

# OIL AND GAS FIELDS IN NORWAY

## INDUSTRIAL HERITAGE PLAN



NORSK OLJEMUSEUM

# THE BALDER AREA

The Balder area embraces the Balder, Ringhorne, Ringhorne East and Jotun fields. It lies about 190 kilometres west of Stavanger in 125-130 metres of water.

Balder is an oil field developed with subsea-completed wells tied back to an FPSO where the oil and gas are processed. Gas from Balder is piped to the Jotun FPSO for gas lift and final processing, while the oil gets offloaded to tankers.

Ringhorne has been developed with a combined steel drilling, wellhead and quarters platform. Oil from Tertiary strata is transferred to the Balder FPSO, while oil and gas from the Jurassic reservoir goes to Jotun for processing. Ringhorne is regarded today as part of Balder.

An oil field located north-east of Balder, Ringhorne East produces through three wells drilled from the Ringhorne platform. This output goes to the Balder and Jotun FPSOs for processing, storage and transport.

Jotun is an oil field about 25 kilometres north of Balder. It has been developed with the Jotun A FPSO and the Jotun B steel wellhead platform. This development is integrated with Balder and Ring-



horne. Oil is discharged to shuttle tankers, with processed rich gas carried via Statpipe to Heimdal or Draupner for onward transport to markets in the UK and continental Europe.

All the fields in the Balder area are operated by ExxonMobil, which is also the sole licensee for Balder and Ringhorne and has holdings of 77 and 45 per cent respectively in Ringhorne East and Jotun.



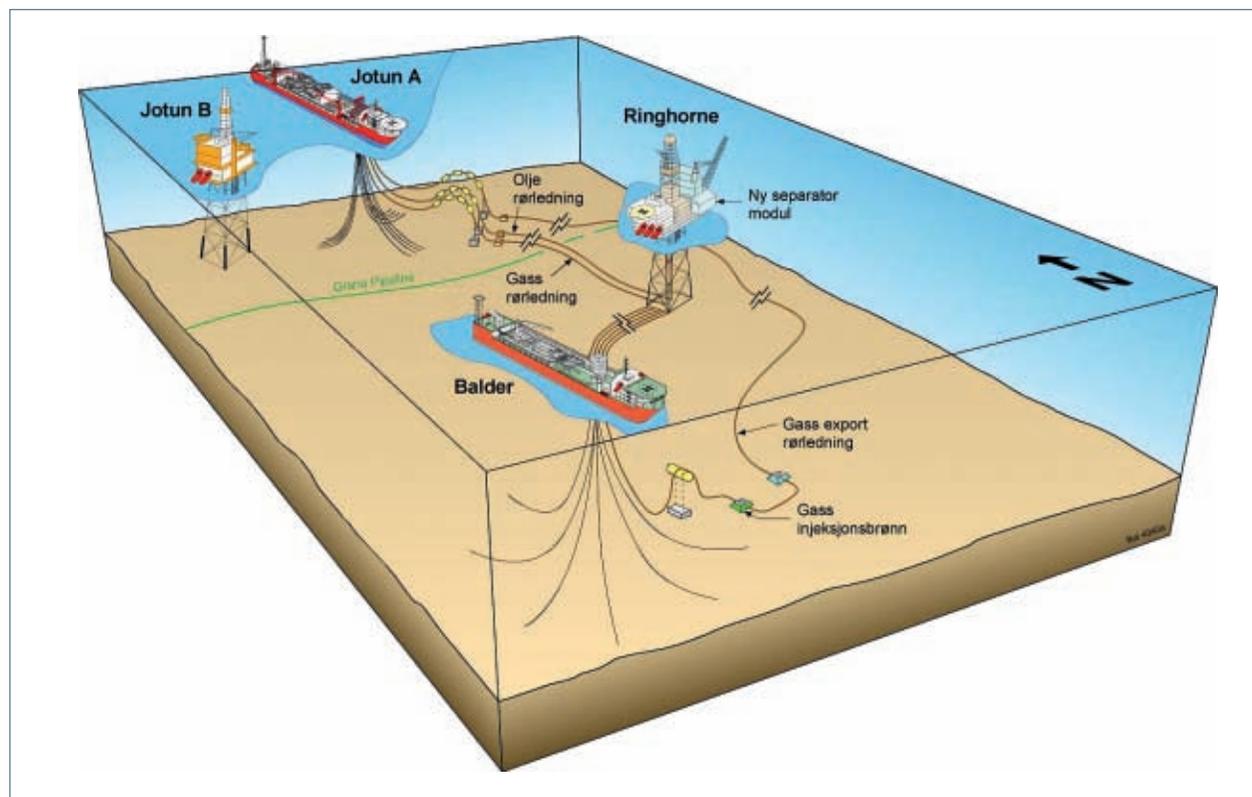


Illustration: ExxonMobil

## Balder

This field was discovered by the second well drilled on the NCS in production licence 001. Drilling rig Ocean Traveler encountered thin sandstone zones containing oil during 1967 which later proved to be the eastern flank of Balder. This was the first discovery of hydrocarbons on the NCS, more than two years before Ekofisk was found and declared commercial.

A combination of marginal oil reserves and complicated geology with big local variations is the principal reason why almost 30 years passed before Esso decided to develop this field. Test output with the Petrojarl 1 production ship in the summer of 1991 provided valuable information and contributed to the final decision to develop in 1996. Balder came on stream in September 1999.

### Reservoir and recovery strategy

The reservoir sands in Balder date from the Palaeocene, and were deposited 50–60 million years ago. These strata, derived from shallow marine sediments on the Shetland platform to the west, were carried east by turbidity currents and deposited in deep marine fan complexes about 50–100 kilometres off the Palaeocene coastline in 600 metres of water.

Balder has reservoir sands in three oil-bearing formations – Heimdal, Hermod and Balder. The first of these, which is the oldest, is up to 100 metres thick. By and large, the rather younger Hermod sands lie between and on the flanks of the Heimdal deposits.

### Balder

Blocks	25/11 and 25/10
Production licences	001 and 028
Awarded	1965 and 1969

Total recoverable reserves including Ringhorne	377.4 mill bbl oil 1.9 bn scm gas
Remaining at 31 Dec 2008 including Ringhorne	89.3 mill bbl oil 0.9 bn scm gas

Discovery year	1967
Approved for development	2 Feb 1996
On stream	2 Oct 1999
Operator	ExxonMobil
Operations organisation	Stavanger
Main supply base	Dusavik

<b>Licensee</b>	
ExxonMobil	100%

For the first time in the world, three-dimensional seismic was shot using six streamers from a single survey vessel during 1994 in the Balder and Sleipner areas. Esso Norge was operator for this programme, with American Explorer as the survey ship. The 3 000-metre-long streamers were towed in an array 500 metres wide. This survey proved highly successful, and the new data made a significant contribution to Esso's exploration success in the Balder and Sleipner areas.

Balder and Ringhorne are produced by natural water drive and injection of produced water. Thirteen production wells, three water injectors, one gas injector and a well to produce injection water have been drilled.

### Development solution

The Balder FPSO is a production, storage and offloading vessel. Subsea-completed wells are tied back to the ship, where oil and gas are processed. Measuring 211 metres long by 36 wide, the ship weathervanes around a turret with a 10-point mooring spread. This cylindrical structure accommodates 20 flexible risers. The ship can receive and process 110 000 barrels of oil per day and store 380 000 barrels. The crude is transferred to tankers for export.

In early 2003, the Ringhorne platform was tied back to the Balder FPSO for processing and export.

Produced gas in excess of fuel requirements were normally injected in the reservoir up to the fourth



*The Balder field. Illustration: ExxonMobil*

quarter of 2003. It has subsequently been piped from Balder to Jotun for export via Statpipe.

The processing and compression systems on the FPSO have been substantially upgraded in recent years to improve operational reliability.



*The Balder FPSO. Photo: ExxonMobil*

## Ringhorne

This field lies about nine kilometres north of the Balder FPSO and features a platform with water injection and processing facilities. Output is piped to the Balder and Jotun installations for final processing, storage and export.

Approved by the Storting in May 2000, the Ringhorne development embraces several structures close to Balder. Production is closely integrated with the latter field, and often regarded as part of it. Ringhorne came on stream in February 2003.

### Reservoir and recovery strategy

The geology in the area is very complex, while much of the crude in the field is heavy and must be helped to the surface with pressure support and gas lift techniques. Fourteen production, eight water injection and one water source wells have been drilled. In addition to platform wells, two subsea completions – one for oil production and the other for water injection – are tied back to the Balder FPSO.

### Transport

The Ringhorne and Balder pipeline system was approved by the King in Council during February



The Ringhorne platform. Photo: ExxonMobil

### Ringhorne

Blocks	25/11 and 25/8
Production licences	001, 027, 027B, 028 and 169
Awarded	1965, 1969, 1991 and 2000

Reserves	See Balder
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Discovery year	1970
Approved for development	June 2000
On stream	February 2003
Operator	ExxonMobil
Operations organisation	Stavanger
Main supply base	Dusavik

Licensee	
ExxonMobil	100%

2003. This project involved installing three pipelines to carry oil and gas from Ringhorne and Balder to Jotun.

Oil and gas from Ringhorne's Jurassic reservoir are transferred to Jotun for processing, while oil from the Tertiary zones is sent to Balder. Oil is offloaded from the Balder FPSO's storage tanks to shuttle tankers for delivery to land-based facilities in Norway, continental Europe and the USA.

### Development solution

The Ringhorne platform was built at Heerema Tønsberg as a virtual copy of the Jotun B installation. Supported on a four-leg steel jacket, this integrated drilling, wellhead and quarters facility has a first-stage separation system. It is tied back to the Balder FPSO for further processing and export of the oil. Heerema's huge Thialf crane ship lifted the topside into position on 20 August 2002. At 11 500 tonnes, this was the world's second heaviest lift. The subsea well came on stream in May 2001, followed by the wellhead platform in February 2003.

Virtually no environmentally harmful discharges/emissions occur from the Ringhorne platform. All drill cuttings and produced water are injected back into wells in the reservoir. The platform has a closed flare system, so that burning gas with associated carbon emissions is avoided in normal operation.

Average daily oil production from Balder and Ringhorne totalled 83 000 barrels in 2007, broken down into 26 000 and 57 000 barrels respectively.

## Ringhorne East

Two additional discoveries were made in 2003 just to the east of Ringhorne, with the wells drilled from the platform on the latter field. Ringhorne East began production in March 2006, and averaged 98 000 barrels of oil per day in 2007.

### Ringhorne East

Block	25/8
Production licences	027 and 169
Awarded	1969 and 1991
Total recoverable reserves	55.4 mill bbl oil 0.2 bn scm gas
Remaining at 31 Dec 2008	27 mill bbl oil 0.1 bn scm gas
Discovery year	2003
Approved for development	25 Nov 2005
On stream	19 Mar 2006
Operator	ExxonMobil
Operations organisation	Stavanger
<b>Licensees</b>	
ExxonMobil	77.38%
Statoil	14.82%
Petoro	7.80%

## Jotun

This field lies in 136 metres of water about 25 kilometres north of Balder and 165 kilometres west of Haugesund. It came on stream in October 1999.

### Reservoir and recovery strategy

Jotun comprises the Elli, Elli South and Tau West reservoirs, proven in 1994 and 1995. The eastern-most of these structures has a gas cap. They lie in a submarine fan system about 2 000 metres down. The three structures are relatively flat and separated only by small depressed areas. Sandstones on the western side have good reservoir quality, while the shale content increases towards the east.

Production makes use of pressure support from natural water drive as well as injection of a proportion of the produced water.

Four-dimensional seismic was shot on Jotun in the summer of 2002 after some years on stream. To understand changes over time, reference data had already been obtained before production began. Both data sets were gathered and processed in the same way, and differences between them reflected the movement of fluids in the reservoir as a result of production. Interpreting the 4D survey results has

### Jotun

Blocks	25/7 and 25/8
Production licences	027, 027 B and 103 B
Awarded	1969, 1998 and 1999
Total recoverable reserves	148 mill bbl oil 0.8 bn scm gas
Remaining at 31 Dec 2008	11.3 mill bbl oil
Discovery year	1994
Approved for development	10 Jun 1997
On stream	25 Oct 1999
Operator	ExxonMobil
Operations organisation	Stavanger
Main supply base	Dusavik
<b>Licensees</b>	
ExxonMobil	45%
Dana Petroleum	45%
Lundin Norway	7%
Petoro	3%

yielded useful information on how the water front moves in the Jotun. Three infill wells positioned and drilled on the basis of these data have all proved successful producers.

### Transport

Oil is sent via loading buoys to tankers, with the gas exported through a pipeline tied into the Statpipe system. Since 2004, Jotun has received oil and gas from Balder and Ringhorne for processing and onward transport.

Daily oil production averaged 9 000 barrels per day in 2007. Output from Jotun has declined in recent years, creating spare production capacity. To exploit this, Balder was tied back to Jotun via a gas pipeline in 2003. A pipeline from Ringhorne followed in 2004, making it possible to produce part of that field to the Jotun FPSO in addition to the Balder facility. A total of 41 000 barrels of oil per day were sent from Ringhorne to Jotun in 2007 for processing, storage and export. In addition, 700 000 scm of gas were exported daily from Balder and Ringhorne to Jotun.

### Development solution

Jotun B is a normal unstaffed wellhead platform supported by a four-leg steel jacket. Heerema Tønsberg was the main contractor in a consortium with ABB Offshore Technology.

Measuring 233 metres long and 42 wide, the Jotun A production and storage vessel was built



*Jotun B. Photo: ExxonMobil*

at Kværner Rosenberg in Stavanger and Kværner Masa Yards in Finland.

Platform and ship are tied together with flowlines for oil and gas production and for water injection, as well as with power and control cables.



*Jotun A. Photo: ExxonMobil*