

Progress in meeting the Royal Society and Royal Academy of Engineering recommendations

March 2015

Recommendation 1 - To detect groundwater contamination

Status: Complete

- A) 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.**

The British Geological Survey (BGS) is working with the Environment Agency to establish a national baseline. BGS gave an update on its current work in December 2014, which can be found at <http://www.bgs.ac.uk/research/groundwater/shaleGas/methaneBaseline/results.html>.

- B) Operators should carry out site-specific monitoring of methane and other contaminants in groundwater before, during and after shale gas operations.**

The Environment Agency requires monitoring of methane and other potential contaminants in groundwater, before during and after shale gas operations, as a condition of the environmental permits required under law for those operations.

UKOOG has published guidelines for the establishment of Environmental Baselines. These guidelines have been reviewed by a scientific panel appointed by the Society for the Environment.

The recently passed Infrastructure Act requires that for all sites involving high volume hydraulic fracturing, operators complete 12 months monitoring of methane in groundwater prior to hydraulic fracturing operations.

- C) Arrangements for monitoring abandoned wells need to be developed. Funding of this monitoring and any remediation work needs further consideration.**

The Environment Agency requires ongoing monitoring of groundwater for methane and other potential contaminants after shale gas operations have ceased and the well site has been abandoned as a condition of the environmental permits required under law for those operations. There are no time restrictions set out for such monitoring and the EA requires that sites are monitored post decommissioning until any risks to the environment of the decommissioned well are deemed by it to be sufficiently low to facilitate environmental permit relinquishment. This will be site dependant and based on local risk assessment.

Arrangements and financing for the monitoring and, if necessary, remediation of abandoned wells is the responsibility of the industry. UKOOG and DECC are in discussions about a scheme to ensure that abandoned wells remain safe and which satisfies environmental permits, and is incorporated within site restoration and remediation agreements under the planning process. Regulators already have the power to impose financial bonds as a part of environmental permits.

D) The data collected by operators should be submitted to the appropriate regulator.

Monitoring data has to be submitted to the Environment Agency and this is a condition of environmental permits for hydraulic fracturing granted by the EA.

Recommendation 2 - To ensure well integrity

Status: Complete

A) Guidelines should be clarified to ensure the independence of the well examiner from the operator.

Regulation 18 of the *Offshore Installations and Wells (Design and Construction etc.) Regulations 1996 (DCR)* requires the well operator to set up a well examination scheme and appoint an independent competent person – the well examiner – to review the proposed and actual well operations to confirm that they meet the well operator’s policies and procedures and comply with DCR and follow good industry practice. Schemes of well examination must comply with the “*Guidelines for well operators on well examination*” and “*Guidelines for well operators on competence of well examiners*”, published by Oil & Gas UK.

The requirement for the independence of the well examiner is crucial, and “independent” is further defined in DCR. This independence is usually achieved by well examiners being from a separate company from the well operator. However, there are a few well operators who wish to use in-house examiners, and that option is legally open to them if they can fulfil the DCR requirements of an appropriate level of impartiality and independence from any aspects of the well design/construction/operation. HSE provides guidance on this aspect, both in the Guidance on DCR (Booklet L84) and in SPC/TECH/OSD/43.

B) Well designs should be reviewed by the well examiner from both a health and safety perspective and an environmental perspective.

Scrutiny of well designs by the independent well examiner to ensure well integrity will, in practice, already serve as an environmental review. This is because such scrutiny is designed to prevent the release of any harmful material from the well into the environment, as the goal setting requirements ensure there can be no unplanned escape of fluids or gases from the well, so far as is reasonably practicable.

There may be some aspects, such as an environmental review of the appropriateness of drilling or fracturing chemicals, which would be outside the strict legal scope of the well examination scheme, but these are addressed by the Environment Agency under its environmental permitting arrangements.

The UK Onshore Oil and Gas (UKOOG) guidelines, first published 1 February 2013, and updated January 2015, entitled “**UK Onshore Shale Gas Well Guidelines - Exploration and Appraisal Phase**”, includes reference to this action, such that the operator should assess the environmental implications, either through the well examiner, if he/she has appropriate skills, or by a separate contractor liaising with the well examiner.

C) The well examiner should carry out onsite inspections as appropriate to ensure that wells are constructed according to the agreed design.

Well operators should have their own quality assurance processes to ensure wells are constructed to the agreed design. The separate work undertaken by well examiners depends on the scope of the well examination scheme devised by the well operator.

Well examiners use documentary evidence of well integrity as the primary means of examination (as per the published DCR Regulation 18 Guidance) to obtain assurance that wells are designed and constructed properly and maintained adequately. It is not the practice that examination schemes need provide for physical examination of wells, unless reliance cannot be placed on the veracity of the documentary evidence.

However, for the purpose of increasing public confidence in the UK shale gas industry whilst it is in its infancy, UKOOG consider it appropriate for shale gas well operators to ask their well examiners to examine certain well integrity and fracturing operations in real time, especially during the early stages of a development, to provide a further level of independent assurance. Such periodic site visits should be made at the discretion of the examiner, in addition to assessing documentary evidence of well integrity, to observe and verify that such operations have been executed satisfactorily in accordance with the approved programme. The frequency and need for such site visits to shale gas operations would reasonably be expected to reduce with time.

A new condition has been set out in the Infrastructure Act which requires the Secretary of State to ensure that an independent inspection of the integrity of the well has been carried out including a site visit.

D) Operators should ensure that well integrity tests are carried out as appropriate, such as pressure tests and cement bond logs.

In order for well operators to ensure compliance with the goal setting requirements of DCR (which requires that wells should be “...so constructed.....that so far as is reasonably practicable there can be no unplanned escape of fluids from the well...”), a range of appropriate well integrity tests will be required during the construction phase, as detailed in standards and guidance such as the Oil & Gas UK “Well integrity guidelines”, which were drafted in consultation with HSE and DECC. The guidance prepared by UKOOG includes reference to best practice specifically for shale gas wells.

E) The results of well tests and the reports of well examinations should be submitted to the Department of Energy and Climate Change (DECC).

Data concerning well integrity related information such as pressure tests and cement bond logs is regulated by the Health and Safety Executive and operators are required to supply this data to the HSE.

DECC requires copies of digital logs to be lodged with the BGS, together with an end of well examination reports. These data are available through DECC’s data release agents, and operators will be additionally required to make this data available upon request.

Data underpinning well flow test and geologic examinations are submitted to DECC in end of well reports.

Recommendation 3 - To mitigate induced seismicity

Status: Complete

- A) 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.**

BGS has already published regional memoirs which describe the tectonic history and faulting in many of the areas which are prospective for shale gas (<http://www.bgs.ac.uk/research/ukgeology/subsurface.html>). Structure contour and isopach maps, associated palaeogeographical maps, sections and correlation diagrams, are based on an analysis and interpretation of seismic, borehole and surface geological data, together with gravity and magnetic data, as well as other sources. This e-data is held at 10K & 50K scale in BGS's DigMap data set.

DECC requires operators to prepare a hydraulic fracturing plan for its review/approval before fracturing operations can take place and in preparing that plan to use these regional analyses, along with their own site-specific surveys, to characterise in-situ stress and identify faults that a well bore may penetrate.

- B) Seismicity should be monitored before, during and after hydraulic fracturing.**

DECC requires that a fracturing plan be submitted, for consideration. DECC requires that operators, in this plan, evaluate the historical and background seismicity and the *in situ* stress regime; and delineate major faults in the area of the proposed well to identify the risk of activating any fault by fracking. The fracturing plan should also include appropriate plans to monitor seismicity before, during and after the well operations conclude and the provision of a traffic light system so operations can be quickly stopped and date reviewed.

- C) 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 consent for shale gas hydraulic fracturing will only be granted when a "traffic-light" regime is in place so that operations can be paused and data reviewed if unusual levels of seismic activity are observed. Operations are to be halted and immediate action taken to initiate flow-back to reduce pressure if seismic activity above a predefined level is observed. The predefined action levels will be chosen so as to minimise any felt disturbance to local residents and so far as possible eliminate any risk of damage.

- D) 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.**

DECC has worked closely with the other regulators, BGS, industry experts and operators to establish controls for mitigating induced seismicity, with the development of robust traffic light arrangements forming an important component of this.

BGS has compiled orientation and relative magnitudes of the contemporary in situ stress regime in the UK into a BGS stress GIS and database. BGS and operators will contribute to this national stress database.

Recommendation 4 - To detect potential leakages of gas

Status: Complete

A) Operators should monitor potential leakages of methane or other emissions to the atmosphere before, during and after shale gas operations.

The Environment Agency requires monitoring of air quality for methane and other potential contaminants such as CO₂ or VOCs before during and after shale gas operations, as a condition of the environmental permits required under law for those operations.

UKOOG's baseline monitoring guidance document, published in January 2015 – **"Guidelines for the Establishment of Environmental Baselines for UK Onshore Oil and Gas"** – includes monitoring of fugitive emissions, such as methane.

This action is also included in the Infrastructure Act.

B) The data collected by operators should be submitted to the appropriate regulator. This data could inform wider assessments, such as the carbon footprint of shale gas extraction.

Operators are required to submit air monitoring data to the Environment Agency as a condition of the environmental permits required for hydraulic fracturing.

The UK Onshore Oil and Gas (UKOOG) guidelines, first published 1 February 2013, and updated January 2015, entitled **"UK Onshore Shale Gas Well Guidelines - Exploration and Appraisal Phase"**, includes reference to this action. Section 10 states: *"Operators should make available and disclose emissions data in line with best practice and any regulatory reporting requirements (e.g., flaring would be in accordance with DECC approvals etc.)."*

Recommendation 5 - Water should be managed in an integrated way

Status: Ongoing

A) Techniques and operational practices should be implemented to minimise water use and avoid abstracting water from supplies that may be under stress.

Water used for hydraulic fracturing may be sourced, either by the operator directly, or indirectly through a licensed supplier. In either case, the licensing of water abstraction must take account of stresses caused by water demand, and this must be undertaken in consultation with the environmental regulator.

Operators will be required to follow good oil field practice and adopt techniques that minimise water use.

The UK Onshore Oil and Gas (UKOOG) guidelines, first published 1 February 2013, and updated January 2015, entitled **"UK Onshore Shale Gas Well Guidelines - Exploration and Appraisal Phase"** require operators to adopt a transparent approach to water use, and specific reference to the management of water is made in section 9 of these guidelines.

B) Wastewater should be recycled and reused where possible.

This recommendation is supported by the regulators where it is acceptable within the current legislative framework. *The Mining Waste Directive* and the *Environmental Permitting Regulations (EPR)* require a review of options, prior to an environmental permit for disposal being granted by the regulator. This ascertains the most appropriate method for managing wastewater at each location.

UKOOG has commenced an initiative to consider water holistically across the all activity onshore, entitled '*Integrated Water Management for Onshore Oil and Gas*'. This initiative brings together experts from across the water and onshore sector to address issues on:

- Supply and delivery
- Site water management
- Operational use and re-use
- Waste management

UKOOG has signed a memorandum of understanding with the water industry to cover water usage and potential contamination issues.

C) 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.

This is required as part of the *Environmental Permitting Regime* and is a requirement of the *Mining Waste Directive*.

Waste Water and waste treatment were considered as part of the supply chain and skills review carried out by EY in April 2014 (Getting ready for UK shale gas, May 2014 [http://www.ey.com/Publication/vwLUAssets/Getting_ready_for_UK_shale_gas/\\$FILE/EY-Getting-ready-for-UK-shale-gas-April-2014.pdf](http://www.ey.com/Publication/vwLUAssets/Getting_ready_for_UK_shale_gas/$FILE/EY-Getting-ready-for-UK-shale-gas-April-2014.pdf)). It made two recommendations which the industry has followed up:

“Waste management, storage and transportation are categories of spend with significant interdependencies. Storage and transportation costs can be reduced if a proportion of water and drilling waste is treated on-site; or if facilities are located close to sites. Mobile waste water and drilling waste treatment technologies exist in the UK already:

- *“UKOOG, with the support of the Government, and supply chain companies should build an investment case, including finance options, for developing UK-based capabilities in shared infrastructure (e.g., water treatment, waste disposal facilities) required to effectively support UK shale development.*
- *“UKOOG should engage with the Environment Agency on the types of treatment that would be authorised for re-injection and used to recycle waste water.”*

Both of these recommendations are currently being considered as part of the overall integrated water management policy at UKOOG.

Recommendation 6 - To manage environmental risks

Status: Complete

- A) An *Environmental Risk Assessment (ERA)* should be mandatory for all shale gas operations, involving the participation of local communities at the earliest possible opportunity.**
- B) 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.**

DECC now requires all shale operators to carry out an ERA assessment as a matter of good practice. This assessment can then be mapped onto the assessments, required by other legislation, such as the *Environmental Impact Assessment*, where this is required following screening by the relevant planning authority. DECC published ERA guidance for the industry on 24th April 2014.

UKOOG has made ERAs mandatory for all members as part of the community engagement charter and process of consultation prior to a planning application being made.

Recommendation 7 - Best practice for risk management should be implemented

Status: Ongoing

- A) 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.**

Risk assessment is central to a goal based regime and is required by UK health and safety legislation. Guidance on best practice for well integrity has been prepared by the Well Life Cycle Forum and published by Oil & Gas UK. This has been integrated into UKOOG guidance. HSE/EA are both involved in this and do not intend to develop separate guidelines at this stage.

- B) Operators should ensure mechanisms are put in place to audit their risk management processes.**

This is supported by HSE, as auditing of health and safety management systems is required by UK health and safety legislation.

- C) Risk assessments should be submitted to the regulators for scrutiny and then enforced through monitoring activities and inspections.**

The recommendation is already achieved with respect to well integrity via the notification requirements of *the Borehole Sites and Operations Regulations 1995 (BSOR)*. These require the well operator to submit details of well operations to HSE prior to their commencement, including the basis of the well design with respect to the geological strata and any hazards. These notifications are assessed by HSE's wells specialists, and issues likely to have an impact on well integrity can be identified and addressed by the operator. In addition, a variety of safety risk assessment information is included in the Health and Safety Document for the site, required by BSOR. These documents are a crucial part of an operator's approach to well integrity and health and safety on the site, and are valuable tools for HSE inspectors to use to devise intervention work and to assess well operator compliance.

When applying for environmental permits, operators are required to submit mandatory environmental risk assessments to support their applications. If an environmental permit is granted, the environmental regulator will develop a compliance assessment plan for each site to measure the operator's compliance and ensure that environmental risks are properly managed. This may include methods such as audits, site inspections, check monitoring and sampling and reviewing operator records and procedures.

DECC, accordingly, has now specified the preparation of an appropriate ERA, at a sufficiently early stage in the project cycle to facilitate dialogue and engagement with key stakeholders, as a required element of good practice for shale gas operations involving the use of hydraulic fracturing. This should ensure that any significant risks associated with the proposed operations, and appropriate mitigation strategies, are identified from the outset.

D) 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.

There are already a range of mechanisms for well operators to share lessons from wells incidents, ranging from the global OGP Wells Expert Group to the UK Well Life Cycle Practises Forum and Oil & Gas UK and UKOOG. However, these fora have a much wider remit than just shale gas wells, so DECC will discuss this with the shale gas industry and ascertain the most appropriate routes to share best practice across shale gas operators.

The rules surrounding the new licencing round launched in July 2014 have been amended to allow for quicker release of data, which would previously been considered commercially confidential information. The remit of this clause is currently being discussed with operators.

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.

Status: Ongoing

This can only be largely informed by the early exploration activity which has yet to start.

UKOOG is working on models for the supply and demand chain and the skill requirements needed. Announcement of the creation of a National College was made in November 2014.

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.**

Status: Complete

The Office of Unconventional Gas and Oil was established in March 2013 to co-ordinate the Government's activity on unconventional gas and oil in the UK.

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.

Status: Ongoing

The Government and/or Research Councils have announced a number of projects over the last 12 months:

- The Technology Strategy Board and the Department of Energy and Climate Change (DECC) are to invest up to £2m in feasibility studies to encourage the development of innovative technologies for the safe and responsible exploitation of the UK's shale gas resources.
- In January the Chancellor of the Exchequer, George Osborne, announced that the Government would allocate £31 million of funding to create world-class subsurface research test centres through the Natural Environment Research Council (NERC). This will establish world-leading knowledge which will be applicable to a wide range of energy technologies including shale gas and carbon capture and storage.
- The Government has also supported Strathclyde University and the Weir Group in their creation of the UK Centre for Hydraulic Fracturing Equipment.
- Finally the government has announced funding to allow transparent independent monitoring of the early shale gas sites in the UK.