Department of Energy & Climate Change

Guidance on the preparation of an environmental risk assessment of shale gas operations in Great Britain involving the use of hydraulic fracturing

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WORKING DRAFT

This document is published as a working draft which DECC intends to refine and develop further, in collaboration with the other regulators and the industry, in the light of practical experience of its application. Operators should make use of this draft as guidance in all new projects, and seek to apply its principles so far as practicable to projects in which early engagement with stakeholders is already in hand.

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Purpose and context

Purpose of this guidance

1.1 This guidance is aimed at operators required to carry out an initial or early-stage environmental risk assessment (ERA), for shale gas operations including fracing, and sets out reasonable expectations for such an assessment. It is issued by the Department for Energy and Climate Change (DECC) and has been developed collaboratively with the Department for Environment, Food and Rural Affairs (Defra), the Environment Agency (EA) and the Health and Safety Executive (HSE), with the assistance of Cranfield University.

The guidance is not intended to be prescriptive on the content of any assessment that may be performed, but to assist operators in conducting assessments that will be appropriate in the specific circumstances that may apply to their plans or proposals.

Purpose of an ERA

1.2 In general, ERAs are intended to provide a systematic and prioritised review of the environmental risks attending on the operations proposed, and a demonstration of the safe and environmentally responsible management of these operations. When prepared at an early stage in any project such an assessment can be used as a basis of discussion and communication with regulators, communities and other stakeholders, helping to build confidence that all key risks are being viewed as a whole, across the entire life cycle, with a central focus on environmental and human health protection. Compilation of such an assessment will also demonstrate that issues of concern are appropriately addressed and will show how identified risks have been, or will subsequently be, analysed in sufficient depth. It can play a valuable early role in informing pre-application discussions with local communities, planning authorities and regulators. It can also inform the preparation of more detailed environmental risk assessments that may be required later as the project moves forward**.**

Context of this guidance

1.3 This guidance is prepared in the context of recommendations made by the Royal Academy of Engineering and Royal Society in their report on hydraulic fracturing in shale gas extraction (RAE, 2012). For the better management of environmental risks where hydraulic fracturing was conducted for shale gas extraction, the academies recommended that an ERA should be prepared, which should address risks across the entire lifecycle of shale gas extraction including disposal of wastes and well abandonment; and that this should involve the participation of local communities at the earliest possible opportunity.

The terms of DECC's licences require the application of good practice in the conduct of operations. DECC accordingly now regards 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. Among other benefits, it will assist stakeholders including local communities in understanding the potential impacts, and the mitigation strategies and measures being proposed to manage residual risks. The ERA should address risks across the entire lifecycle of the activities proposed, including disposal of wastes and well abandonment. Where the activities proposed are only for exploration work, the ERA need not address issues specific to the possibility of later production operations.

This guidance focuses on the preparation of an initial or early-stage ERA in the early stages of project planning and consenting. At that stage, it is recognised that operators will not necessarily have all the information required to assess any risk fully, or to specify in full detail the mitigation strategy intended, and the ERA should use the information reasonably available at the time of its compilation.

While DECC's focus will be to ensure that an appropriate ERA is produced early in the project planning cycle, operators are recommended to continue to update and adjust the assessment thereafter with new knowledge as it becomes available, and to integrate into the analysis all significant changes to the operation as they are planned. In this way it becomes a living document of continuing utility to the operator's ongoing management of the operations, and to regulatory and other scrutiny, throughout the life of the project.

The recommendations of the academies apply only to shale gas operations involving hydraulic fracturing. DECC and the regulators will consider separately the potential application of ERA principles to other oil and gas operations involving hydraulic fracturing.

Shale gas operations

1.4 Shale gas is part of a range of unconventional hydrocarbon resources including tight gas sands, gas shales, oil shales and coal bed methane (CBM) that depend, to greater or less degree, on horizontal drilling or hydraulic fracture technology to enable the recovery of natural gas or oil from low permeability formations. Exploration for shale gas and CBM is currently underway in Great Britain.

The process for developing unconventional gas or oil wells is similar to that for conventional wells. For both, the full life cycle includes stages such as site identification and preparation, drilling, production and abandonment. Where unconventional wells differ is principally in the intensive use made of hydraulic fracturing, which introduces additional wastes (i.e., flow-back water, so far as this cannot be recycled) and has given rise to concerns about potential pollution, particularly of aquifers, and about potential seismicity. The full life cycle of the operations which might fall within the scope of an ERA could include: site identification and preparation; well design, drilling and cementing; hydraulic fracturing and well completion, including the management of wastewater; production operations and maintenance; possible re-fracturing to revive production; decommissioning, abandonment and post abandonment monitoring; site restoration.

2. Broad principles of environmental risk assessment

The main principle of an environmental risk assessment is to demonstrate that the operator understands the links between the environmental risks, the underpinning evidence required to characterise the impacts of the planned operations, and the need for more detailed analysis as required by permitting and regulation to identify appropriate means of protecting the environment throughout the life of the proposed activities. The environmental risk assessment and its supporting material will provide a more systematic basis on which operators can decide how environmental risks can best be prioritised and managed.

Through compiling an environmental risk assessment, the operator communicates his knowledge of operations to regulators and the broader stakeholder community. The value of an environmental risk assessment is in the disciplined and systematic approach it imposes and in the identification of risks and their prioritisation for onward management, as much as in the demonstration of supporting evidence for the assumptions made.

Defra have published generalised expectations of environmental risk assessment and management (Defra, 2011) to guide developers, their professional advisors and regulators on the essential steps required for assessing and managing environmental risk. These are a useful reference point for those new to the field. In general, environmental risk assessments draw on a broad set of risk management principles including the need for sound problem definition and scoping; the development of a conceptual model; the use of appropriate risk analysis tools and techniques tailored to the underpinning evidence and nature of the risk; the early use of risk screening to sift out insignificant risks so assessment effort can be focused on risks of greater significance; identification and appraisal of the management or mitigation options available and development of a risk communication strategy to promote stakeholder engagement and build trust.

Environmental risk assessments can be set in the context of broader company procedures for corporate risk governance (e.g. by reference to ISO 31000 Risk Management, or internal risk frameworks) with links to strategic corporate objectives, risk governance arrangements and mechanisms for consultation and dialogue with relevant parties. This demonstrates an organisation's 'joined-up' approach to risk management, which can build confidence among stakeholders that the operator's board and executive will implement effective mitigation strategies across the entire life cycle of operations. Communications planning, engaging with stakeholders and regulatory bodies early and often throughout the risk assessment process, also plays a key role.

3. General expectations of the ERA for shale gas

The fundamental objective of the ERA for shale gas is to provide at an early stage in the planning and consenting cycle an overview of environmental (including health) risks relevant to the proposed shale gas activities, comprehensive in scope though not in depth of detail, as a basis for early engagement with stakeholders including local communities. It should be prepared as early in the project planning cycle as practicable and before planning permission is sought. It should address all significant environmental risks relevant to the proposed operations, from site preparation through to decommissioning and site restoration, and demonstrate the operator's strategies for effective management of these risks. It should include an overview or summary description of the operator's environmental risk management system. Operators should make explicit the categorisation adopted for risk levels, e.g., by means of a risk matrix with supporting definitions.

The ERA can subsequently inform more detailed assessments required in other regulatory contexts; for example, under the Environmental Permitting Regulations (EPR) administered by the EA, or any Environmental Impact Assessment (EIA) that may be required by the relevant planning authority. (It is not however intended to replace or subsume these or any other statutory or regulatory requirements.) Providing the ERA is systematically updated - see section 1.2 - it may also inform the planning and consenting processes relevant to subsequent stages or phases of the project.

In preparing the ERA, operators may refer to appropriate authoritative environmental risk assessment guidance and principles, expectations and guidance. Taking account of the early stage at which this ERA is prepared, operators may adopt a tiered approach that allows for risk screening, prioritisation and, in general, a qualitative treatment rather than necessarily requiring a quantified analysis. Many risk issues may be sufficiently addressed at this stage by a qualitative analysis providing the logic is sound, transparent and well-justified. In compiling the ERA, operators should clearly set out:

1. a clear statement of the problem, establishing up front what is at risk, what it is at risk from and what the scope of the risk assessment is;

2. a systemic description of their operations, including the relationships between tasks and activities, management procedures and standard operational procedures;

3. sufficient information on the environmental setting in the immediate and near vicinity, above and below ground, including identification of an appropriate set of environmental features (receptors) that might be affected by their activities;

4. appropriate detail of regulatory requirements and their inter-relationships, with reference to relevant guidance documents and additional sources of information; and

5. how relevant corporate objectives, internal procedures for assessing and managing risks including environmental risks, operational controls and competency of operational and managerial staff will ensure effective management of these risks.

At this early stage, there is no expectation that operators need include in the ERA the full supporting material that may be required or appropriate for risk assessments subsequently required in the processes of environmental permitting or safety scrutiny; and normal considerations of commercial confidentiality apply.

Dialogue during development of the ERA provides benefit to the operator, the regulators and the wider stakeholder community. Early dialogue is useful for establishing risk assessment boundaries, for making explicit expectations, for establishing timeframes and for increasing the stakeholders' knowledge and understanding of the proposal so they may provide better informed comments. This engagement with the public is distinct from formal consultation such as is required later, in particular in respect of planning permission, and should aim to establish shared understanding and to build confidence within the public that key issues can be discussed openly. In this context, the public may include a range of stakeholders e.g. non-governmental organisations, industry, utilities, and engagement with them helps to broaden an understanding of the process and how it informs decisions about how risks are managed. A helpful discussion of methods for stakeholder engagement is available in "Green Leaves III" (Defra, 2011); operators should choose the modes most appropriate to their circumstances.

4. Further guidance on specific topics

This section provides further guidance on specific topics relevant to the compiling of an ERA.

4.1 Framing the problem

The ERA should consider the full life cycle of the proposed operations, from site identification and preparation through to abandonment and post-closure monitoring. Operators should provide a brief summary of operations and a conceptual model, which may be a schematic, depicting the risks associated with the full life cycle operation of the planned operations. (The ERA need not however address the implications of subsequent operations which would be subject to a separate process of permitting and consenting. Thus, where current plans are limited to exploration operations, the ERA need not address subsequent production operations.)

The ERA should consider all elements of the operations that may contribute to any adverse effect on the environment or human health. The aim of the ERA should be to demonstrate that the operator has an overarching understanding of the risks entailed by the proposed operations, and how these risks may change over space and time across the full life cycle of operation. The ERA does not require the depth of detail of risk assessment necessary to meet the conditions of environmental permitting and planning requirements, because these will be addressed later through other regulatory requirements. However, the ERA should contain sufficient analysis and detail to facilitate early discussions on risk management with the Mineral Planning Authority (MPA) or environmental agency, identifying potential challenges and issues early on.

The ERA should provide a high-level overview of the geological, hydrogeological, and biodiversity characteristics of the operational area, as well as identifying environmental (including health) impacts that the activities may have on operational personnel or the public. Spatially, risks should be considered beyond the immediate footprint of the well pad, and potential impacts should be considered out to a sufficient distance from the source to capture all significant impacts.

The body of literature specific to shale gas development remains limited at this time though progress is being made to better understand the risks associated with the activity, and in the development of ‘good practice’ guidance. Recent reports by AEA (2012a,b), Green et al (2012), City of Fort Worth (2011), Mackay and Stone (2013) and the RAE (2012) help to identify the major risks to the environment as a result of development, and Public Health England have published a helpful overview of risks to public health (PHE 2013), while DNV (2013) and UKOOG (2013) have published good practice guidance for safe operation.

4.2 Issues to be addressed

Operators should aim to include in the ERA sufficient information on the geological and hydrogeological characteristics of the area to support a high-level assessment of the risk potential of the proposed operations. This should take account of available data on the location of natural fault lines that could be impacted by hydraulic fracturing. Although it has not been demonstrated to have occurred in practice, the potential exists for fracturing fluids to migrate via fractures into groundwater aquifers. The ERA should take due account of the location of local aquifers, and assess, in sufficient detail for this early stage, the relevance of any pre-existing natural fractures, the likelihood of interactions with fractures generated during the proposed operations and the potential for groundwater aquifers to be contaminated with fracturing fluids. Limited research on the subject exists, though general guidance is available from UKOOG (2013) and DNV (2013).

Geological characteristics vary spatially, therefore a single well pad hosting multiple horizontal wells of variable length and direction may interact with different geologies. Operators should take account of these potential differences.

The issues addressed in the ERA should also include

- A provisional list of chemicals proposed for injection into the well and an initial characterisation of their potential hazards to the environment and human health.

- Environmental risks related to the abstraction of water, where this is proposed as an alternative to reliance on public supplies. Information and regulatory requirements for water abstraction can be provided by the EA/NRW/SEPA.)

- Potential risks of fugitive emissions, including emissions from well completion processes, on the environment and the health of local communities. The ERA should also address potential impacts from flaring.

- Risks arising in connection with the capture, storage, treatment and/or transport of waste materials, including waste water. It should include risks related to produced water, and for a production well should consider the possibility of re-fracturing the well. Flow-back water that contains elevated levels of contaminants (e.g. dissolved solids, heavy metals, NORMs), in excess of regulatory thresholds, will require treatment. The ERA should take account of risks of accidental spills of water/chemicals waste.

- Potential impacts on the environment, human health or road safety of transporting proppant chemicals and where relevant water to the site, and of transporting waste water from the site. Increased traffic on local roadways will pose risks related to noise and vehicle emissions and accidental spills.

Where relevant in the location, the ERA should also address risks from flooding.

4.3 Operational phases

Site identification and preparation

This stage of operations includes initial efforts in identifying a suitable site for locating a well pad as well as steps taken to prepare a site for drilling. At this stage, if not before, operators should identify the appropriate permits and permissions necessary for the proposed operations. The Regulatory Roadmap published by DECC in December 2013 (http://preview.tinyurl.com/mmzj8gb) will be helpful.

Early communication with the MPA, with the EA/NRW/SEPA (each of which is a statutory consultee for planning applications in its area), and with the HSE, will help operators better understand what will be required of them and to share with regulators their early plans for managing risks. Communication with the Department of Transport and Highways Agency may be helpful to identify key transport routes and any associated risks posed by increased industrial traffic.

In compiling the ERA, the operator should consider risks which their operations may pose for elements of the biological environment beyond the well pad boundary. These may include:

- Sites within the Natura 2000 network (Special Protection Areas, Special Areas of Conservation);
- Ramsar Sites;
- Sites of Special Scientific Interest;
- Areas of Outstanding Natural Beauty;
- National Parks;
- National Nature Reserves
- Country Parks;
- Local Nature Reserves;
- Woodland Parks

Operators should take account of the proximity of operations to protected species habitats, or location of operations with respect to migratory bird routes. Agencies and bodies such as Natural England, Natural Heritage Scotland and Natural Resources

Wales, the National Trust, the RSPB, English Heritage, the British Geological Survey and the EA/NRW/SEPA provide though their websites basic information to support a high-level assessment of risks, while communication with the MPA, land owners, local utilities and local environmental interest groups can provide additional expertise.

Well design, drilling and cementing

This stage of operations includes the drilling, casing and cementing of a well (hydraulic fracturing is covered in the next section). Well design, drilling casing and cementing processes for onshore shale gas wells are similar to those in other petroleum sectors. Considerable guidance regarding good practice on well design, drilling casing and cementing is available through documents provided by the United Kingdom Onshore Operators Group (UKOOG, 2013), by Oil and Gas UK and on the Health and Safety Executive website.

The environmental risks associated with well design, drilling casing and cementing a shale gas well will not differ generically from those encountered with well development in other onshore petroleum operations. Where risks may differ is in their interaction with particular site specific conditions and it is important that operators should take due account of such factors in the conceptual model.

The ERA should address risks associated with well preparation, including, but not limited to risks arising from:

- Transport to and from site of drilling equipment;
- Transport, storage and treatment of drilling fluids;
- Recovery and treatment of drilling waste including cuttings;
- Contamination of recovered fluids and tailings by subsurface contaminants;
- Surface management of water and chemicals;
- Gas emissions (including emergency or unplanned emissions) and emissions from flaring.

Hydraulic fracturing

This stage of operations involves the injection of water, proppant and chemical or other additives into a shale formation under high pressure with the intent of fracturing the rock to release tightly bound gas. The process requires large volumes of water, which in turn contributes to large volumes of flow-back, which may be augmented by produced water from adjacent formations. Hydraulic fracturing also has the potential to induce low levels of seismicity. The scale of that risk can be reduced by appropriate choice of the volume and rate of fluid injected and of the volume and rate at which the flow-back fluid is allowed to return to the surface.

Well completion and management of wastewater

This stage follows the completion of the hydraulic fracturing process and includes the return of a proportion of the injected fluids to the surface. The returned flow-back water or produced water may contain substances found in the formation such as dissolved solids, heavy metals, organic compounds or NORMs. It may be possible to recycle such process streams, but once they become a waste, will be stored and/or treated appropriately pending disposal.

Production

Where the proposed operations include a production phase involving the recovery, capture and transport of gas into the gas network, or its utilisation on site for local electricity generation, the ERA should also address the processes involved, including those required to connect the well to the gas network and any associated environmental risks, so far as these processes are to be carried out or executed by the operator or his contractors.

The ERA should provide an initial assessment of any environmental risks associated with the permanent structures expected to be erected on site, including risks to local biodiversity and local amenity, and indicate how these are expected to be addressed, though the planning and permitting processes.

Site restoration and well abandonment

As wells come to the end of their serviceable life, they may be sealed to prevent fluids from entering or escaping, and this is likely to be done for all remaining wells once the site is no longer productive. The main issue to consider before wells are abandoned is the long-term containment of well fluids, and the ERA should indicate how this is expected to be secured. Guidance for the decommissioning and abandonment of a well is provided by the EA, HSE and UKOOG.

Site restoration after cessation of operations will be addressed through planning conditions. The ERA should indicate how risks associated with aftercare operations and monitoring are expected to be addressed in the period up till permits are surrendered or control of the site relinquished.

4.4 ERA document structure

Operators should consider how to present the risks associated with their planned activities in a transparent way. Early discussion with the MPA and other regulators will assist in establishing an appropriate format and structure. It is recommended that the ERA should include:

- A conceptual model of the operator's shale gas operation;
- A description of the environmental setting
- A summary of any known problems or issues to establish the scope of the assessment
- An overview of the operator's environmental risk management system.
- Identification of relevant environmental including health risks and impacts and brief description of the operator's strategy for further assessment of risks, for mitigation of risks and for management of residual risks.
- Preliminary categorisation of the expected level of risk, e.g., by reference to a defined risk matrix.
- Relevant references or other supporting evidence.

Operators should include in their ERA appropriate treatment of the risks associated each of the discrete stages of shale gas operations planned:

1. Site identification and preparation.
2. Well design, drilling and cementing.
3. Hydraulic fracturing activities.
4. Well completion and management of wastewater.
5. Well production where currently planned proposals include a production phase.
6. Well/pad abandonment.
7. Aftercare and monitoring.

The ERA should seek to provide an easily comprehensible summary of the assessed risks. This might include a summary table of risks with the results of the preliminary assessment of risk. A simple tabular or spread-sheet format could be used for the summary table (see Annex for an illustrative example). Tables may include:

- the identity and source of a hazard;
- the transport mechanism and exposure pathway;
- the receptor, or feature valued;
- the consequence, or potential severity, of exposure;

- the estimated probability of exposure, taking account of planned mitigation;
- the preliminary categorisation of risk (as, say, very low, low, medium or high);

Examples for structuring and presenting the ERA can be found elsewhere (Defra, 2011; AEA, 2012a).

4.5 Procedure

If the approach recommended above is followed, the ERA should develop in a collaborative way involving the key regulators and other stakeholders from an early stage. To confirm that the expectations set out in this guidance are being appropriately met, the operator should submit the document to DECC at a suitable point prior to making formal application for planning permission. Subject to confirmation from the other regulators that they are content that the operator has consulted them appropriately, DECC will either confirm that the ERA meets the expectations set out in this guidance, or ask for further or more detailed work if necessary. To allow sufficient time, the ERA should be submitted at least four weeks prior to the intended submission of the application for planning permission.

Thereafter, the ERA should be updated as recommended above so as to remain of continuing utility to the operator in his ongoing management of the operations, and to regulatory and other scrutiny, throughout the life of the project.

Where an exploration site is proposed to be further developed as a production site, it may be satisfactory to update and expand the existing ERA, and to resubmit to DECC prior to the new planning application, rather than start afresh. Where initial exploration work leads to proposals for production located at a different site, a new ERA should be compiled for the production project.

5. References and useful material

AEA (2012a) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe. European Commission, DG Environment

AEA (2012b) Climate impact of potential shale gas production in the EU. European Commission, DG Clima.

City of Fort Worth (2011) City of Fort Worth natural gas air quality study – Final report.

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EA (2012) Monitoring and control of fugitive methane from unconventional gas operations. Environment Agency.

Green AC, Styles P and Baptie BJ (2012) Preese Hall shale gas fracturing review and recommendations for induced seismic mitigation. DECC

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UKOOG (2013) UK Onshore shale gas well guidelines: exploration and appraisal phase. UK Onshore Operators Group.

6. Glossary

Aquifer – underground layers of water-bearing permeable rock or drift deposits from which groundwater can be extracted

DECC – Department of Energy and Climate Change

Defra – Department for Environment, Food and Rural Affairs

EA – Environment Agency

EIA – Environmental Impact Assessment

EPR – Environmental Permitting Regulations

Flow-back water or produced water – any water that is produced from a gas well

Fracturing fluid – fluid injected in to a shale or other petroliferous formation, with the aim of stimulating fracture development to facilitate gas or oil recovery.

Groundwater – all water which is below the surface of the ground in the saturation zone and in direct contact with the ground subsoil.

HSE – Health and Safety Executive

NORMs - naturally occurring radioactive materials

NRW – Natural Resources Wales

MPA – Minerals Planning Authority

SEPA –Scottish Environmental Protection Agency

Annex – Illustrative ERA summary table

Though no specific format for structuring the ERA document is prescribed, it is recommended that a simple table be used to summarise the risk assessment. Table 2 is a representative example that adopts the source-pathway-receptor model for assessment of risks (Defra, 2011). "Consequences" represents the actual, potential or perceived harms as a result of a hazard being realised; "likelihood of exposure" the probability or likelihood of a receptor being exposed to a hazard; and "risk" represents a qualitative assessment of significance taking account of both the possible consequences and the likelihood of the exposure.

Table 1 - Illustrative table for summarising a risk assessment

The source of the hazard	Hazard – the substance or situation with a potential to cause harm	Receptor – the feature we value	Exposure pathway	Possible consequences of exposure	Likelihood of exposure (post mitigation)	Risk	Justification for this assessment of risk	Key measures for risk mitigation and management of residual risk

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