

Shale gas extraction in the UK: a review of hydraulic fracturing

June 2012

SUMMARY

Summary

The health, safety and environmental risks associated with hydraulic fracturing (often termed 'fracking') as a means to extract shale gas can be managed effectively in the UK as long as operational best practices are implemented and enforced through regulation. Hydraulic fracturing is an established technology that has been used in the oil and gas industries for many decades. The UK has 60 years' experience of regulating onshore and offshore oil and gas industries.

Concerns have been raised about the risk of fractures propagating from shale formations to reach overlying aquifers. The available evidence indicates that this risk is very low provided that shale gas extraction takes place at depths of many hundreds of metres or several kilometres. Geological mechanisms constrain the distances that fractures may propagate vertically. Even if communication with overlying aquifers were possible, suitable pressure conditions would still be necessary for contaminants to flow through fractures. More likely causes of possible environmental contamination include faulty wells, and leaks and spills associated with surface operations. Neither cause is unique to shale gas. Both are common to all oil and gas wells and extractive activities.

Ensuring well integrity must remain the highest priority to prevent contamination. The probability of well failure is low for a single well if it is designed, constructed and abandoned according to best practice. The UK's well examination scheme was set up so that the design of offshore wells could be reviewed by independent, specialist experts. This scheme must be made fit for purpose for onshore activities. Effects of unforeseen leaks or spills can be mitigated by proper site construction and impermeable lining. Disclosure of the constituents of fracturing fluid is already mandatory in the UK. Ensuring, where possible, that chemical additives are non-hazardous would help to mitigate the impact of any leak or spill.

Concerns have also been raised about seismicity induced by hydraulic fracturing. Natural seismicity in the UK is low by world standards. On average, the UK experiences seismicity of magnitude 5 M_L (felt by everyone nearby) every twenty years, and of magnitude 4 M_L (felt by many people) every three to four years. The UK has lived with seismicity induced by coal mining activities or the settlement of abandoned mines for a long time. British Geological Survey records indicate that coal mining-related seismicity is generally of smaller magnitude than natural seismicity and no larger than 4 M_L . Seismicity induced by hydraulic fracturing is likely to be of even smaller magnitude. There is an emerging consensus that the magnitude of seismicity induced by hydraulic fracturing would be no greater than 3 M_L (felt by few people and resulting in negligible, if any, surface impacts). Recent seismicity induced by hydraulic fracturing in the UK was of magnitude 2.3 M_L and 1.5 M_L (unlikely to be felt by anyone). The risk of seismicity induced by hydraulic fracturing can be reduced by traffic light monitoring systems that use real-time seismic monitoring so that operators can respond promptly.

Monitoring should be carried out before, during and after shale gas operations to inform risk assessments. Methane and other contaminants in groundwater should be monitored, as well as potential leakages of methane and other gases into the atmosphere. The geology of sites should be characterised and faults identified. Monitoring data should be submitted to the UK's regulators to manage potential hazards, inform local planning processes and address wider concerns. Monitoring of any potential leaks of methane would provide data to assess the carbon footprint of shale gas extraction.

The UK's goal based approach to regulation is to be commended, requiring operators to identify and assess risks in a way that fosters innovation and continuous improvement in risk management. The UK's health and safety regulators and environmental regulators should work together to develop guidelines specific to shale gas extraction to help operators carry out goal based risk assessments according to the principle of reducing risks to As Low As Reasonably Practicable (ALARP). Risk assessments should be submitted to the regulators for scrutiny and then enforced through monitoring activities and inspections. It is mandatory for operators to report well failures, as well as other accidents and incidents to the UK's regulators. Mechanisms should be put in place so that reports can also be shared between operators to improve risk assessments and promote best practices across the industry.

An Environmental Risk Assessment (ERA) should be mandatory for all shale gas operations. Risks should be assessed across the entire lifecycle of shale gas extraction, including risks associated with the disposal of wastes and abandonment of wells. Seismic risks should also feature as part of the ERA.

Water requirements can be managed through integrated operational practices, such as recycling and reusing wastewaters where possible. Options for disposing of wastes should be planned from the outset. Should any onshore disposal wells be necessary in the UK, their construction, regulation and siting would need further consideration.

Wastewaters may contain Naturally Occurring Radioactive Material (NORM) that are present in shales at levels significantly lower than safe limits of exposure. These wastewaters are in need of careful management should NORM become

more concentrated during waste treatment. NORM management is not unique to shale gas extraction. NORM is present in waste fluids from the conventional oil and gas industries, as well as in mining industries, such as coal and potash. Much work has been carried out globally on monitoring levels of radioactivity and handling NORMs in these industries.

Shale gas extraction in the UK is presently at a very small scale, involving only exploratory activities. Uncertainties can be addressed through robust monitoring systems and research activities identified in this report. There is greater uncertainty about the scale of production activities should a future shale gas industry develop nationwide. Attention must be paid to the way in which risks scale up. Co-ordination of the numerous bodies with regulatory responsibilities for shale gas extraction must be maintained. Regulatory capacity may need to be increased.

Decisions are soon to be made about shale gas extraction continuing in the UK. The next round of issuing Petroleum Exploration and Development Licences is also pending. This report has not attempted to determine whether shale gas extraction should go ahead. This remains the responsibility of the Government. This report has analysed the technical aspects of the environmental, health and safety risks associated with shale gas extraction to inform decision making. Neither risks associated with the subsequent use of shale gas nor climate risks have been analysed. Decision making would benefit from research into the climate risks associated with both the extraction and use of shale gas. Further benefit would also be derived from research into the public acceptability of all these risks in the context of the UK's energy, climate and economic policies.

Recommendations

Recommendation 1

To detect groundwater contamination:

- The UK's environmental regulators should work with the British Geological Survey (BGS) to carry out comprehensive national baseline surveys of methane and other contaminants in groundwater.
- Operators should carry out site-specific monitoring of methane and other contaminants in groundwater before, during and after shale gas operations.
- Arrangements for monitoring abandoned wells need to be developed. Funding of this monitoring and any remediation work needs further consideration.
- The data collected by operators should be submitted to the appropriate regulator.

Recommendation 2

To ensure well integrity:

- Guidelines should be clarified to ensure the independence of the well examiner from the operator.
- Well designs should be reviewed by the well examiner from both a health and safety perspective and an environmental perspective.
- The well examiner should carry out onsite inspections as appropriate to ensure that wells are constructed according to the agreed design.
- Operators should ensure that well integrity tests are carried out as appropriate, such as pressure tests and cement bond logs.
- The results of well tests and the reports of well examinations should be submitted to the Department of Energy and Climate Change (DECC).

Recommendation 3

To mitigate induced seismicity:

- BGS or other appropriate bodies should carry out national surveys to characterise stresses and identify faults in UK shales. Operators should carry out site-specific surveys to characterise and identify local stresses and faults.
- Seismicity should be monitored before, during and after hydraulic fracturing.
- Traffic light monitoring systems should be implemented and data fed back to well injection operations so that action can be taken to mitigate any induced seismicity.
- DECC should consider how induced seismicity is to be regulated. Operators should share data with DECC and BGS to establish a national database of shale stress and fault properties so that suitable well locations can be identified.

Recommendation 4

To detect potential leakages of gas:

- Operators should monitor potential leakages of methane or other emissions to the atmosphere before, during and after shale gas operations.
- The data collected by operators should be submitted to the appropriate regulator. These data could inform wider assessments, such as the carbon footprint of shale gas extraction.

Recommendation 5

Water should be managed in an integrated way:

- Techniques and operational practices should be implemented to minimise water use and avoid abstracting water from supplies that may be under stress.
 - Wastewater should be recycled and reused where possible.
 - Options for treating and disposing of wastes should be planned from the outset. The construction, regulation and siting of any future onshore disposal wells need further investigation.
-

Recommendation 6

To manage environmental risks:

- An Environmental Risk Assessment (ERA) should be mandatory for all shale gas operations, involving the participation of local communities at the earliest possible opportunity.
- The ERA should assess risks across the entire lifecycle of shale gas extraction, including the disposal of wastes and well abandonment. Seismic risks should also feature as part of the ERA.

Recommendation 7

Best practice for risk management should be implemented:

- Operators should carry out goal based risk assessments according to the principle of reducing risks to As Low As Reasonably Practicable (ALARP). The UK's health and safety regulators and environmental regulators should work together to develop guidelines specific to shale gas extraction to help operators do so.
- Operators should ensure mechanisms are put in place to audit their risk management processes.
- Risk assessments should be submitted to the regulators for scrutiny and then enforced through monitoring activities and inspections.
- Mechanisms should be put in place to allow the reporting of well failures, as well as other accidents and incidents, between operators. The information collected should then be shared to improve risk assessments and promote best practices across the industry.

Recommendation 8

The UK's regulators should determine their requirements to regulate a shale gas industry should it develop nationwide in the future. Skills gaps and relevant training should be identified. Additional resources may be necessary.

Recommendation 9

Co-ordination of the numerous bodies with regulatory responsibilities for shale gas extraction should be maintained. A single body should take the lead. Consideration should be given to:

- Clarity on roles and responsibilities.
- Mechanisms to support integrated ways of working.
- More formal mechanisms to share information.
- Joined-up engagement of local communities.
- Mechanisms to learn from operational and regulatory best practice internationally.

Recommendation 10

The Research Councils, especially the Natural Environment Research Council, the Engineering and Physical Sciences Research Council and the Economic and Social Research Council, should consider including shale gas extraction in their research programmes, and possibly a cross-Research Council programme. Priorities should include research into the public acceptability of the extraction and use of shale gas in the context of UK policies on climate change, energy and the wider economy.