

Consultation exercise: geological disposal of nuclear waste

Statement by Professor David Smythe

1. SUMMARY

I have relevant expertise and experience in the geological aspects of siting of a potential deep radioactive waste repository in the UK. There is clear evidence, after the expenditure of some £400M, mostly directed to the Sellafield area, that West Cumbria possesses no suitable rocks in which to site such a repository. However, the current consultation exercise is flawed, in that it places the ‘voluntarism’ of potential host communities ahead of scientific considerations. The result is that only one community, that in the Sellafield locality, may come forward. The undue concentration of effort on research at Sellafield (and Dounreay) in the past, which may be due to non-scientific considerations rather than sound science, means that many other potentially promising localities in the UK have never been investigated further. To choose Sellafield yet again, by way of community voluntarism, and despite the lessons that have been learned, would be wrong and possibly illegal in international law.

2. RELEVANT PERSONAL DETAILS FROM MY CV

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.

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. During that phase of my career I remember being asked to comment briefly on the suitability of offshore islands west of the UK, and of offshore salt domes in the southern North Sea, as potential nuclear waste repositories.

I served on the BNFL Geological Review Panel from 1990 to 1991. I was invited to join the panel by one of its members, Professor John Lloyd, a hydrogeologist from the University of Birmingham. The panel comprised four university professors, with expertise in: hydrogeology (Lloyd), structural geology (Coward), sedimentology (Williams) and geophysics (myself). I served on this panel 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 resigned from the panel after the case for Sellafield had been successfully made.

I was closely involved with Nirex during the early 1990s. I was surprised that Nirex had ruled out the feasibility of three-dimensional (3D) seismic surveys at Sellafield, and offered to conduct for Nirex an experimental 3D survey, which took place in 1994. The survey was over a 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 is now an essential tool of the oil exploration industry. Unfortunately, the results showed that the geology of the site was far more

complex than Nirex had assumed, and that the geological structure differed greatly from Nirex's predictions.

The Sellafield public planning inquiry appeal (held 1995-96; hereinafter called the Inquiry) by Nirex into Cumbria County Council's refusal of planning permission to develop the RCF took evidence from a number of expert scientists and engineers, myself included.

3. INTRODUCTION

The current public consultation document [1] makes no mention of the history of the search for a suitable site for a UK waste repository, including, in particular, the previous investigations in West Cumbria, which cost the public purse some £400M. It is probable that only one district will be volunteered as a site under the current exercise; Copeland Borough Council in West Cumbria. The documents's criteria ([1], Annex B) for excluding volunteered sites from further consideration *exclude* any criteria under which the complex geology of West Cumbria would be ruled out *a priori*. The criteria are therefore fundamentally flawed.

The purpose of this statement is to remind the government that:

- The geology, hydrogeology, and therefore the long-term safety, of potential sites must be the primary and over-riding criterion in the search.
- West Cumbria, the focus of UK research into a waste repository between 1989 and 1997, has already been proven to be completely unsuitable, when examined under the above criterion.

4. STEPS LEADING TO THE CHOICE OF SELLAFIELD

Early research by BNFL, Nirex and the BGS, prior to 1986, focussed on suitable characteristics of the repository host rock. Sites within sediments at Windscale (now Sellafield) and nearby Drigg had been examined and rejected by the BGS in 1980. A 1984 proposal for a repository offshore from Sellafield, hosted in anhydrite beds within the Permian St Bees Evaporite Formation, was followed by investigations by BNFL and Nirex in 1987, despite having been dismissed as unsuitable by the BGS [2].

A major change in emphasis took place on the publication by the BGS [3] of new criteria for a UK waste repository, based on the complete hydrogeological environment, and not simply on the host rock characteristics (Table 1). Table 1 comes from the 1997 Nirex discussion document 'The way forward' [4]. It states that categories 1-3 were the preferred BGS options at that epoch.

Two Sellafield potential repository sites fall into this list:

- Sellafield-A; hosted in anhydrite beds within the Permian St Bees Evaporite Formation
- Sellafield-B; hosted in crystalline rock, the Borrowdale Volcanic Group (BVG)

Sellafield-A is in the category of seaward-dipping and offshore sediments. The anhydrite had already been shown to be a highly unsuitable host rock. Sellafield-B is alleged by Nirex to be in

the BUSC category, but this was refuted at the Inquiry. I discuss this in more detail in the next section.

Sellafield-B was never in the initial list of 537 sites drawn up by the BGS in 1987 (see Table 2). This site, which Nirex wished to develop initially as an RCF, was added in at a very late stage of the selection process, when the list had already been whittled down to 17 onshore possibilities. It does not conform to the internationally agreed criteria for suitability as a waste dump, and ultimately that was Nirex's downfall at the Inquiry.

Nirex has recently tried to document the history of this site selection process [5], as part of its new, belated, policy of transparency. However, the document is disingenuous, as it describes the site 'sieving' from the initial 537, down to the last few, and then leading to the final choice of Sellafield-B, without ever clarifying when, exactly, this particular version of a Sellafield site appeared in the lists. Thus, for example, the document lists comprehensively the sites *excluded* at each stage of the sieving process, but without declaring the initial list. Even more curious is the assertion in the document that at the sieving exercise of December 1987, when 39 sites were whittled down to 17 onshore, Sellafield-A was not "*discussed*", whereas Sellafield-B was discussed - having just been introduced. This can only mean that Sellafield-A had been either:

- Discarded during an earlier winnowing exercise (but not noted as such in [5]), or
- Like Sellafield-B, it was never in the initial list.

This uncertainty is noted by the '?' symbol in Table 2. Nevertheless, Sellafield-A re-appears in the short-list of 9 sites, but with the splitting of 'Sellafield' into two, we arrive at a total of 10 onshore sites. Table 3 shows the list of these 10 onshore sites. The Nirex document [5] admits:

There is no record of the reasons for the "re-entry" of the sedimentary option but correspondence between BNFL and Nirex notes the nature of political support for any repository as strongly conditional upon its location beneath the nuclear site. At that time, such a location would have applied to the sedimentary option only, Since the basement rocks were then considered to be at too great a depth directly below the nuclear site.

Nirex document [5] describes the multi-attribute decision analysis (MADA) exercise, which was an attempt to rank the 10 sites. Sellafield-B emerged very strongly, mainly due to the high weighting given to transport costs – since 60% of the UK's waste originated at Sellafield, there would be no transport costs in taking it to a repository on-site.

The document goes on to allude to correspondence between the Secretary of State and Nirex between July and November 1988. We do not know what the Secretary of State himself wrote, but the 'Sellafield' sites were now referred to in the singular by the Nirex chairman in his response:

'... the emerging consensus that whatever the technical merits of the various short-listed sites... they in fact divide into two categories: those where there is a measure of local support for nuclear activities in the local community (Sellafield and Caithness) and those where there is not. We are doubtful whether, given the expected level of opposition, it would prove possible to pursue to a successful conclusion a site where there is no measure of support in the local community no matter how good its technical features ...'.

'... the best way forward will be to carry out site geological exploration during 1989 at both Sellafield and Caithness in parallel (covering both the sites at Caithness which are geologically different).'

One of the two Caithness sites, Altnabreac, was dropped in favour of Dounreay, reducing the short-list to two. Sellafield-B was finally selected in July 1991, but its location was shifted slightly, to the PRZ under Longlands Farm.

In conclusion, the two Sellafield alternatives entered and/or re-entered the site selection process by dubious, non-scientific means. Political and/or other non-scientific arguments, as stated by Nirex (above):

- *“measure of support in the local community”*
- *“political support for any repository as strongly conditional upon its location beneath the nuclear site”*

were advanced to narrow the choice down to Sellafield-B and Dounreay, in spite of the unfavourable geology at both localities. International guidelines were ignored or distorted (see next section). The advice of the BGS was disregarded.

5. BASEMENT UNDER SEDIMENT COVER (BUSC)

Some comments are necessary concerning the generic category of geological waste repository, ‘basement under sedimentary cover’ (BUSC; see Table 1). Nirex insists that Sellafield-B belongs to this category, but this is not the case. Firstly, West Cumbria was not defined as a BUSC region by the BGS in its mapping outline for Nirex [4]; the coastal region is instead classified as ‘seaward-dipping and offshore sediments’ (see Table 1). At the Inquiry, the Inspector’s Assessor [6] concurred with Cumbria County Council’s view that Sellafield-B is not a true BUSC site. He also pointed to three other features of the district:

1. The district lies along the boundary between two major geological provinces, and where, therefore, *“a degree of structural complexity might be expected”*,
2. The BVG is too complex, and
3. The original Sellafield-B site lay below Carboniferous limestones – a sub-category of BUSC which Chapman *et al.* [3] had previously said should be avoided.

The Assessor (op. cit. para. B34) concluded:

“Thus the Sellafield Basement site introduced at a late stage did not comfortably meet what were earlier seen as requisite features. Nor did it comfortably fit into one of the previously adopted generic types of target geology. Nirex introduced a site that might reasonably have been expected to be difficult to investigate and characterise. If the Sellafield B site had been included in the original pool of nearly 500 potential repository locations and had passed through the same qualitative geological sieving process as the others then I would have expected it to have been excluded on comparative geological and hydrogeological grounds at a relatively early stage.”

6. NIREX AND THE CASE FOR SELLAFIELD, 1995-1996

In 1995 I was commissioned by Friends of the Earth to provide expert opinion and advice on the geological and geophysical interpretation of the Sellafield area. Although I felt unable to reveal the preliminary findings of the 3D seismic trial survey, which I understood to be Commercial in Confidence, I was able to use my intimate understanding of the geology and geophysics of the locality to demonstrate that Nirex did not understand the essential geological structure of the proposed site. During the Inquiry the Inspector instructed me to discuss whatever details I felt were necessary regarding the results of the 3D survey, as ‘Commercial in Confidence’ had no valid status in the Inquiry. I was thus able to testify that the survey corroborated what I had already said, using the publicly available information.

My evidence formed only a small part of the case against Nirex, which was comprehensively defeated – not just on planning and environmental criteria, but also on the fundamental science underpinning Nirex’s choice of site. The evidence presented to the Inquiry showed that the whole of the West Cumbrian region, not just the locality of the RCF, is geologically unsuitable for siting a waste repository. No geological or geotechnical advances have been made since 1997 that might reverse the scientific consensus, which teaches us that:

- The crystalline rocks at depth, the Borrowdale Volcanic Group (BVG), are too complex and criss-crossed by faults to be the host rock for a repository.
- The overlying sediments do not provide the ‘cap’ or seal in case of future leaks, but in fact host a vigorous fluid flow regime.
- There is no BUSC category of repository in the area.
- The BVG itself is too permeable, and the geology of the former volcanic caldera is far too variable on the scale of a repository, ever to be characterised and modelled sufficiently well to serve as a repository host.
- The area is also prone to occasional large earthquakes.
- The Sellafield-A option (disposal in anhydrite beds) is also untenable.

The refusal of the Secretary of State in 1997 to allow the appeal must therefore be seen as an acknowledgment that West Cumbria is unsuitable for geological disposal of radioactive waste

7. CONSIDERATION OF ALTERNATIVE SITES

The nuclear industry has tried to downplay the wide impact of the planning refusal of 1997. It tries to give the impression that the refusal concerned merely local issues surrounding construction of the RCF. For example, ref. [7] states:

“The Inspector’s grounds for recommending dismissal of the appeal concerned straightforward planning matters, which might apply to any type of development; and reasons particular to the RCF and to the repository which might have followed it. The planning matters included the adverse environmental impact of the development. He also stated that the proposal to build the RCF was premature as more needed to be known about the hydrogeology and geology of the site and the underground impact of constructing the RCF. The Inspector also concluded that the site had not been selected in an objective and methodical manner.”

In fact the Inspector [8] considered at length the issue of alternatives and availability of information (ref. [8] section 3B). Nirex had been trying to limit the terms of the Inquiry to the technical merits of the RCF. After summarising the submissions of Nirex and the objectors, he stated:

- “... even on a narrow view of the UK law it would be material to examine comparable sites” ([8] para. 3B.35)
- “I also feel that there is some force in the argument that, if, as apparently intended, the regulatory regime does not review site selection, then the planning system will have to do so to comply with Euratom justification requirements” ([8] para. 3B.39)
- “... it is plainly wrong under EU & UK law, in my view, to suggest that an authority cannot rely on an alternative site simply because less information is available about it.” ([8] para. 3B.40)
- “... contrary to Nirex’s understanding, it is appropriate for the planning authority to look broadly at the relative radiological protection offered by various sites before the regulators look in detail at the protection offered by the chosen site. Indeed that is, in my view, the logical approach which accords with the Preamble to the Directive.” ([8] para. 3B.42)
- “On reflection, I accept that it is not possible for the environmental authorities & the public concerned to express an informed opinion on the direct and indirect environmental effects and benefits of the RCF unless they are given outline profiles, including locations, of the analysed alternative sites, so that they may make their own judgements of the appropriateness of the developer’s choice. This I now believe to be an overriding requirement notwithstanding the inevitable alarm it would raise in the vicinities of the alternative locations. I am reinforced in this belief by the realisation that this case is concerned with the potential safety of sites over millions of years, in comparison with which the period of public alarm should be fleeting.” ([8] para. 3B.45).

The Inspector’s view are therefore clear; a lot of geological and hydrogeological work has to be taken at a number of potentially promising sites before any one is chosen for more detailed work. In the ten years since the Inquiry reported none of this work has been carried out. Merely the formerly secret list of the ten sites short-listed has been released (Table 3).

8. OUTCOME OF THE CURRENT CONSULTATION

Once volunteered sites have been proposed, the British Geological Survey (BGS) will apparently be employed to apply the exclusion criteria to the short-list of volunteered potential sites, “in order to eliminate ... any that are obviously unsuitable” [1]. By employing the specified criteria West Cumbria would be back in the picture. This demonstrates that the current geological criteria are fundamentally flawed.

It would have been much better for the government to acknowledge the lessons and errors of the past, by selecting geologically suitable regions or districts first, and only then inviting local communities to bid for the right to host the site. The difference between the 1980s and now is that

packages of benefits for the host community are now on offer; that was not the case 20-30 years ago.

Both at the Inquiry and in earlier investigations it was stated that potential BUSC areas are present over large tracts of central and eastern England, and whereas there is a paucity of deep boreholes to confirm the variability or otherwise of the basement geology, it appears that this region is fundamentally far simpler, geologically, than West Cumbria (see, for example, [8] paras. 6B.51-6B.52). During the 1980s, Northern Ireland was ruled out of consideration because of the political situation. That has changed significantly, so it may be that there are potential sites to be identified there as well.

9. CONCLUSIONS

1. The appropriate order for site selection is:
 - geology, hydrogeology (and hence long-term safety) first, before
 - involvement of local communities
2. Notwithstanding the order of site selection, West Cumbria has been proven to be geologically unsuitable.
3. Site selection has to be based on scientific principles, before applying any socio-political considerations.
4. The current consultation exercise should be considered to be fundamentally flawed, unless and until volunteer communities, *excluding any in West Cumbria*, come forward from districts which are known to have geological potential for hosting a waste repository.
5. There are many dozens of districts within the UK outwith West Cumbria which merit further investigation as potential repository site.
6. Basing a site short-list or selecting a site primarily on the wishes of a local community may be contrary to EU and international guidelines.

10. REFERENCES

- [1] *Managing radioactive waste safely: a framework for implementing geological disposal*. DTI/Defra discussion document, June 2007.
- [2] *Long term effects on potential repository sites: occurrence and diagenesis of anhydrite*. BGS Fluid Research Group report no. 85-12. Bath, A. *et al.* 1985.
- [3] Geological environments for deep disposal of intermediate level wastes in the United Kingdom. IAEA-SM-289/37. Chapman, N. A. *et al.* (1986).
- [4] *The way forward. A discussion document*. UK Nirex Ltd 1987.
- [5] *Review of 1987-1991 site selection for an ILW/LLW repository*. Technical note no. 477002. UK Nirex Ltd 2005.

- [6] *Assessor's Report* (Appendix 1 to Inspector's Report). Cumbria County Council; Appeal by UK Nirex Limited. Inquiry document no. APP/H0900/A/94/247019. Knipe, C.V. 1996.
- [7] *Waste and decommissioning. An evidence-based report by the Sustainable Development Commission*, Paper 5, with contributions from Nirex and AMEC NNC March 2006.
- [8] *Inspector's Report. Cumbria County Council; Appeal by UK Nirex Limited*. Inquiry document no. APP/H0900/A/94/247019. McDonald, C. S. 1996.

Table 1. Categories of hydrogeological environment

1. Hard rock, low relief
2. Small islands
3. Seaward-dipping and offshore sediments
4. Inland basins
5. Basement under sediment cover (BUSC)

Table 2. 'Sellafield' sites in the UK-wide selection process

Date	Process	Sell-A	Sell-B	Comments
1980	First BGS study	Discarded	-	
1984	Offshore anhydrite	Revived		Proposal ruled untenable by BGS in 1985
9/1987	Offshore anhydrite	Still live		Joint BNFL/Nirex contract to investigate
11/1987	'The Way Forward'	-	-	General Nirex strategy
1987	537 sites picked	Included?	-	Initial BGS list based on 5 categories (Table 1)
1987	Sieving 537 to 204	?	-	Sites with "obvious deficiencies" eliminated
1987	Sieving 204 to 165	?	-	Land ownership problems - eliminated
1987	Sieving 165 to 117	?	-	Size/shape of site unsuitable - eliminated
1987	Sieving 117 to 39	?	-	Geological evaluation
12/1987	Sieving 39 to 17	No mention	Included	Sell-B appears for first time
7/1988	Sieving 17 to 9(10)	Revived		Sell-A re-appears (so 9 onshore become 10)
7-10/88	Ranking of 10 sites	Poor	High	Using 'MADA' process
Late-88	Political directive	'Sellafield'		2 areas to be preferred; 'Sellafield' and Caithness
3/1989	Nirex decision	Excluded	Included	2 sites (*) to be investigated by desk studies
7/1991	Final choice		Chosen	Sellafield-B selected

Key: Sell – Sellafield.

BGS – British Geological Survey

MADA – multi-attribute decision analysis.

? – see text.

* - Sellafield-B and Dounreay

Table 3. Shortlist of ten onshore sites (alphabetical order)

Altnabreac, Caithness (low-relief hard rock)
Bradwell, Essex (coastal BUSC)
Dounreay, Caithness (low-relief hard rock)
Fuday, Western Isles, Scotland (small island)
Killingholme, Humberside (seaward dipping sediments)
Potton Island, Essex (coastal BUSC)
Sandray, Western Isles, Scotland (small island)
Sellafield 'A' (anhydrite), Cumbria (seaward dipping sediments)
Sellafield 'B' (Borrowdale Volcanic Group), Cumbria (BUSC)
Stanford, Norfolk (inland BUSC)

This list was arrived at in July 1988, but remained confidential till 2005.