.

The diameter of the borehole has a significant impact on how strong the oil flow will be in the event of a blow-out. When drilling in relatively shallow reservoirs, drilling can first take place at smaller diameters, which can subsequently be drilled to the planned diameter. This can decrease the volume.

All exploration drilling activity has a plan, adapted to local conditions, for how to stop a potential blow-out. If a blow-out occurs, work will immediately commence to drill a relief well. A new well is drilled in diagonally towards the bottom of the well that is out of control. Using magnetic-based guidance technology, one can "see" the casing in the problem well, and thereby guide the new well to the correct point. Heavy mud can then be pumped in via the new well so that the blow-out is stopped.

In many cases, nature itself will stop blow-outs at an early stage. This can occur by means of sand that accompanies the oil flowing into the well. The sand can more or less fill up the well, thus forming an effective plug against the blow-out. In other cases, the pressure drop that occurs during uncontrolled flow may lead to the well collapsing and thus sealing itself.

The blow out preventer consists of 3-5 large valves that can be closed so that oil and gas cannot flow to the surface.

Risk management

An ever-present and paramount goal is to conduct exploration drilling without harming the environment. Nevertheless, there will always be the risk of an accident. The oil companies devote substantial resources and work systematically to reduce this risk to a minimum.

An environmental risk analysis is part of the planning of every exploration well on the Norwegian Shelf. The most important basis for the analysis is knowledge concerning specific challenges in the relevant well operations, environmental conditions and natural resources in the area, including their vulnerability to oil.

Safety, environmental and drilling experts work together to prepare this analysis. With the aid of models and historical and local data, they quantify the likelihood of a blow-out, as well as how forcefully and for how long the type of oil in question could flow to the surface. Advanced simulations provide forecasts for how the oil slick could spread in the sea, and possibly reach the coastline. This in turn provides insight into the type of damage that could occur to the environment. It is a precondition that the oil companies can demonstrate that the environmental risk is within the acceptance criteria for each and every well.

The environmental risk analysis is an important basis on which to implement preventive measures, both to avoid accidents and to establish suitable oil spill preparedness.

Modern oil spill preparedness

If all barriers fail and oil ends up on the sea, the oil companies have an oil spill preparedness that is intended to limit the consequences of the accident to the maximum degree possible. On the Norwegian Shelf, the oil companies have established an alliance - NOFO (the Norwegian Clean Seas Association for Operating Companies) - which handles the oil spill preparedness. NOFO has divided the coastline into five regions with depots, equipment and emergency response plans for each area. The emergency response encompasses 14 sea-going oil spill vessels, towing vessels, oil booms and oil skimmers that can pump oil up from the sea. Three of the systems are mobilized at any given time on the stand-by vessels out on the fields. The vessels also have the capacity to hold super tankers.

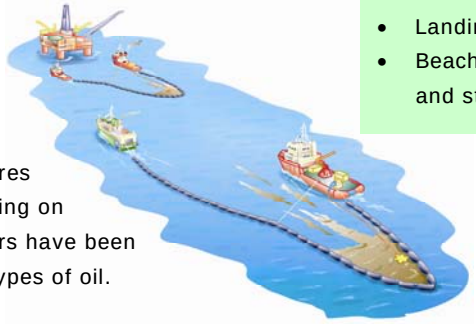
> *Oil production in the North will reduce the overall environmental risk from accidental spills of crude oil and bunkers. This is because the oil industry's emergency response resources can also be used to reduce the consequences of shipping accidents.*
> *Source: Det Norske Veritas (DNV).*

All platforms and installations have systems that monitor and detect potential leakages. Monitoring can also take place via satellite, airplane or helicopter. If a spill should occur, it is important that NOFO is in place with its equipment as quickly as possible. The quicker they are in place and the closer they come to the source of the spill, the greater the chance for recovering most of the oil. A rule-of-thumb says that 90 percent of the oil is found in 10 percent of the slick. Therefore, in an oil spill campaign, the focus is on keeping that part of the slick inside the boom, where an oil skimmer is placed to pump the oil up to the oil spill vessel.

> *In Norway, the preparedness against acute pollution consists of three main elements: private, municipal and state preparedness. These elements cooperate and benefit from each other's resources in the event of an oil spill campaign.*

NOFO has access to specially-equipped helicopters that can find oil using infra-red cameras and transmit the pictures to the collection vessel. NOFO can also seek assistance from surveillance airplanes equipped with sensors that can discover oil slicks on the surface of the sea. In recent years, the oil industry has worked to develop new radar technology for ships that can find oil on the sea, regardless of light and weather conditions.

The challenges associated with low temperatures, wind and ice can be solved by various counter-measures, including use of antifreeze solutions. Low temperatures in the sea can lead to some oils stiffening on the sea surface. Therefore, oil skimmers have been developed especially to handle these types of oil.



Sample emergency preparedness from exploration drilling in the Barents Sea:

Requirements for emergency preparedness against acute pollution:
During drilling, a stand-by vessel will always be located next to the rig. In addition to the ordinary emergency response tasks, this vessel has the task of monitoring the safety zone around the rig and reporting any leaks. Searchlights on the rig are reinforced so that spills can also be seen in the dark. Any leakages of drilling fluid or hydraulic fluid at the seabed will be detected immediately, since both the well and the control lines for the safety valves are continuously monitored.

A monitoring procedure, including satellite, helicopter and airplanes, will be implemented immediately in the event of an oil spill.

Requirement for mapping biological resources, remote measurement and post-activity studies:
Mapping and sampling, as well as measurement of potential effects on birds, fish, etc., before and after exploration drilling. Detection and follow-up of potential oil spills.

Requirement for mechanical measures, if a spill occurs:

Barriers 1 and 2: Open sea

- One NOFO system on a vessel at the rig, operative within two hours
- NOFO system number two operative within 14 hours
- Additional nine systems within 66 hours
- One NOFO system consists of 400 meters of sea boom and oil skimmer

Barrier 3: Coastal zone

- Four coastal systems
- Consist of Coast Guard/Coastal Directorate and fishing vessels with boom and skimmer

Barriers 4 and 5: Fjord and beach

- Seven fjord systems
- Consist of Coastal Directorate and fishing vessels with boom and skimmer
- Landing craft within 24 hours
- Beach clean-up equipment - all municipal and state resources