Regulatory guidance:
Coal bed methane and shale gas

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Regulatory guidance on coal bed methane and shale gas

Introduction

1. This regulatory guidance deals with shale gas and coal bed methane which are types of 'unconventional gas'.
2. We support the Scottish Government's energy policy to establish a diverse and balanced energy portfolio to provide Scotland with secure and affordable heat and electricity for decades to come. A diverse range of sources in Scotland's energy portfolio will make our energy system more resilient.
3. Along with other regulatory bodies we have a wide range of regulatory tools that can be used to effectively control and mitigate the environmental impacts that may be caused by unconventional gas activities.
4. We currently believe that these regulatory tools provide a high level of protection to the environment. Should further evidence demonstrate that this is not the case and more protection is required, we will support the Scottish Government in bringing forward further measures.
5. Our belief in there being a high level of protection is supported by the results of a recent report[8] commissioned by the European Commission which concluded that the EU regulatory framework was sufficiently flexible to be adjusted to the specific requirements of unconventional gas operations. This does not preclude the possibility that additional legislation may be brought forward if gaps in existing legislation become apparent.
6. Under the Climate Change (Scotland) Act 2009 we have a duty to consider how Scotland can reduce the greenhouse gas emissions from regulated industry and businesses.

[8] Philippe and Partners, Final Report On Unconventional Gas In Europe, 2011

Coal bed methane and shale gas extraction summarised

7. Conventional gas deposits are contained in porous reservoirs (often limestone or sandstone) which have interconnected spaces. These interconnected pore spaces give rise to permeability that allows the gas to flow freely within the rock and through well boreholes. These reservoirs may be many miles from the organic material that was the original source of the gas.

8. Conversely, unconventional gas deposits are contained in reservoirs of lower permeability which may require different technology or investment for economic recovery. Unconventional gas deposits are often also the source of the gas.

9. Shale gas and coal bed methane deposits contain organic rich source rock in which the gas is held within fractures, pore spaces, and adsorbed on to organic material in the strata. Operations to extract the gas involve drilling boreholes, often to considerable depth (e.g. 1000m compared with boreholes drilled for drinking water which are generally less than 100m deep) and in some cases horizontally as illustrated in Figure 1 below.

10. In strata of low permeability, recovery of gas may be impossible if the rock has very low fracture density. Sometimes extending the borehole horizontally within the strata provides a sufficient surface area for economic rates of gas recovery but, where this does not work, hydraulic fracturing (often referred to as hydro-fraccing or simply fracking) may be undertaken to increase the permeability and enhance the rate of gas release.

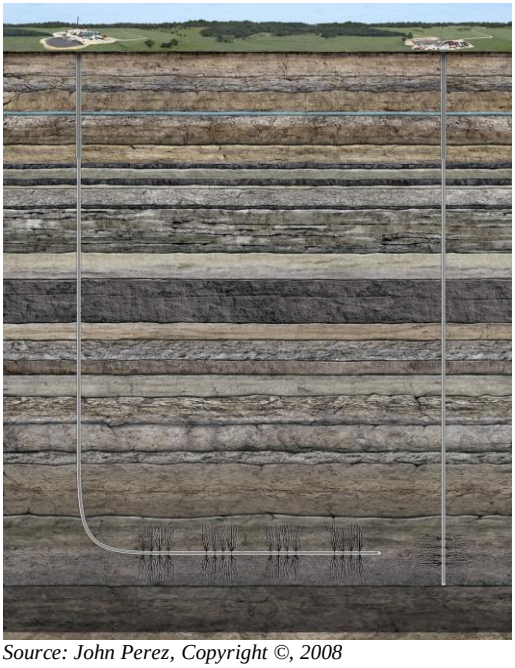
Fracturing

11. Fracturing may entail injecting a gas, fluid or foam into the well/borehole at high pressure to create and propagate fractures in the surrounding rock formation. These fractures may be only a few micrometres in width and usually limited in length to a few tens of metres. In some cases (particularly in coal) the natural fracture density is sufficient for the release of adequate amounts of gas and fracturing is not necessary.

12. In shale, the injected fracturing fluid is mainly water based with small quantities of sand or similar particulate matter used to prop open the fractures. This method also uses a very small concentration of a mixture of chemicals that help keep the proppant in suspension and increase the lubricating properties of the fluid.

13. In coal, the fracturing fluid may consist of a similar fluid to that used for shale fracturing. Alternatively a foaming agent created from much smaller quantities of water or an inert gas such as nitrogen could be used. The foam will also contain a proppant. Irrespective of the technique, fracturing for coal bed methane is less aggressive than for shale gas as lower pressures are needed.

Figure 1: Vertical and horizontal well completion

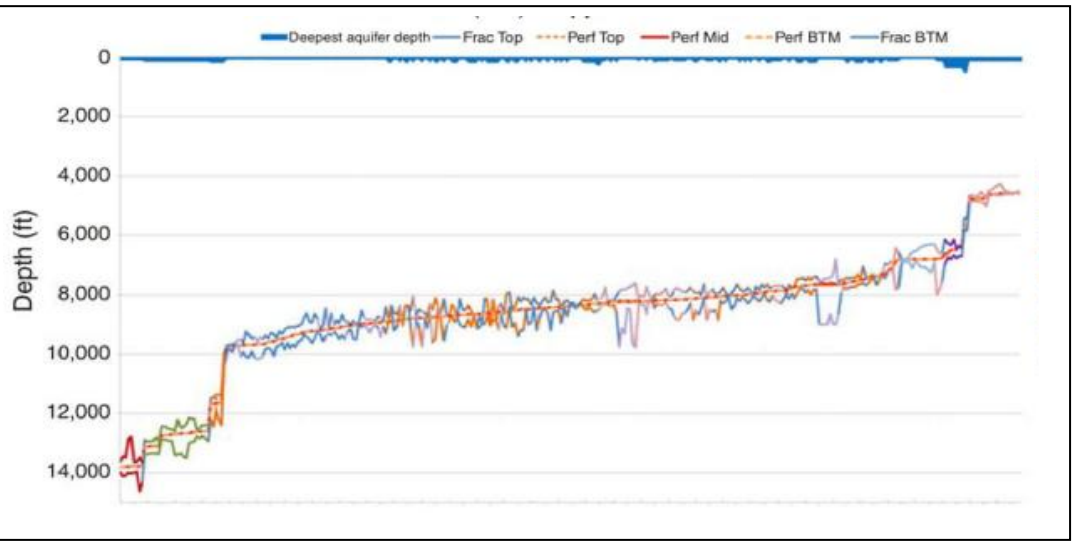


Source: John Perez, Copyright ©, 2008

14. Figure 2 illustrates the maximum fracture length compared to typical aquifer thickness of the Woodford shales in the United States of America. This shows that the created hydraulic fractures remain within the planned range, even in the presence of faults.

Figure 2: Woodford shale fracture depth compared to fracture length

Fracturing operations *Copyright SPE*



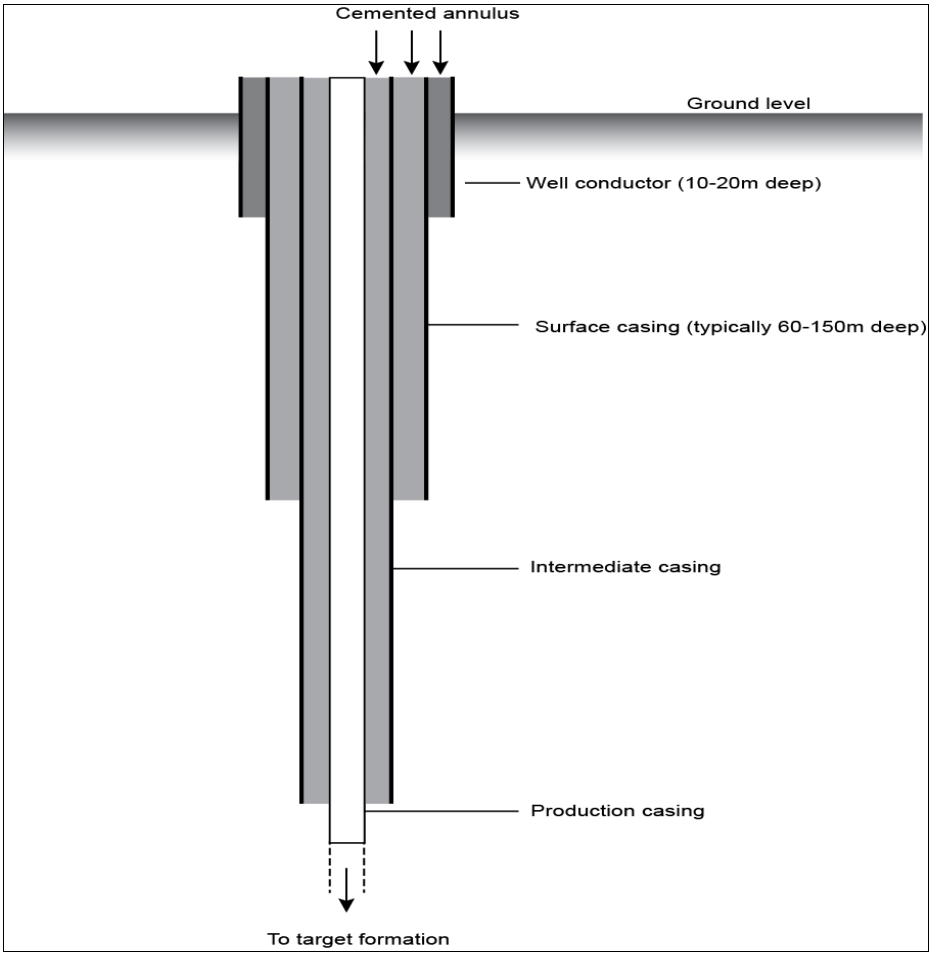
15. Following the release of an injection of pressure, some of the injected fluid returns upwards from the borehole to the surface. Initial recovery rates of this ‘flow back’ water can vary between 20% and 80%. Subsequently a mixture of groundwater and the remaining fluid is abstracted to facilitate the release of gas. Injection may be repeated several times.

16. In addition to the added chemicals, the abstracted flow-back water typically contains naturally occurring substances such as bicarbonates, sulphates, and chlorides of sodium and potassium and radionuclides.

Boreholes

17. Borehole construction is particularly important to prevent the release of fugitive emissions or cross contamination of groundwater of different quality (salinity invariably increases with depth from the surface). Correct construction methods also prevents leakage of fracturing fluid, flow-back water, or gas, any of which could pollute water supplies. Figure 3 illustrates a typical borehole construction.

Figure 3: Schematic of a typical casing from a 'Review of assessment procedures for oil and gas well casing installation' Environment Agency

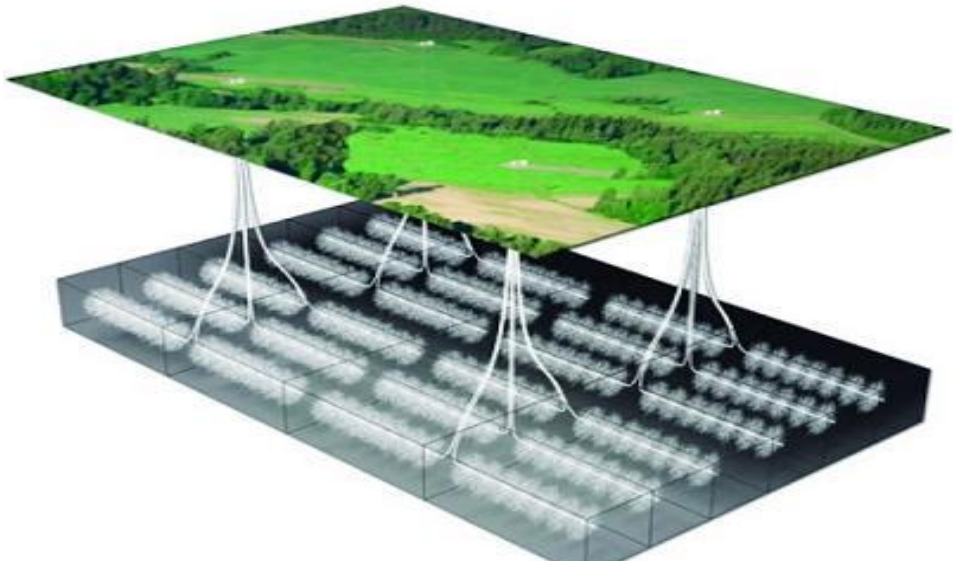


18. Development of a gas field usually involves drilling a series of boreholes from a single well site (well pad). The wells are normally drilled vertically then horizontally from the well pad so that they radiate out to draw gas from a wide area. There may be a number of well pads within a field. Surface expression of each well pad is often restricted to wellheads and collection and distribution pipework.

19. If possible operators prefer to transmit the gas directly into local infrastructure (e.g. gas pipelines) following any necessary treatment and/or pressurisation. However this may not always be possible and on-site purification and compression might be required. Additionally sometimes gas is used to generate electricity at a local site.

20. Figure 4 illustrates a typical field installation where there are four well pads in which the wells/boreholes have been drilled to exploit 6 drainage areas.

Figure 4: Unconventional gas field *(source Tyndall Centre)*



Possible environmental impacts

21. A number of potential direct and indirect environmental impacts have been identified as being associated with unconventional gas exploration and production. These include:

    - possible adverse effects on the water environment arising from drilling and fracturing operations;
    - possible increased seismic activity during fracturing operations;
    - potential increased greenhouse gas emissions from fugitive releases.

    Some of these impacts may also be associated with conventional gas activities.

    In addition, the use of unconventional gas could lead to delays in the programme to convert to renewable energy sources causing a delay in the reduction of greenhouse gas releases and the decarbonisation of the energy sector. However, it could also reduce CO_2 emissions if natural gas displaces coal.

22. Water environment impacts associated with operations may include:

    - cross contamination of aquifers due to poor borehole construction;
    - pollution from an unexpected release of gas or fracturing fluid into other parts of the water environment;
    - pollution from the uncontrolled disposal of liquid or solid waste containing potentially polluting substances;
    - abstraction of uncontrolled quantities of water which could lead to an unacceptable impact on the water environment.

23. There is evidence that fracturing can induce low magnitude seismic events. A recent report produced for the Department of Energy and Climate Change (DECC)[9] concluded that the events recorded at Preese Hall in Lancashire were directly connected to the fracturing operations. The report also suggested a series of measures that could be introduced by the operator to minimise the likelihood of events of a magnitude sufficient to cause damage.

24. Methane is a more potent greenhouse gas than carbon dioxide. There is a lack of real field data in this area and more research is required, however it has been reported that fugitive releases of methane during shale gas operations is higher than those of conventional gas but less that from coal[10]. However, others have questioned the validity of the data used to justify this position[11] until this dispute is resolved by collection and analysis of actual data we will remain neutral but will require operators to make full use of technologies that capture the gas prior to escape in order to reduce methane emission to air. We are also considering the need for monitoring.

[9] Preese Hall Shale Gas Fracturing Review & Recommendations For Induced Seismic Mitigation; Green, C. A., Styles, P., and Baptie, B. J., DECC, 2012

[10] Climate impact of potential shale gas production in the EU Report for European Commission DG CLIMA AEA/R/ED57412 Date 30/07/2012

[11] A commentary on 'The greenhouse-gas footprint of natural gas in shale formations' by R.W. Howarth, R. Santoro, and Anthony Ingraffea; Cathles, L. M. III, Larry Brown L., Taam M., Hunter A., 2011

Regulation of coal bed methane and shale gas operations

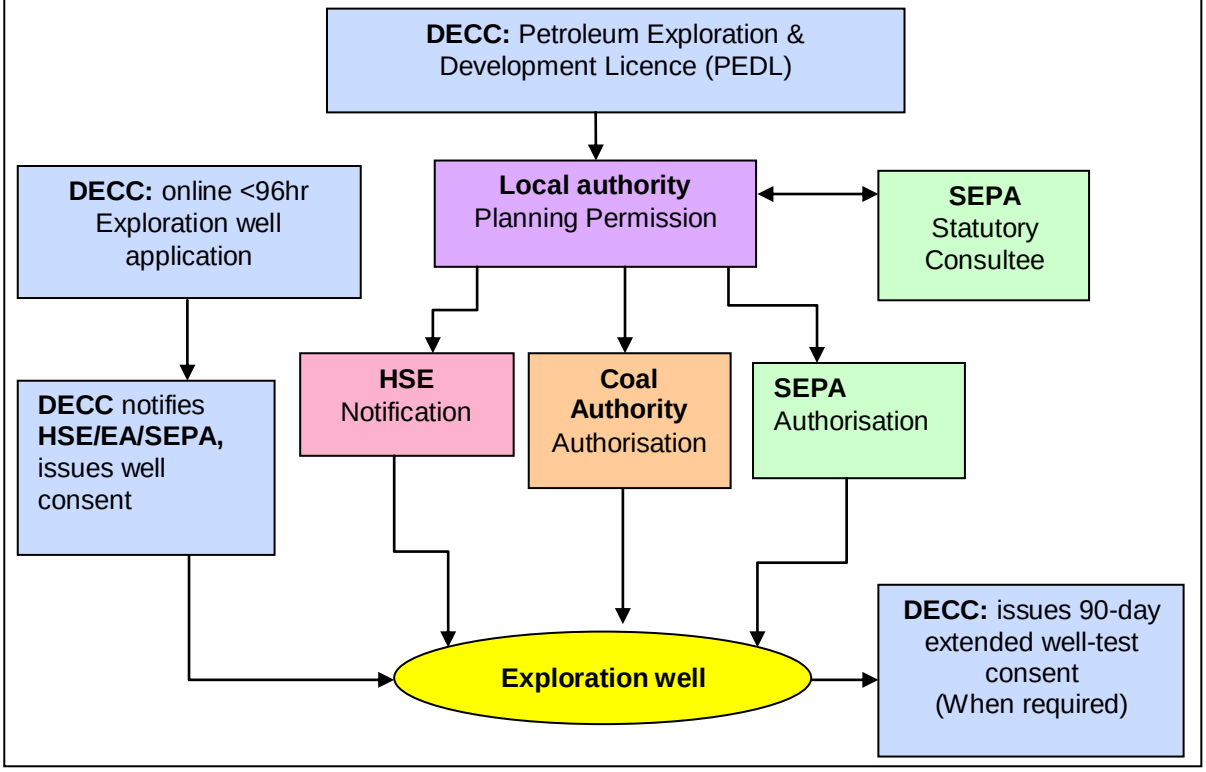
25. As well as SEPA there are a number of regulators involved in the control of these operations:

    - The Department of Energy and Climate Change (DECC) is responsible for issuing a petroleum licence (PEDL). This licence confers exclusivity in a defined area as against other exploration companies, but does not confer any exemption from other legal/regulatory requirements. In particular a licensee needs the consent of the landowner(s) and planning permission for any operations on land. Information about DECC onshore activities can be found on the DECC website [12].
    - The Local Planning Authority is responsible for granting planning permission (under the Town and Country Planning (Scotland) Act 1997) for surface works associated with borehole construction, fracturing operations and wellhead development. Operators may need to submit an environmental impact assessment and a waste management plan with their application. SEPA is a statutory consultee to planning applications.
    - The Health and Safety Executive (HSE) - The Borehole Sites and Operations Regulations 1995 place a duty on operators of petroleum borehole sites to ensure that no operations which would make a significant alteration to the well or involve a risk of accidental release of fluids from the well are carried out unless they have notified the HSE at least 21 days in advance, according to the requirements of the regulations which are available on The HSE website[13]. The HSE will serve an improvement notice requiring modifications to the plan if they are not satisfied with the well design and changes must be made before drilling operations can commence.
    - The Coal Authority - any activity which intersects, disturbs or enters coal seams requires prior written authorisation from the Coal Authority. More information is available on their website[14].

26. The sequence of permissioning is shown in the Figure 5. The arrows show the way an application for permission to explore for coal bed methane or shale gas resources would be examined by all the agencies involved in a sequential way, e.g. an operator would always seek a PEDL before applying to the local authority for planning permission to construct a borehole.

[12] http://og.decc.gov.uk/en/olgs/cms/explorationpro/onshore/onshore.aspx
[13] www.hse.gov.uk/pubns/books/l72.htm
[14] www.coal.gov.uk/services/licensing/modeldocuments.cfm

Figure 5: Regulation of unconventional gas exploration operations



Details of our regulatory role

The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR)

27. Article 11 3(j) of the Water Framework Directive (WFD) in conjunction with Article 6 of the groundwater daughter directive (Directive 2006/118/EC) provide a framework of regulations for adequately protecting groundwater. We control the impacts on groundwater through CAR. As coal bed methane and shale gas operations can have an adverse impact on the water environment (particularly groundwater) they are subject to controls under CAR.

28. Due to the potential impacts from coal bed methane and shale gas exploration and extraction activities, operators are advised to contact us at the earliest opportunity to discuss their plans.

29. We do not have a remit to regulate the fracturing of rock, and as such we do not issue licences for fracturing. Our role is in relation to controlling the impacts on the water environment from the physical exploration and extraction of unconventional gas resources (shale gas and coal bed methane).

30. As noted above, we control impacts on the water environment and other water users using CAR. The following activities, associated with coal bed methane and shale gas exploration and extraction fall within the CAR regulatory regime:

- **Borehole construction:** An application for a CAR complex licence[15] will be required to allow a deep borehole (>200m) to be constructed and condition any maintenance or monitoring required to ensure that the borehole does not result in contamination of groundwater. Once the borehole has been decommissioned to our satisfaction, the licence can be surrendered.
- **Injection of fracturing fluid:** An application for authorisation for injection should be submitted to us. We will require monitoring of groundwater as a condition of authorisation.
- **Abstraction of water for injection purposes:** Where water is abstracted from the water environment to be used for example during fracturing, an application for authorisation must be submitted to us, unless the abstraction falls within the scope of Activities 2 or 4 of Schedule 3 of CAR[16] (and therefore authorised by General Binding Rules (GBRs)). Where the water intended for fracturing is supplied by a water provider who abstracts that water from the water environment and the abstraction is not authorised via a GBR, the supplier must hold an appropriate SEPA authorisation.
- **Abstraction of flow-back water:** Where flow-back water and/or groundwater are abstracted from the borehole, an application for authorisation should be submitted to us, unless the activity falls under Activities 2 or 4 of Schedule 3 of CAR and the abstraction meets all the General Binding Rules for that activity.
- **Management of abstracted fluids:** Discharges that are likely to have an impact on the water environment require prior authorisation under CAR. Re-injection of flow-back water is not capable of authorisation under CAR; flow-back water is classed as extractive waste and is regulated by the local authority through planning controls and the Extractive Waste Regulations.

31. Operators must submit a risk assessment and/or details of the borehole construction to us with their application for CAR authorisation to show that any adverse effects on the water environment or other water users will not be significant. The submission should include any mitigation measures that will be used to reduce adverse effects. Any authorisation granted will specify conditions to limit impacts and may also require a monitoring plan to be developed and agreed with SEPA and implemented by the operator.

32. Operators must provide details of all of the chemical additives contained in drilling and fracturing fluids. We can use this information in our examination of any application for injection, to ensure the substances involved are of a type and at a concentration that will not cause pollution of the water environment. The injection must also meet the appropriate WFD exemption. Operators have the right to claim that information contained

[15] This change will come into affect for any boreholes which drills to or below a depth of 200m from the 1st April 2013

[16] http://www.legislation.gov.uk/ssi/2011/209/schedule/3/made

within or attached to an application is commercially confidential. Further information is provided in the CAR Licence Applicant Guidance[17].

33. We will assess whether audit monitoring will be required based on the environmental risk assessment of the potential environmental impact of the activity. Where monitoring indicates that pollution of the water environment is occurring or has occurred as a result of any activity authorised by CAR, we will take action under CAR to stop any activity, prevent further impacts and remediate those that have happened.

34. Advertising and consultation of any application will take place in accordance with our guidance WAT-RM-20: Advertising and Consultation.

35. The activities may be included in a multiple water use licence and may be authorised at different levels e.g. borehole construction a complex licence, abstraction a simple licence etc.

Pollution Prevention and Control (PPC)

36. We also have regulatory powers under PPC[18] for certain activities, such as those involving refining of gas, gasification or other heat treatments, combustion, or disposal of solid and liquid wastes.

37. The PPC regulations are designed to control emissions to the environment from certain specified activities. If any of the following processing steps are necessary to satisfy statutory and contractual specifications, an application for a PPC permit will possibly need to be submitted and early engagement with ourselves is encouraged:

- Removal of the treatment chemicals or well contaminants from the extracted gas:
  - gases, e.g. hydrogen sulphide, sour/acid gas, CO2, mercaptens etc;
  - water;
  - solids (sands, clay, potentially scale-like carbonates and sulphates, mercury etc);
  - treatment chemicals added at well head.
- Removal of longer chain hydrocarbons.
- Storage.
- Compression.
- Flaring/venting.

38. It should be stressed that the initial exploration for gas, drilling etc. does not fall into one of these activity descriptions and would not require a PPC permit. However, to allow the processing of any gas on the site, a PPC permit must be in place (applied for, determined and where appropriate issued) prior to gas being accepted into the process, i.e. the treatment process must not begin unless a valid permit is in force.

[17] http://www.sepa.org.uk/water/water_regulation/guidance/all_regimes.aspx
[18] Currently the Pollution Prevention and Control (Scotland) Regulations 2000. To note that new PPC Regulations (2012) will be introduced on 7th January 2013 to consolidate the existing Regulations and introduce the requirements of the Industrial Emissions Directive

39. On consideration of a PPC permit for an installation it may be necessary to consider existing and future drilling operations, if located on the same site, as directly associated activities. This would mean controls relating to the drilling operations and any injections into groundwater may be included in the permit and will come into effect at the point gas processing commenced. The PPC permit will require the operator to monitor emissions to air / water / land from both point sources and fugitive emissions within the permit boundary.

The Control of Major Accident Hazards Regulations 1999 (COMAH)[19]

40. Whilst on site storage of large volumes of gas is unlikely, operators should bear in mind that COMAH may apply.

Planning

41. We are a statutory consultee for certain applications as set out within The Town and Country Planning (Development Management Procedure) (Scotland) Regulations 2008[20].

42. Town and Country planning legislation defines within Scotland
    a) what constitutes development,
    b) what development does not require a planning application (permitted development) and
    c) what forms of development require a planning application.

43. Under The Town and Country Planning (Scotland) Act 1997[21] Section 28(1), as amended by The Planning etc. (Scotland) Act 2006, subject to certain provisions, "[...] 'development' means the carrying out of building, engineering, mining or other operations in, on, over or under land [...]". It is our understanding that in Scotland drilling of onshore boreholes therefore constitutes 'development'.

44. Furthermore, it is our understanding is that the drilling of exploratory boreholes for the purposes of coal bed methane and shale gas exploration and appraisal fall outside permitted development Classes 53 and 54 within The Town and Country Planning (General Permitted Development) (Scotland) Order 1992[22], as we consider that the material is "petroleum" as defined under the Petroleum Act 1998[23], and hence these Classes do not apply due to exclusions Class 53 (2) (a) and Class 54 (2) (a).

[19] The Control of Major Accident Hazards Regulations 1999
[20] http://www.legislation.gov.uk/ssi/2008/432/contents/made
[21] http://www.legislation.gov.uk/ukpga/1997/8/contents
[22] http://www.legislation.gov.uk/uksi/1992/223/contents/made
[23] http://www.legislation.gov.uk/ukpga/1998/17/contents

Environmental Impact Assessment Directive (EIA)

45. The European Commission has published guidance on the applicability of the EIA Directive to projects related to the exploration and exploitation of unconventional hydrocarbon, including on the interpretation of relevant project categories in Annex I and II of the Directive. Where proposals concern development under the Town and Country Planning (Scotland) Act 1997, the corresponding reference is to Schedules 1 and 2 of The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2011. Developments of a type listed in Schedule 1 to the 2011 Regulations will always require EIA. Development of a type listed in column 1 of Schedule 2 which:
    a) is located wholly or in part in a 'sensitive area' as defined by those regulations; or
    b) meets one of the relevant criteria or exceeds one of the relevant thresholds listed in the second column of the table in Schedule 2;

    must be subject to case by case screening by the relevant planning authority to determine whether an EIA will be required. Further guidance on EIA procedures is contained in the Scottish Government's planning Circular 3/2011. http://www.scotland.gov.uk/Publications/2011/06/01084419/0

Environmental Liability (Scotland) Regulations 2009 (ELR)

46. The Environmental Liability (Scotland) Regulations 2009 (ELR) place operators of a wide range of activities (e.g. activities requiring a licence under CAR or a PPC permit) under obligations to take preventive measures where there is an imminent threat of environmental damage and to take remedial measures where their activities have caused environmental damage. Activities associated with unconventional gas extraction are likely to come within the scope of ELR. Operators must notify SEPA if they have caused land or water damage or if there is an imminent threat of such damage. Scottish Natural Heritage (SNH) (or Marine Scotland for the marine environment) should be notified in cases where the damage is likely to affect protected species and natural habitats. Further information on this subject is available on our website. (http://www.sepa.org.uk/land/land_regulation.aspx)

The Management of Extractive Waste (Scotland) Regulations 2010

47. The production of ‘flow-back’ fluid from hydraulic fracturing is a mining waste activity. These activities will be controlled through planning permission for the site through an agreed waste management plan. Operators will need to have a waste management plan in place, and be able to demonstrate to planning authorities how they will store and dispose of wastes safely without causing pollution to the environment. This may include a requirement to have a CAR authorisation for any discharge of any pollutants to the water environment. The storage of waste from “prospecting” may not be covered as a mining waste activity. In such cases, the storage of waste at the site of production, prior to onward transfer for recovery or disposal is automatically covered by a Paragraph 41 Waste Management Licence Exemption, which does not need to be registered.

Waste Management Licensing (Scotland) Regulations 2011

48. Abstracted water can be used to make up drilling fluid without any waste management licensing implications. However, any material (such as silt) removed from the abstracted water for disposal is Controlled Waste and needs to be stored, treated and disposed of appropriately.

NORM Radioactive Substances

49. From experience in the industry it is very likely that the fluids that flow-back to the surface after hydraulic fracturing will contain *naturally occurring radioactive materials* (NORM). The production of oil and gas is classed as a *NORM Industrial Activity* for which the Radioactive Substances Act (1993)[24] (RSA93) provides threshold values for radioactive concentration. Above these the fluid will be classed as radioactive waste but below them RSA93 does not apply. Based on experience, we are adopting a prudent position that unless the operator can demonstrate by measurements that the concentrations of NORM are below the threshold values, all developments will require an authorisation issued under RSA93, prior to the start of groundwater abstraction, for the accumulation and disposal of the fluids that flow back as radioactive wastes.

[24] http://www.legislation.gov.uk/ukpga/1993/12/contents