

Drilling for shale gas: Is the UK well-prepared?



This research brief is based on “Oil and Gas Wells and Their Integrity: Implications for Shale and Unconventional Resource Exploitation” by Richard Davies, Sam Almond, Rob Ward, Robert Jackson, Charlotte Adams, Fred Worrall, Liam Herringshaw, Jon Gluyas and Mark Whitehead (2014). The paper was published in *Marine and Petroleum Geology* and is available for free download at www.refine.org.uk.

To extract **hydrocarbons** (oil and gas) from rocks, wells have to be drilled deeply into the sub-surface. Globally, more than four million oil and gas wells have been drilled on land. At least 2.6 million wells have been drilled in the USA since 1949. In the UK, there are 2152 onshore wells, drilled between 1902 and 2013.

In North America, a large number of wells have been drilled in recent years to extract shale gas. If the exploitation of shale gas is to take place in other regions of the world, such as the UK, many more onshore wells will need to be drilled. In this regard, long-term well integrity is very important. If the wells leak, they could pollute the environment, including drinking water sources and wildlife habitats. To investigate these risks, researchers at Durham Energy Institute led a global study of hydrocarbon well integrity.

What is a shale gas well?

Gas may be trapped in shale rocks deep below the Earth’s surface. To find and extract this gas, narrow wells (**boreholes**) are drilled down into the shale (Fig. 1A). The borehole is normally lined with steel **casing** tubes. **Annuli** are spaces between the casings that allow fluids to flow up or down the well. **Casing cement** is used to seal off these spaces and to stop fluids escaping.

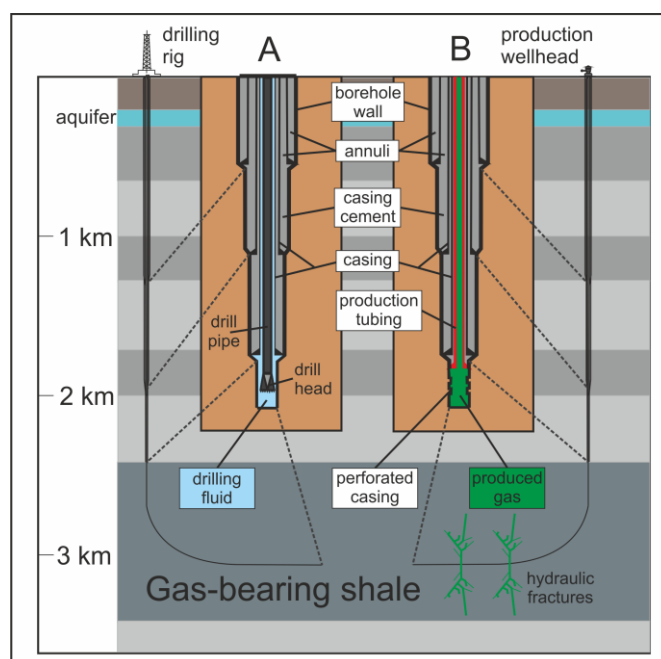


Figure 1: Schematic diagram showing the structure of a shale gas exploration well (A) and production well (B).

To produce gas from shale, the rock must be **hydraulically fractured**. This involves fluids being injected into the shale at high pressure, through the **perforated casing** in the well (Fig. 1B). This creates small fractures in the shale, and the gas then flows through these fractures into the well and up to the surface.

What is well integrity?

To prevent hydrocarbons leaking out of a well before they reach the surface, barriers (such as casing cement) are added. **Well barrier failure** is where one or more of these barriers fail, but hydrocarbons do not leak out of the well. However, if all the barriers fail, this is known as **well integrity failure**. Well integrity failure is of particular concern, as it enables oil, gas or other fluids to escape into the surrounding environment and may lead to pollution.

What is the risk of well integrity failure?

The risk of well failure varies according to the type of well, its age, and the geology it penetrates. Our research examined the leakage rates of hydrocarbon wells in various countries, onshore and offshore, and indicates that well barrier failure occurs in between 1.9% and 75% of wells.

In the UK, shale gas production has yet to take place. However, large quantities of data are available on shale gas well integrity in the USA. Of more than 8,000 shale gas wells monitored in Pennsylvania between 2005 and 2013, our research shows that 6.3% had evidence of well barrier or well integrity failure. For context we also examined the failure rate of conventional onshore oil and gas wells in the UK. Of 143 wells active at the end of the year 2000, one (0.7%) showed evidence of well integrity failure.

How is well integrity monitored?

Well integrity can be monitored by measuring pressure changes within the borehole. Ultrasound and other detection equipment can be used to check that the casing cement is intact. Leakage can also be monitored by probing the soil surrounding the well, and by sampling the groundwater.

What happens after a well stops producing?

When a hydrocarbon well is abandoned, cement is pumped into the production tubing to form a plug that seals the well. In the UK, the top of the well is normally welded shut and the land is remediated. After a well is abandoned it is not typically monitored for leakage.



Figure 2: Shale gas production wells in Pennsylvania, USA. (Image from Wikimedia Commons)

Of the 2152 onshore UK hydrocarbon wells, our research shows that up to 53% were drilled by a company that no longer exists, or which has been taken over or merged. Between 50 and 100 are what we term '**orphaned**' wells, where the company that drilled them has gone out of business or is insolvent. Without the monitoring of abandoned wells, their long-term integrity is not known. Furthermore, if a leakage incident occurred at an orphaned well site, it is uncertain whose liability it would be.

What can we conclude?

The integrity of shale gas wells during production and after abandonment is an important issue. We recommend that data from the monitoring of active wells should be placed in the public domain. We also recommend that periodic surveys of abandoned well sites be carried out and the findings made publicly available.

