Elgin/Franklin
Central Graben Area & operations
TOTAL E&P UK Limited is one of the largest oil and gas companies in the UK and part of the global business of the TOTAL Group, the fourth largest integrated oil and gas company in the world. The TOTAL Group, which has its headquarters in Paris, has operations in 130 countries and employs almost 100,000 people worldwide.

The Group’s operations cover the entire range of oil and gas related activities, including exploration & production, trading & shipping and refining & marketing - as well as the manufacture and supply of a comprehensive range of chemical products.

The UK Upstream subsidiary, TOTAL E&P UK, has its headquarters in Aberdeen, Europe’s oil and gas capital, and is one of the largest operators on the UK Continental Shelf in terms of production and reserves.

The company employs over 700 people, split between its onshore sites and its offshore facilities. Being part of an international Group means that the workforce includes both local and expatriate staff, drawn from more than 30 countries.

With its affiliates, TOTAL E&P UK owns and operates the Alwyn North, Dunbar, Ellon, Grant, Nuggets, Forvie, Jura and Otter fields in the Northern North Sea. It also operates the Elgin, Franklin, West Franklin and Glenallan Fields in the Central Graben Area of the Central North Sea.

The company and its UK affiliates also have a number of non-operated interests in the Central and Northern North Sea including Bruce, ETAP, Alba, Armada and Nelson and has an interest in the Sullom Voe Oil Terminal on Shetland.

Onshore, TOTAL E&P UK operates the St Fergus Gas Terminal on the northeast coast of Scotland, which receives and processes up to 20% of the UK’s natural gas requirements from over 20 fields in the UK and Norway. It owns 100% of the Terminal’s facilities and 50% of the Common Facilities, the remainder of the plant being owned by the Norwegian Association, Gassled.

The company has a 100% interest in the UK Frigg pipeline (PUKA), an interest in the SEAL, (Sheanwater Elgin Area Line) pipeline through Elgin Franklin Oil and Gas Limited (EFOG), which is owned 77.5% by Elf Exploration UK Limited and 22.5% by Gaz de France. EFOG has a 25.73 per cent share in SEAL.
The welfare of its workforce is TOTAL E&P UK’s top priority and it conducts all its activities taking full account of the health and safety of its people, ensuring the safest possible working environment and the prevention of work-related illness. Our goal is to achieve an accident-free work environment and thinking ‘Safety First’ is the responsibility of all staff at their work locations, whether onshore or offshore.

Best in class environmental performance is another major goal.

We set measurable safety, health and environmental objectives and work hard to improve performance, making sure that all our staff and contractors are fully equipped to understand and implement our procedures. In addition, we work with partners, suppliers, competitors, regulators and the general public in developing and testing our emergency plans, which we believe help to set and raise industry standards.

We also encourage a broad culture of openness and co-operation in the firm belief that this creates a positive attitude towards the advancement in understanding and improvement of performance in the areas of safety, health and environment – all of which is reviewed and audited. Those who contribute directly to improvements are recognised and performance evaluations for all employees include safety, health and environmental aspects. This is particularly important for those employees with managerial or supervisory responsibilities.

TOTAL E&P UK continues to maintain its company-wide registration to ISO-14001, the international Environment Management System standard. This is globally recognised as reflecting a level of ‘good business practice’ and underlines a company’s genuine commitment to sustainable development. We are very proud of this achievement and through the maintenance and improvement of our management systems, hope to continue improving our environmental performance.

2008 saw the launch of TOTAL E&P UK’s Safety, Health and Environment (SHE) Vision – five individual elements that work together to drive our SHE performance. These five areas – competence, supervision, SHE culture, risk assessment and asset integrity – will give us clear platforms on which to focus our efforts in the coming years.
The Elgin and Franklin fields are outstanding examples of how boldness and technological innovation can lay the foundations for a successful development. Developing the fields demanded the establishment of global industry standards for overcoming the huge challenges of deep, high-pressure/high temperature (HP/HT) wells and unlocked the potential for developing HP/HT reservoirs around the world.

Elgin/Franklin is the largest offshore HP/HT development ever undertaken. Individual wells had been managed with high temperatures or high pressures before, but there had never been such a deeply buried field with such a combination of both. Research and development to manufacture quality components capable of withstanding these extreme pressures and temperatures required investment of over £20 million and many other aspects of this complex development needed extensive research and innovation.

The fields are located in the Central Graben Area of the North Sea, 240km East of Aberdeen in 93 metres of water. Franklin was discovered in 1986 and Elgin five years later. When first discovered, there was no experience of developing such reservoirs and no equipment fully capable of coping with the associated HP/HT conditions.

The predicted reserves in the two fields was sufficiently large to make recovery attractive but it took four years of extensive research and development work before the project could finally be given approval in 1995.

Elgin began production in March 2001, with gas export beginning in May of the same year. Very shortly afterwards, in August 2001, production began from the Franklin Field. Initial plateau production was reached in March 2002 at a rate of 140,000 barrels of condensate per day and 13 million cubic metres of gas per day, a combined 220,000 barrels of oil equivalent per day (boed), approximately 5% of the entire UK production.

The Elgin/Franklin fields contain the UK North Sea’s largest remaining discovered reserves and so play a vital part in the UK’s security of supply.
As with the Alwyn Area in the Northern North Sea, TOTAL E&P UK sees the Elgin/Franklin facilities as a hugely important hub and vital in helping to unlock other discoveries in the region. Through further exploration and more research into managing complex reservoirs, the platform, processing plant and pipelines around Elgin/Franklin have enabled additional fields to be developed.

In January 1999 the Glenelg exploration well was completed as a gas-condensate discovery at a depth of 5600 metres. This was a highly deviated well of 7.3km length, drilled from the Elgin wellhead platform to a bottom hole location 4 km West of the Elgin field.

In March 2006 the Glenelg field began production with potential to produce in excess of 30,000 boed, thereby ensuring that the Elgin/Franklin facilities remained at their production capacity of 220,000 boed. It was the deepest, highest pressure and highest temperature field developed in the UK at that time.

In July 2003 the West Franklin exploration well was announced as a successful gas-condensate discovery. It was drilled from the Franklin wellhead platform to a true vertical depth (TVD) of 5950 metres below sea level. Production began in October 2007 at which point it became the deepest, highest pressure and highest temperature development in the UK, outstripping even the extreme conditions of the Glenelg field.

A second well, known as West Franklin B (WFB) well, drilled in 2007-2008 significantly increased the reserve estimates of the field to almost 200 million barrels of oil equivalent (boe) - a very significant field for the UK Continental Shelf (UKCS).

The Elgin/Franklin fields are located in a complex geological structure, almost 6km below the sea bed. Located in Block 22/30b, 22/30c and 29/5b, the Elgin Field was discovered in 1991 by well 22/30c-8 which tested a complex, faulted, anticlinal structure.

The nearby Franklin Field, approximately 5.5km southeast of Elgin within Block 29/5b was discovered with well 29/5b-4, which drilled a tilted fault block in 1986. Both fields contain high pressure, high temperature reservoir fluids (HP/HT) known as gas condensates. The principal reservoir in each field is a very fine grained, shallow marine sandstone of the Upper Jurassic Fulmar Formation. These were deposited around 140 million years ago. Excellent reservoir quality exists due to the significant porosity, preserved by the extreme overpressures.

The pressure of an average North Sea field is in the order of 300 bar, equivalent to 300 times that of atmospheric pressure, while Elgin/Franklin pressures measure around 1100 bar equivalent to 1100 times that of atmospheric pressure.

Temperatures in a conventional North Sea reservoir are in the region of 90 degrees centigrade, while in Elgin/Franklin are around 200 degrees centigrade. The extreme temperatures and pressures encountered in Elgin/Franklin posed very considerable development challenges and were exacerbated by the dangerous and corrosive gases - hydrogen sulphide and carbon dioxide - contained within the reservoir fluids.
Before production could begin, two heavy duty jack-up drilling rigs were contracted from Santa Fe to drill the fields’ production wells. The Galaxy 1 drilled five wells on the Elgin Field and also connected two previously drilled exploration wells at a cost of £10 million per well. These were extremely difficult and challenging operations.

Franklin’s six wells were drilled by the Magellan drilling rig. Originally it was planned to drill just five wells, but estimates of the combined field reserves rose by over 100 million barrels of oil equivalent (boe) to around 800 million boe so that in 1999, approval was given for an additional well.

When drilling through the rock formations above the Jurassic aged reservoirs, pressures could jump dramatically from 650 bar to 1100 bar in just a few metres. It is essential to anticipate these very large changes and ensure an appropriate weight of ‘mud’ (the mix of chemicals used down the well) to avoid a blow-out. A new computer programme was developed to help determine how best to control the well pressures and this proved to be of great benefit.

The cost of drilling rigs has varied enormously, reaching over US $500,000 per day and resulting in extremely high costs to drill wells in these difficult and sometime unpredictable reservoirs. Careful and detailed engineering planning, well design and reservoir studies are essential before and during drilling to ensure the availability and use of correct equipment and fluids. This also relies upon highly efficient co-operation between onshore management and the drilling rigs and the expertise of the drilling team.

Since production began in 2001 highly deviated wells have been drilled from the Elgin wellhead platform, 7.3km into the Glenelg prospect, which came on stream in 2006, and also into West Franklin that began production in 2007.

In addition to the complex drilling operations already described, it was recognised in 2004 that at some stage it would be advantageous to drill field infill wells to maximise field recovery and to tap areas of the field with additional reserves. However, it had previously been thought near to impossible and too hazardous due to the extreme pressure differences between depleted and undepleted zones.

Between 2004 and 2007 TOTAL E&P UK invested considerable money and expertise to develop possible solutions to the many problems identified and in 2007 rose to the challenge with the successful drilling of the Franklin Infill Well (FIA) now known as the producing well 29/5b-F8. This learning experience has greatly enhanced the possibility of phased HPHT developments and places TOTAL E&P UK at the very forefront of this new technique.
The Elgin and Franklin Fields have similar wellhead platform structures consisting of four legs and steel jackets. Each is connected to the PUQ (Production/Utilities/Quarters) platform where hydrocarbons produced from the Elgin, Franklin, Glenelg and West Franklin fields are separated into gas and liquid components.

The PUQ is connected to the Elgin wellhead platform by a 90 metre bridge which, as well as providing access for personnel, houses the cables and pipes taking electrical power, water for the fire protection equipment and other utilities to the wellhead platform.

A 5.25km subsea pipeline bundle links the PUQ to the Franklin wellhead platform. Franklin has a helideck to allow access for maintenance and although this is usually carried out on a day-trip basis there is an emergency overnight shelter for up to 20 people.

Both the Elgin and Franklin wellhead platforms are normally unmanned and operated remotely from the control room on the PUQ. Each platform is equipped with a freefall lifeboat, life rafts and other essential safety equipment.

The vital link between the Franklin wellhead platform and the PUQ is the 5.25km pipeline bundle. Inside this 42" pipe bundle are two 12" diameter flowlines, through which the gas condensate travels between the wellhead platform and the processing equipment on the PUQ.

A significant challenge in the design of this pipeline bundle was ensuring that it would be capable of operating efficiently and safely with the very large temperature variations predicted over the field life of more than 20 years.

During the early days of production the condensate was at about 80ºC, then rising to 150ºC before cooling again. The cooling riser and pipeline bundle have to ensure that the condensate neither drops below 38ºC, at which point waxes and hydrates can develop, nor be hotter than 145ºC when it reaches the PUQ.

In addition to the bundle there are two umbilicals that supply the Franklin field with chemicals and hydraulic fluids plus an electrical cable to supply power and fibre optics to control production.
The Elgin and Franklin fields lie approximately 5.5km apart, each with its own wellhead platform. Production from both fields is fed by pipeline through a third installation, known as the PUQ (Production/Utilities/Quarters) platform that is situated adjacent to the Elgin wellhead platform and linked to it by a bridge.

The 43,000 tonne PUQ jack-up platform is similar to a traditional jack-up drilling rig except that it has no drilling facilities onboard. Instead, it is essentially a mini oil and gas refinery with a sophisticated process system onboard to produce commercial quality gas that can then be sent to shore. It is also home to the core crew who live onboard, usually for two weeks at a time.

Most North Sea fields produce large quantities of gas or large quantities of oil with gas as a by-product. Elgin/Franklin produces large quantities of both liquid condensate and gas and it was determined that the most efficient and cost effective way to develop the fields was to separate the oil and gas offshore and then send the liquids to an oil terminal and the commercial quality gas to a gas terminal.

Technological development and the scale of processing equipment was at the very forefront of industry experience at the time and set many challenges, but performance since production began has shown that the offshore processing decision was the correct one.

Liquids are exported through the BP-operated Forties Pipeline System into Cruden Bay and on to Kinneil in Fife. Gas flows through the purpose built, 468km SEAL (Shearwater Elgin Area Line) pipeline to the Bacton Terminal in Norfolk, where it joins the UK gas grid and where there is also a link to the Interconnector pipeline to Belgium.
The welfare of its workforce is TOTAL E&P UK’s highest priority and, in addition to ensuring their safety and health, this includes doing everything we can to ensure that off-duty time on the PUQ is as comfortable and relaxing as possible. There is accommodation for up to 97 persons and additional accommodation is being installed for a further 40 persons to enable crew numbers to increase during periods of maintenance and modification works.

All cabins have radio, satellite TV and en-suite facilities offering crew a private space to enjoy reading, listening to music or just relaxing. Communal facilities are located in a recreational area and include two full-sized snooker tables, darts, music room, fitness suite, TV lounge with extensive film collection and a library. Internet access is available to all staff offshore. Newspapers arrive regularly with helicopter supplies and there is an excellent dining room offering quality food and refreshments at all hours, catering for the 24 hour nature of operations.

The accommodation area is separated from the process facilities and all hydrocarbons by a blast wall. This blast wall is designed to contain any explosion and allow the crew to reach the four 42-man lifeboats in case of an emergency.
Hydrocarbons produced from the Elgin/Franklin area fields are separated and treated in the small, offshore refinery on the PUQ. Liquids are transported to shore through the BP-operated Forties Pipeline System. A new spur pipeline was built to connect the PUQ to the Forties System, joining it close to BP’s Marnock platform.

Liquids from Shell’s Shearwater field, located just a few kilometres northeast of the Elgin field also uses this new Shell operated spur pipeline, called GAEL (Grabben Area Export Line), to connect to the BP Forties Pipeline System. The Forties System makes landfall at Cruden Bay, North of Aberdeen and then continues southwards on to Kinnel in Fife for processing of the hydrocarbons.

To export the commercial quality gas from Elgin/Franklin and Shearwater a new 34” pipeline was built. This line, called SEAL (Shearwater Elgin Area Line), also operated by Shell, carries the gas some 468km South to purpose-built reception facilities within Shell’s gas terminal at Bacton in Norfolk.

Gas is then routed through a 450 metre, 24” pipeline to the Transco Terminal and into the National Grid. There is also the option to use a 900 metre long, 34” pipeline, called SILK (SEAL Interconnector Link) which connects to the Interconnector terminal for onward transmission to Europe.

Although the gas produced from Elgin/Franklin and Shearwater is processed offshore to meet UK sales gas specifications, the facilities at Bacton adjust the temperature and pressure of the gas and meter its delivery to the Transco and Interconnector terminals.
TOTAL E&P UK’s development of Elgin/Franklin opened a whole new era of activity in the North Sea. These were, and remain, world class projects extending the ability to drill and develop high pressure and high temperature reservoirs to ever greater depths. Since bringing the Elgin and Franklin fields into production in 2001, the research carried out and operational experience gained has combined with extensive subsurface studies to facilitate the successful exploration of and production from Glenelg and West Franklin.

Both Glenelg and West Franklin have been highly complex and technically challenging, but the successful conclusion of developing these fields has considerably extended plateau production levels through the PUQ. This has not only given optimism for new discoveries but also heightens the potential of infill drilling into depleted reservoirs, further maximising recovery from these deep HP/HT fields.

Other undeveloped discoveries in the area will be assessed for future tie back to the PUQ. To ensure the long term future of the Elgin/Franklin field facilities for existing and future developments, TOTAL E&P UK continues to invest many millions of £’s into asset integrity and the upgrading of systems. The Elgin/Franklin area represents the largest remaining proven reserves in the UK North Sea and has excellent potential for further development in the future, providing a vital contribution to the UK’s security of supply and representing a major investment for the company.
### Ownership/Interests

**Elgin/Franklin and Block 29/5b**

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<th>Company</th>
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<td>E.F. Oil and Gas Limited #</td>
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<td>Dyas UK Limited</td>
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<tr>
<td>Oranje-Nassau U.K. Limited</td>
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# E.F. Oil and Gas Limited, a company in which the shares are held 77.5% by Elf Exploration UK Limited and 22.5% by Gaz de France.

* Wholly owned subsidiary of Total Upstream UK Limited

**Glenelg, Block 29/4d**

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<td>Eni UKCS Limited</td>
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