

OIL AND GAS FIELDS IN NORWAY

INDUSTRIAL HERITAGE PLAN



NORSK OLJEMUSEUM

THE VALHALL AREA

The Valhall area lies right at the southernmost end of the NCS in the North Sea, just south of Ekofisk, Eldfisk and Embla. It embraces the Valhall oil field with its southern and northern flanks, and the Hod oil field.

Valhall

Valhall is an oil field located in 70 metres of water in blocks 2/8 and 2/11. Discovered in 1975, it was approved for development in 1977 and came on stream in October 1982.

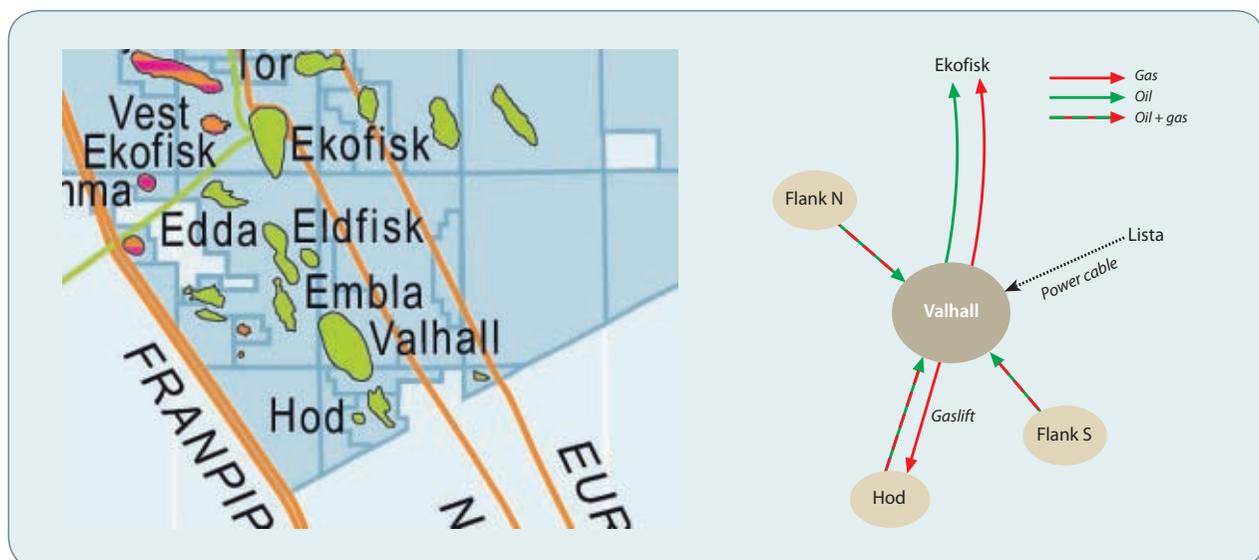
In recent years, this field has become the first in the world with a permanent life-of-field seismic system which permits highly accurate 4D surveys. These are 3D surveys repeated over time so that such aspects as the movement of oil in the reservoir can be studied. Permanently installing more than 10 000 sensors on the seabed over an area of 45 square kilometres means that their position is unchanged from survey to survey, giving a considerable improvement in accuracy. That in turn has meant that new wells can be drilled in the right place and a larger proportion of the oil reserves recovered.



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Reservoir and recovery strategy

Valhall produces from chalk rocks in the Tor and Hod formations of late Cretaceous age. Its oil has





The Valhall field centre with the QP (left), DP, PCP, WP and IP installations. Photo: BP Norge AS

a low sulphur content and a high proportion of naphtha and other volatile fractions, while the gas is primarily pure methane with some ethane, propane and butane.

The reservoir lies at a depth of roughly 2 400 metres. The chalk in the Tor formation is fine-grained and soft, riven with fractures which allow oil and water to flow through more freely. Because extraction reduces reservoir pressure, the chalk has become compacted – a process which created major production problems at an early stage. Processing equipment became blocked by toothpaste-like chalk which accompanied the oil up to the platform. One countermeasure adopted was to inject virtually the entire Norwegian stock of glass marbles to keep the natural fractures open. Methods eventually became more sophisticated, and steadily improving well control is one of the main reasons why recoverable reserves in Valhall have increased four- and five-fold from the original PDO. The field is now expected to remain on stream until 2050. Moreover, compaction of the chalk explains why the seabed has subsided by six metres since 1982. Over the years, the rate of subsidence has declined from 25 centimetres per annum to about 13 – thanks in part to water injection.

Until 2004, Valhall was produced with pressure reduction. Waterflooding in the central part of the reservoir began during January 2004.

Valhall

Blocks	2/11 and 2/8
Production licences	006 and 033
Awarded	1969
Total recoverable reserves	912 mill bbl oil 26.4 bn scm gas 5.3 mill tonnes NGL
Remaining at 31 Dec 2008	290 mill bbl oil 6.9 bn scm gas 2.2 mill tonnes NGL
Discovered	1975
Approved for development	2 Jun 1977
On stream	1 Oct 1982
Operator	BP Norge AS
Operations organisation	Stavanger
Main supply base	Tanger
Licensees	
BP Norge AS	28.09%
Hess Norge AS	28.09%
Enterprise Oil Norge AS	28.09%
Total E&P Norge AS	15.72%

Transport

Two 20-inch pipelines for oil and gas respectively have been laid from Valhall to the Ekofisk centre. The 2/4 G riser platform was where Valhall originally tied into Ekofisk. A bridge with piping systems connected this installation to the Ekofisk tank, 2/4 T. The platform was installed and became operational in 1981. Valhall oil was piped on from Ekofisk to Teesside, while its gas went to Emden. In connection with the Ekofisk II development in 1998, a new 24-kilometre gas pipeline from Valhall was tied directly into the Norpipe line to Germany. The oil pipeline was tied to Ekofisk 2/4 J, and 2/4 G ceased operation.

Development solution

Valhall was originally developed with separate platforms for quarters, drilling and processing/compression. All three came on stream in 1982.

The WP wellhead platform, providing 19 extra slots, was installed in 1996. These four installations are tied together with bridges.

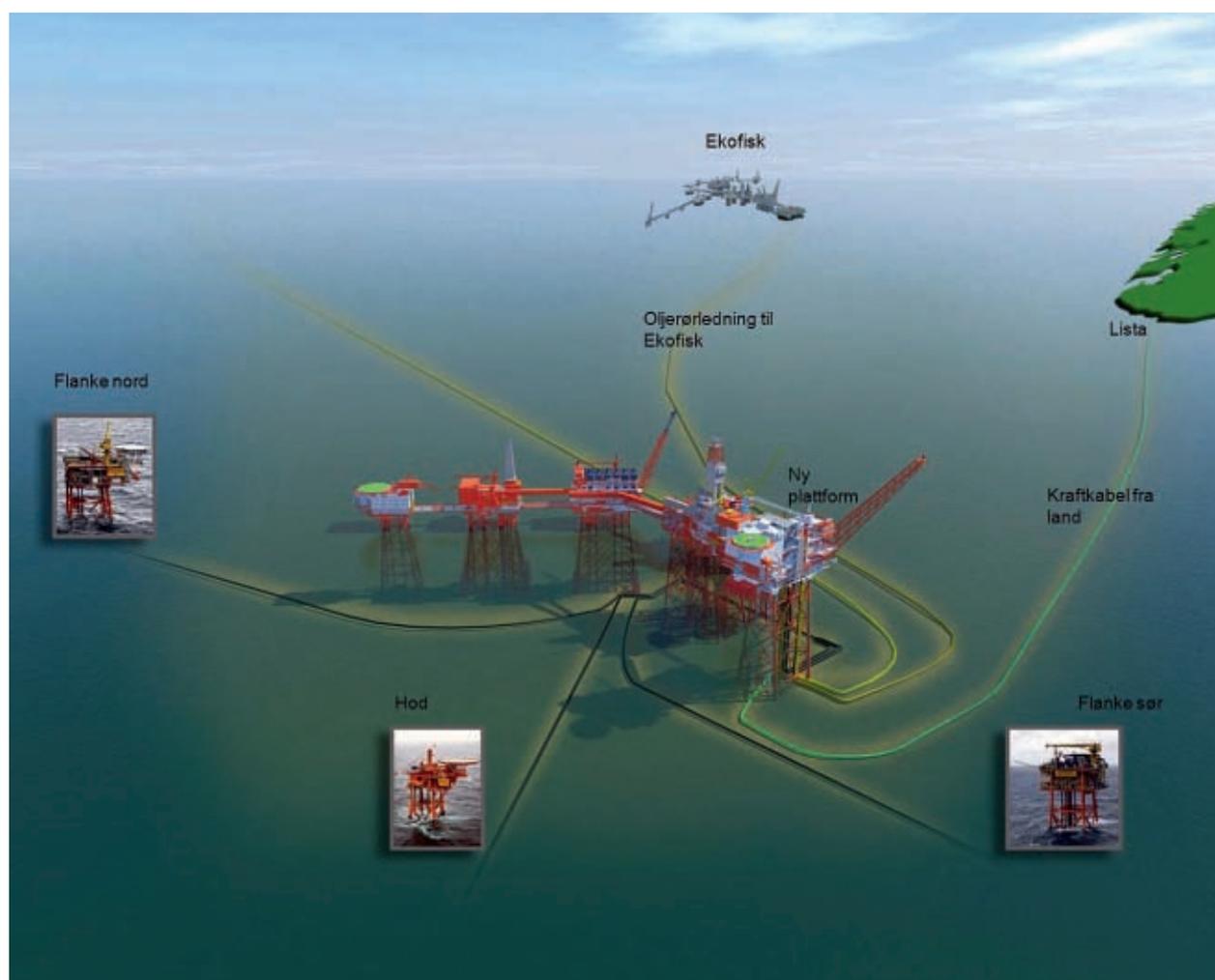
A water injection platform, Valhall IP, was installed on the field in the summer of 2003 and linked to WP by a bridge. These platforms are so close that drilling equipment on IP can also be used over the wells on WP.

The flank development embraces two platforms – Valhall Flank South (VFS), on stream in 2003, and Valhall Flank North (VFN). The latter began producing in 2004. These installations are unstaffed and controlled from the field centre, in part via fibreoptic cables, and also get their power from there.

Valhall processes Hod production and also delivers gas for gas lift in that field.

Valhall redevelopment

The Valhall redevelopment project involves the construction of a new integrated production and



Valhall redevelopment. Illustration: BP Norge AS

quarters platform on the field to replace the three oldest installations. Energy supply on Valhall will be converted from gas turbines to electricity delivered through a transmission cable from Lista. Carbon emissions from the field will be reduced by 97 per cent, equivalent to more than 400 000 tonnes compared with the use of the existing gas turbines. Emissions of nitrogen oxides will be cut by 90 per cent, from close to 1 000 tonnes per annum to 90 tonnes. Gas from the flare which functions as the platform's safety system will also be recovered. Plans call for production from the new installation to start in late 2010. An extra fibreoptic cable linking Valhall via Lista to Stavanger will make it possible in the future to control all production from the field from land. Modern integrated operations centres will be installed both on the new platform and on land.

Valhall QP

The quarters platform was built in 1979 and became operational in July 1981. A number of the cabins have today been converted to single occupancy, with a corresponding reduction in accommodation.



The Valhall QP quarters platform. Photo: BP Norge AS

Valhall DP

The drilling platform stands in the middle of the field complex and provides 30 well slots. It became operational in December 1981 as the first North Sea platform with an enclosed derrick. The derrick and its foundation were removed in the spring of 2009. All drilling takes place today from Valhall IP and the adjacent Valhall WP, and by taking drilling rigs into the flank platforms.



The Valhall DP drilling platform. Photo: BP Norge AS

Valhall PCP

The production and compression platform is designed to produce 168 000 barrels of oil and 10 million standard cubic metres (scm) of gas per day. It stands 65 metres high and weighs 21 000 tonnes. While the oil is piped to the 2/4 J platform on Ekofisk and thence to Teesside in the UK, the gas travels via a pipeline tied into the Norpipe line to Emden in Germany.

Valhall PCP also receives oil and gas from Hod and returns gas to the latter field for gas lift.



*The Valhall PCP production and compression platform.
Photo: BP Norge AS*



*The Valhall WP wellhead (left) and IP injection platforms.
Photo: BP Norge AS*



The Valhall PH production and hotel platform. Photo: BP Norge AS

Valhall WP

The wellhead platform was installed in April 1996 and provides 19 well slots. Including drilling, this installation cost about NOK 1.5 billion.

Valhall IP

Installation of the injection platform began in the last half of 2008. Waterflooding with seawater has begun from a well on WP, while injection of produced water started in early 2005.

Valhall PH

The new production and hotel platform has been installed at the Valhall field centre. Its steel jacket was lifted into place by the Saipem 7000 crane ship in June 2009. The platform is tied to Valhall IP by a bridge. Valhall PH is an integrated process/LQ facility that will replace the existing QP quarters and PCP production and compression platforms, as part of BP's Valhall Redevelopment project in the Nor-

wegian North Sea. The new living quarters contains a control room, technical rooms, workshops, store rooms, 180 cabins, canteen, dayroom, and a room for miscellaneous activities.

Ekofisk 2/4 G - Valhall RP

This riser platform was installed on the Ekofisk field to receive oil and gas from Valhall, and was in use from 1982 to 1998.

Valhall VFS

The unstaffed Valhall Flank South wellhead platform stands six kilometres south of the field centre.

Valhall VFN

Valhall Flank North is an unstaffed wellhead platform located six kilometres north of the field centre. Like Valhall VFS, it has 16 slots for production wells. It began producing on 7 January 2004.



Valhall Flank South. Photo: BP Norge AS



Valhall Flank North with the West Epsilon jack-up rig. Photo: BP Norge AS

Hod

The Hod field is located in block 2/11, 13 kilometres south of Valhall, and lies in 72 metres of water. Production began in September 1990. BP Norge AS is the operator.

Reservoir and recovery solution

Hod produces from chalk layers in the Ekofisk, Tor and Hod formations. The field embraces three structures – Hod West, Hod East and Hod Saddle.

Production is based on pressure reduction. Gas lift has been used since 2001 in the most important well to boost output. An injection pilot was initiated in 2006 in order to test whether waterflooding could be a strategy for increasing recoverable reserves.

Transport

Oil and gas are piped in a single line to Valhall for further processing, and exported via Ekofisk to Tees-side and Emden.

Development solution

Hod has been developed with a simple wellhead platform which ranked as Norway's first unstaffed installation, and is remotely operated from the Valhall centre. With quarters for 10 people, it is normally visited once or twice a week for maintenance, monitoring and operational requirements. The platform has a steel jacket and weighs 3 950 tonnes in all. It is designed to accept a drilling rig cantilevered from a jack-up. Hod has eight well slots and a production capacity of 34 650 barrels of oil per day. The oil and gas stream is separated and metered on the platform before transport as a two-phase flow through a simple 12-inch pipeline for processing on Valhall. Wellhead pressure makes pumping of oil and gas unnecessary.



The Hod platform. Photo: BP Norge AS

Hod

Block	2/11
Production licence	033
Awarded	1969
Total recoverable reserves	64.2 mill bbl oil 1.8 bn scm gas 0.4 mill tonnes
NGL	
Remaining at 31 Dec 2008	7.5 mill bbl oil 0.2 bn scm gas 0.1 mill tonnes
NGL	
Discovery year	1974
Approved for development	26 Jun 1988
On stream	30 Sep 1990
Operator	BP Norge AS
Operations organisation	Stavanger
Main supply base	Tananger
Licensees	
BP Norge AS	25%
Enterprise Oil Norge	25%
Hess Norge	25%
Total E&P Norge AS	25%