EPP6 (S)

APPEAL BY ISLAND GAS LTD, PORTSIDE
ELLESMERE PORT

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Inadequacies in the geological and geophysical investigations by IGas at Ellesmere Port, Cheshire

SUMMARY PROOF

by

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EXPERIENCE

My name is David Smythe. I am Emeritus Professor of Geophysics in the University of Glasgow. Although I am now a French resident I remain a British citizen, and take an active interest in UK, French and foreign affairs, as well as in various facets of scientific research. My professional qualifications are: BSc Geology (Glasgow 1970), PhD Geophysics (Glasgow 1987); I was made a Chartered Geologist in 1991 but am no longer registered as such.

Prior to my taking up the Chair of Geophysics at the University of Glasgow in 1988 I was employed by the British Geological Survey (BGS) in Edinburgh, from 1973 to 1987. I was a research scientist, rising to the post of Principal Scientific Officer. In the 1990s I was closely involved in the search for a UK underground nuclear waste repository. I served on the BNFL Geological Review Panel from 1990 to 1991, to support BNFL's case for a Sellafield site for a Potential Repository Zone (PRZ), at the time when Nirex was investigating both Dounreay and Sellafield.

I was closely involved with Nirex at this epoch, and conducted for Nirex an experimental 3D seismic reflection survey, which took place in 1994. The survey encompassed the volume of the proposed rock characterisation facility (RCF) – a deep underground laboratory planned as a precursor to actual waste disposal. This was a double world 'first' – the first ever 3D seismic survey of such a site, and the first academic group to use this method, which at the time was just emerging as an essential tool of the oil exploration industry.

I have published around 70 technical and scientific papers and reports (44 papers in the peer-reviewed literature). Since my retirement from the university in 1998 I have carried out private research, acted as a consultant to the oil industry, and maintained a professional interest in the geological problems raised by nuclear waste disposal, unconventional hydrocarbon exploration and coal-bed methane exploration.

While at the BGS I worked closely with the Department of Energy (DEn) and sometimes with the Foreign and Commonwealth Office. I was once invited to join the panel at which the DEn (predecessor in hydrocarbon regulation to the DTI, DECC, BEIS and the OGA) interviewed BP for a licence west of the UK. I sat on the regulatory side with the Chief Geologist and the Chief Geophysicist of DEn. Some 25 years later, during the period when I worked as an oil industry consultant, I sat at the other side of the table representing an Applicant for an onshore licence in the south of England. I am probably the only person who has ever sat on both sides of the table at PEDL award interviews.

SUMMARY

Definition of "Conventional" and the Pentre Chert

1. The Appellant asserted initially that its target to be flow-tested is a conventional hydrocarbon resource, but later changed its view, admitting that the target, the Pentre Chert embedded within the Carboniferous Bowland Shale Group, is unconventional. Although there are no universally agreed definitions of the difference between conventional and unconventional hydrocarbon mineral extraction, the permeability criterion of 0.1 millidarcy for the host rock is generally agreed to differentiate between the two extraction procedures. The Appellant has not provided any data on the permeability of the Pentre Chert, but given what information is available it can be concluded that the permeability of the Chert is below 0.1 millidarcy.

Potential Conduits for Contamination

2. In Table 1 of my main Proof of Evidence, I set out the six computer studies published to date modelling migration of contaminants from a shale layer to impact near-surface groundwater resources. I then discuss each study in turn. They all show that upward migration takes place, via pre-existing natural faults and/or via the perimeter of faulty wells. However, the timescales of the impact vary, depending upon the assumptions made, between a few years and more than a millennium. Note that it does not matter for the present purpose whether or not the shale has been, or is being fractured or acidised; it is the prediction of time of passage up a fault of either liquid or gas from a producing layer to the biosphere that is of relevance to Ellesmere Port.

3. Hydrocarbon seepages have been known since antiquity; two examples are known from near Ellesmere Port: one at Formby and one at Wigan. The relevance of such evidence to the Appeal is that the geology around the well is pervaded by many faults, even though these cannot be mapped in detail in the subsurface.

4. Very little evidence of faults acting as conduits for contamination from unconventional shale gas or oil production is available. This is partly because

faulting in the principal US shale basins is very rare (unlike the UK shale basins, where faulting is typically 500 times greater than in the US). Also many of the (admittedly rare) cases in the US in which shale gas production has resulted in damage to homeowner wells have been settled out of court, with non-disclosure clauses signed as part of the settlement. I have carried out a systematic investigation of contamination incidents in the US, in which faults and not faulty wellbores may have provided the pathway, and have discovered around a dozen such case histories. The timescale in all the examples I have found is that contamination occurs in a matter of weeks or months.

5. For a fault to be a potential pathway it does not have to have a large displacement; it merely has to connect the hydrocarbon bearing strata to the near-surface groundwater resources at risk; but a large fault will have a wider damage zone than a small one, so will be a greater conductor. The Bowland numerical study, although geologically unrealistic, demonstrates that a 1 mm wide fracture can transmit fluid upwards in the order of 100 years.

6. Many more cases of contamination are related to faulty wells rather than geological faults. Risk of wells failing due to seismic activity has to be taken into account in NW England, where the Earth's crust appears to be stressed compressively in a N-S direction, and is near to failure. This was demonstrated at the Preese Hall-1 well in the Fylde, drilled in 2011 by Cuadrilla.

7. I set out various studies of wellbore failure as a conduit for contamination in my main Proof of Evidence. Stimulation of the shale, whether by fracking or by acidisation, may trigger earthquakes. This is because both techniques reduce the natural strength of the rock which, in a tectonically stressed geology, as is the case in the UK, then permits this natural tectonic (crustal) stress to released, causing a seismic event. The concern is not that such activity will ever be likely to cause damage to structures at the surface, but they might disrupt wellbores and watercourses leading to contamination. Such disruption is not always likely to lead to serious damage to well casing, as occurred at Preese Hall-1, but on the other hand is more likely to lead to long-term degradation of the cement bonding around the casing, leading to leaks at the surface.

8. At figure 3.2 in my main Proof of Evidence I show a map of oil and gas fields in the eastern Irish Sea and Lancashire where the gas a sour i.e. contains a high hydrogen sulphide (H_2S) content. Some of these have been generated from the same Bowland Shale Group source rock. It is therefore possible, or even probable, that any gas produced from the same source rock at EP-1 will also have a high H_2S content. The Appellant has not considered the risk of production of H_2S as a by-product of its proposed flow testing. The health risk of H_2S is both that it is deadly poisonous to humans and animals. It smells of rotten eggs at low concentrations, but at higher, lethal concentrations it becomes odourless. It is also a fire hazard. In addition, leaks of H_2S to the biosphere may occur via the pathways discussed above.

Structure and stratigraphy at the wellsite

9. I reviewed the EP-1 well logs and final report, and the IG-14 set of seismic reflection data. The geology at the well labelled EP-1 on the cross-section diagram relied on by the Appellant (set out in my main proof as figure 4.1) does not correspond to the data from the well. It would appear that the cross-section has been taken either from IG-14-01 or from a vertical display from within the North Dee-15 3D seismic survey (still confidential), situated about 8 km to the east of EP-1. In fact, the well labelled EP-1 in the diagram may correspond more closely to Ince Marshes-1. This conclusion is supported by the velocity survey, which I also analysed.

10. The structural layering of the Chert target at EP-1 is therefore quite unknown. The concept of a stratigraphic pinch-out, to provide a trapping mechanism, is therefore also mere speculation. The Appellant has failed to provide the suite of maps that would normally be made and presented to justify its interpretation. I conclude that such maps do not exist.

11. The nearest seismic lines to the well is IG-14-03. The well, which is essentially vertical, lies 270 m NE of the seismic line. The seismic data quality is extremely poor.

Regional Faulting

12. The nearly 800 m thickness of Sherwood Sandstone Group (SSG) is an important Primary Aquifer (many Cheshire villages take their drinking water from it). It has been, and continues to be, used for industrial and agricultural purposes, and for that reason cannot be subject to risk of contamination. There are also at least a dozen deep boreholes archived by the BGS within a radius of 4 km of EP-1.

13. I have interpreted faults on the IG-14 set of seismic lines, loaded into the IHS Kingdom v8.8 interpretation program. I have also inspected images of a dozen or so other older 2D released lines in the area, available on the UKOGL website. The SSG is pervaded by many near-vertical faults. These, together with the wellbore itself, may act as conduits for contamination and upward migration of stray gas and liquids.

14. There are no impermeable capping rocks, such as clays or marls, lying between the shale to be exploited and the SSG. The intervening Coal Measures and Millstone Grit Group are both largely arenaceous (sandy, permeable) formations.

15. The Mersey Estuary Special Protection Area and Site of Special Scientific Interest, both adjacent to the site, may therefore be at risk of harm. The Appellant has misled the Inspector over the distance to these areas, which are just 300 m distant, and not the claimed distance of 2.4 km.

The Nature of the Appellant's Proposed Acidisation

16. The Appellant has quoted a requirement for a volume and a strength of hydrochloric acid to be used in the well which implies that it plans to use matrix acidisation, a technique for stimulating unconventional reservoir formations. The acid strength of 15% is double what is required and customary for an acid wash, which would normally be 7%. The total volume of acid was revised up by the Appellant and was described as not exceeding 95m^3 for the entire operation This contradicts its claim that the acid is merely for wellbore washing or

maintenance. The latter would require at most one-seventh of the volume requested, and at half the strength specified.

17. The well was originally planned and designed in 2009 to penetrate and test only the Coal Measures, and no deeper, for the purpose of coalbed methane exploration. But the well was drilled to nearly double the permitted depth. Part of the geological imaging problems with the new target, the Bowland Shale Group, is that the well was not positioned with the new target in mind. A well to test the Carboniferous shales would be better sited elsewhere within the license area.

18. The Appellant states (**EP23** letter dated 22 November 2018) that *"the Pentre Chert encountered at Ellesmere Port is considered to be naturally fractured"*. No evidence has been provided to support this assertion. The Weatherford fracture report concerns only two cores from above the Pentre Chert, which Weatherford states to be from within the Bowland Formation and the Sabden Shale, respectively. The two cores are noted on the composite log at 1532-7-1550.6 m and 1645.3-1663.3 m (MD); according to this log both are from the Holywell Shale, which is an obsolete name for the Bowland Shale Formation. I have found no evidence in the well logs and reports supplied to date to support the contention of natural fracturing in the Chert.

19. The Appellant claimed initially that the Chert target is a conventional reservoir, but has lately conceded that it is unconventional in nature. Therefore the claimed conventional stratigraphic trapping mechanism to retain the hydrocarbons is no longer valid. It is a tacit admission that the hydrocarbons will require stimulation to extract.

20. In conclusion, and bearing in mind the misleading and incomplete nature of many aspects of the Appellant's case for flow testing the Chert, there is little confidence that the proposed development will not lead to contamination of the aquifer or escape of gas. Therefore the appeal should be dismissed.

21. However, if the Inspector is minded to allow the appeal, it should be granted on condition that the acidisation be restricted to what the Appellant claims to wish to achieve by this method; that is, the use of a volume and strength of acid appropriate to wellbore cleaning, applied at a pressure just above formation pressure.

Prof David Smythe

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