DECC Consultation [1,2]

Government Funding & RadWaste

Response from

Dr Rachel Western BA (Oxon) PhD MRSC

June 2010

Dr Western is the Nuclear Researcher for Friends of the Earth groups in Cumbria and also a member of 'Nuclear Waste Advisory Associates'.

Her academic background is in the science and policy issues associated with nuclear waste management; and she has worked for the nuclear waste agency (Nirex), and also for Friends of the Earth (HQ).

[1] DECC "*Consultation on a Methodology to Determine a Fixed Unit Price for Waste Disposal and Updated Cost Estimates for Nuclear Decommissioning, Waste Management and Waste Disposal*" March 2010 http://www.decc.gov.uk/Media/viewfile.ashx?FilePath=Consultations\nuclearfixedunitprice\1_20100324145948_e_@@_ConsultationonFixedUnitPricemethodologyandupdatedcostestimates.pdf&filetype=4

[2] DECC - The Energy Act 2008 – "*Consultation on The Financing of Nuclear Decommissioning and Waste Handling Regulations*" March 2010-06-13http://www.decc.gov.uk/Media/viewfile.ashx?FilePath=Consultations\financingnuclear\1_20100324163031_e_@@_DECR9574URN10D574En.PDF&filetype=4

Preface

In September 2001, at the very start of the: '*Managing Radioactive Waste Safely*' (MRWS) programme the Environment Minister, Michael Meacher stated: [3]

> "*The legacy of a wrong decision could be catastrophic*."

[3] "*Government looks for Public Consensus on Managing Radioactive Waste*" – DEFRA Press Release – 12th September 2001, 132/01

Response in Brief

Given that the current risks presented by the Sellafield Plutonium Complex are so high – and that the impact of an accident / incident at the site would be so devastating; it is imperative that DECC ensures that its work is prioritised to ensure the protection of public safety.

This requires:

i) the cessation of further plutonium separation; and

ii) the focus of all available funds on hazard reduction at Sellafield

The current Consultation on the proposal to subsidise additional RadWaste production would be an extremely dangerous distraction.

The adoption and implementation of such a Policy would create further RadWastes – which would necessarily be a drain on future Public Funds – in exactly the way that we ourselves are facing the costs that have arisen from the nuclear programme of the last Century. [4]

Currently:

- the NII have described the risks at Sellafield as 'far too high', and
- Sellafield have stated that the work that needs to be addressed is of such a high hazard nature that the money would still need to be spent [5] despite pressure on Public Spending

However, no budget has been agreed for Sellafield; and furthermore, job cuts are being made at both the NDA and at Sellafield - Sellafield Unions have predicted job cuts of up to 1,200.

Much of the UK RadWaste costs arises due to the fact that – extraordinarily – this Country still applies the Military approach to RadWaste management that was developed in WWII – ie to treat waste fuel chemically in order to extract the plutonium content.

In 1984 Alwyn McKay [6] - a pioneer nuclear scientist wrote:

---

[4] These costs are projected at over £70 Billion. – for example see :
"*NDA advised on soaring clean-up costs* " World Nuclear News
30th January 2008
http://www.world-nuclear-news.org/WR/NDA_advised_on_soaring_costs_300108.html

[5] Weds 10th June 2009
http://www.contractjournal.com/Articles/2009/06/01/68289/with-13bn-to-spend-per-annum-nuclear-decomissioning-work-has-a-long-half-life.html
"*Contractors warm up for £1.3bn Sellafield clean-up*"

> "*Few people can have known greater happiness than those who discovered the secrets of the atom and its nucleus in the first half of this century. Their work was, to them absorbing, exciting and unquestionably important. They were dedicated: they expected little wealth or public recognition – only the thrill of achievement and the acclaim of their colleagues.*" [7]

We are now in the first half of the following Century.

We are living at a pivotal moment where the mantle of those of those who had claimed authority has been passed on to others. Present day Analysts – and present day Decision-Makers - are from a wholly different era.

This presents an incredible opportunity.

However, this opportunity will only be realised if it is recognised and acted upon.

A Litmus Test of the New Coalition will be whether they face up to this challenge.

---

[6] Alwyn McKay worked at the Niels Bohr Institute in Copenhagen form 1935 to 1937, and at Harwell, the Atomic Researcg Establishment in Oxfordshire from 1947 until his retirement in the early 1980s. (see Back cover of his book "*The Making of the Atomic Age*"

[7] Alwyn McKay - "*The Making of the Atomic Age*" (page vii)
Oxford University Press (OUP) 1984

Table of Contents

SECTION ONE

Problems with the Levy Approach to RadWaste Funding

The Government are proposing to subsidise the building of new nuclear reactors by taking on the costs of managing the resultant nuclear wastes. These wastes would include the weapons material plutonium as well as huge amounts of other cancer causing wastes – that would be dangerous for millions of years to come.

The nuclear industry would simply have to pay a fixed levy beforehand – rather than the actual costs. This is obviously a subsidy because it means that future taxpayers – and not the nuclear industry - would bear the risks of a cost hike.

Not only would this levy system be a subsidy in itself, the calculation methods that are proposed for working out what the levy should be, wildly underestimate the likely out-turn costs of RadWaste management.

For example:

1.History of Price Hikes Ignored

> For each of the three projections of future waste costs, [8] it is assumed that the costs will gradually reach a stable figure. However, the available evidence indicates that a hike in RadWaste costs would be much more likely. For example, just a fortnight into the new administration it was revealed that current RadWaste costs are so high that **Labour had hidden a multi-billion pound black hole in the waste budget.**[9] **For waste disposal costs, over the last thirty years there has been a thirty fold in cost estimates.**[10]
>
> It is much more likely that the costs will not gradually become stable – but instead will spiral out of control. The supporting evidence base for this statement

---

[8] Methodology Document - Figure One - page 19, Figure Two – page 20; and Figure Three – page 21

[9][9] Sunday 16th May 2010
Sunday Times
http://www.timesonline.co.uk/tol/news/politics/article7127819.ece
See also
Guardian 2nd June 2010
http://www.guardian.co.uk/politics/2010/jun/01/chris-huhne-black-hole-nuclear-power-budget
FT 2nd June 2010
http://www.ft.com/cms/s/0/64a7629c-6ddd-11df-b5c9-00144feabdc0.html

[10] For the references and calculation method used for this calculation - see note at the end of this document.

2. Over One Hundred Problems with Disposal

DECC comment that one "*rigorous approach to managing risk and uncertainty is to construct a comprehensive risk register*". [11] However, DECC state that such a comprehensive approach has not yet been completed for disposal. Therefore, DECC advocate the application of the "*Optimism Bias*" approach – as set out in the Treasury 'Green Book' (see Box below).

HM Treasury 'Green Book' and 'Optimism Bias [12]

"*The Green Book is an HM Treasury publication that presents the techniques and issues that should be considered when carrying out assessments of new policies, programmes and projects. The HM Treasury Supplementary Green Book Guidance on Optimism Bias is available at http://www.hm-treasury.gov.uk/data_greenbook_supguidance.htm*"

"*Optimism Bias*," is defined in the Green Book as the "*demonstrated, systematic, tendency for project appraisers to be overly optimistic.*" [13]

A figure of just two-thirds [14] has been selected by DECC to allow for 'Optimism Bias' in the levy calculations. It should be noted that, although DECC state that no 'risk register' has been compiled for disposal, in March 2010 Nuclear Waste Advisory Associates [15] (NWAA) collated a list one **over hundred technical problems with waste disposal that remain to be resolved** before disposal could be given the go-ahead..[16]

This figure of over one hundred problems remaining to be solved before disposal could even begin, indicates that DECC's figure of just two-thirds for 'optimism bias' is wildly inaccurate.

3. The possibility of Dangerous Leakage

In order to take account of "*wider uncertainties*" DECC specify that a "Contingency Allowance" should be calculated.[17]

[11] See page 28 of 'Methodolgy' doc
[12] DECC – Ref 24 (page 28 – Methodology doc)
[13] See – Methodology doc – para 3.3.16 page 28
[14] Methodology document – page 28 – para 3.3.15
[15] http://www.nuclearwasteadvisory.co.uk/
[16] Nuclear Waste Advisory Associates (NWAA) 'Issues Register' - March 2010
"*Outstanding Scientific and Technical Issues Relating to the Production of a Robust Safety Case for the Deep Geological Disposal of Radioactive Waste*"
http://www.nuclearwasteadvisory.co.uk/uploads/6901NWAA%20ISSUES%20REGISTER%20COMMENTARY%20letterhead.doc
[17] Methodology doc – page 5 – para 1.15 – bullet point three

As in the case for the specification of the 'Optimism Bias', DECC's approach to the 'Contingency Allowance' may also be seen to be wholly unreliable. This may be illustrated by consideration of the possibility that the wastes may need to be recovered.

The DECC calculations assume that there would be no need to recover the waste.[18] However as discussed above, the available evidence indicates that the waste disposal cannot be relied on. Therefore it is possible that people in the future may want to recover wastes that had been buried. This possibility that waste would need to be recovered from a dump in the future would add enormously to the costs.

Currently the nuclear industry are not even sure that worker doses would be low enough for workers to be able to put waste into a nuclear dump in the first place. [19] The doses would of course be much higher if workers were trying to recover wastes from a dangerously leaking dump.

These doses could easily be unacceptable – and the compensation figures resulting from the radioactive contamination of a region's water supplies and agricultural land would be likely to be huge. At the time of writing BP is facing a multi-billion dollar bill for the oil release in the States.[20]

The technical difficulties associated with the notion of nuclear waste disposal is dealt with at some length in the Appendix.

The present Consultation documents on the proposed subsidy were produced under the Labour administration. This Consultation represents an early Litmus test of the Coalition's commitment not to bankroll the nuclear industry with taxpayer's money. **At a time when massive cuts are planned in Public Spending it would be wholly irresponsible to commit future Public Funds to this dangerous and pointless energy source.**

For each of the three graphical illustrations given in the 'Methodology Consultation' [21] the long-term waste cost projection is set out as an 'horizontal asymptote' – ie the value is value is assumed to plateau at a stable value – and remain at this value indefinitely into the future.

Asymptotes can also be vertical [22] or oblique;[23] similarly there is the prospect of RadWaste costs increasing far more than had been anticipated. In fact the evidence base suggests that this is the more likely outcome.

DECC state that:

---

[18] Methodology – page 86
[19] "*Generic Design Assessment: Disposability Assessment for Wastes and Spent Fuel arising from Operation of the UK EPR*", Jan 2010 Part 1: Main Report. – page 91
[20] See for example, the Guardian, Monday 7 June 2010 http://www.guardian.co.uk/environment/2010/jun/07/bp-oil-spill-fines-government
[21] Figure One - page 19, Figure Two – page 20; and Figure Three – page 21
[22] http://img.sparknotes.com/figures/1/15debaf09555bfc7c688d9ee8ae574bc/asymptote_vertical.gif
[23] http://wpcontent.answers.com/wikipedia/en/thumb/4/4f/SlantAsymptoteError.jpg/220px-SlantAsymptoteError.jpg

"*It is possible that 66% is too high,*[for the Optimism Bias] *but* ***equally it is possible that it is <u>too low</u>. This requires further analysis, and the Government does not propose to commission this work until a prospective operator requests a Fixed Unit Price***". (para 3.3.22 – page 29, Methodology Cons)

This *laissez faire* attitude is simply contemptuous of future Governance

Evidence that Future Waste Costs are Likely to Increase Substantially

Below five examples are given that indicate the most likely out-turn for future waste costs is that they will increase.

i) Disposal Costs – Thirty Fold Increase in Thirty Year

References and Calculation

<u>Current Cost Estimate £12.2 Billion</u>

Source:

NDA (Nuclear Decommissioning Authority)
Annual Report & Accounts (2007/08) - page 35
http://www.nda.gov.uk/documents/upload/Annual-Report-and-Accounts-2007-2008.pdf

"The current best estimate for the undiscounted lifetime costs of a GDF is **£12.2 billion** (at 2008 money values)"

<u>1978 - Dump Costs Estimated at £100 Million</u>

Source:

L.E.J Roberts UKAEA, "*Radioactive Waste – Policy and Perspectives*"
A lecture given to the British Nuclear Energy Society in Nov **1978**, published by UKAEA in April 1979

"The estimated cost of a repository of this size is £100 million." (page 19)

£100 Million in 1978 is approximately worth **£450 Million** [24] in current money (ie allowing for inflation.)

<u>Calculation of Rate of Increase in Cost Estimate</u>

[24] (Source of '450 multiplier' – personal communication from Hugh Richards to Rachel Western Thurs 17th June 2010)

12,200 / 450 = 27.1

= 30 (approx)

2010 – 1978 = 32

= 30 (approx)

Thus approximate rate of increase in nuclear industry estimates for the cost of nuclear waste disposal (from 1978 to 2010)

= thirty fold over thirty years

ii) NDA - 40% cost increase from 2005 to 2007

In January 2010 a report by the National Audit Office (NAO) on the Nuclear Decommissioning Authority (NDA) reported that costs for the first five-year period rose by over 40% between 2005 and 2007.[25]

iii) Plutonium from 'Credit' (1955) to Liability (1989)

1955

In 1955 the White Paper "*A Programme of Nuclear Power*" (Cmd. 9389) – which ushered in the UK's 'Magnox' nuclear power stations sets out a value of **£1 million per tonne** [26] as the appropriate value for the so-called 'plutonium credit'**.** It was recognised that the value selected for the 'plutonium credit' would have a considerable effect on the net cost of electricity. [27]

2009 (cf 1989)

In January 2009, the NDA described plutonium [28] as

"*a zero value asset*" [29] (page 3)

---

[25] World Nuclear News - 30th January 2008
"*NDA advised on soaring clean-up costs* "
http://www.world-nuclear-news.org/WR/NDA_advised_on_soaring_costs_300108.html
[26] Page 4 – para 18
[27] Page 4 – page 16
[28] NDA – "*Plutonium Topic Strategy*" - Current Position
30th January 2009
EDRMS No. FPv1/ Doc No: SAF/171108/001
http://www.nda.gov.uk/documents/loader.cfm?url=/commonspot/security/getfile.cfm&pageid=27424
[29] Pu Topic Strategy (Jan 2009) page 3 – Footnote 2 – "*The concept of a zero value asset means that there are no cost or revenues attributed to the balance sheet, either from immobilisation or from any revenue that may be generated by recycling options*"

However, such a notion of a 'zero-valued' asset is misconceived. As long ago as 1989, the Nuclear Energy Agency (NEA) reported plutonium storage costs as being in the in the region of $1 to $2 per gram of total plutonium per year. [30] - which is equivalent to a **COST of £1 Million per tonne per year**. (approx)

iv) Failure to Recognise the Future Costs Contingent on Extracting Plutonium from Waste Fuel. (1955) – cf present NDA budget for Sellafield Site. [31]

v) 'Yucca' and the US experience with a 'Levy Approach

In November 2009 Citigroup reported that:

> "*The UK government is proposing adopting the "pay as you go" approach [to RadWaste } **used successfully** in the USA*"[32]

> However, in June 2010 , the Washington Post reported that, after more than 20 years, four administrations and billions of dollars spent focussing on the proposed Yucca Mountain RadWaste disposal site, the Yucca site is the one place in America that a new Blue Ribbon Commission on America's Nuclear Future cannot look to put this country's nuclear waste. [33]

Failures of the Deferral Approach

The fact that in (June 2010) it was reported both that the Labour Administration had left a £4 Billion black hole in the RadWaste accounts - and also that EdF had left a £100 Million hole in their pension funds – indicates that the DECC proposal for the payment of the RadWaste levy to be deferred [34] is quite clearly a non-starter.

i) Labour £4 Billion Black Hole in RadWaste Accounting

Britain is facing a **£4bn black hole** in unavoidable nuclear decommissioning and waste costs, Chris Huhne, the energy and climate change secretary disclosed tonight. The decommissioning costs over the next four years revealed by officials to Huhne are so serious that he has already flagged the crisis up to the cabinet. The revelation places an unexpected burden on his department's **£3bn annual budget** ahead of difficult spending negotiations this summer. "As you can imagine, this is a fairly existential problem. The costs are such that my department is not so much the department of energy and climate change, as the department of nuclear

---

[30] "*Plutonium Fuel – An Assessment*" – Nuclear Energy Agency (NEA) of the Organisation for Economic Co-operation and Development (OECD) 1989 – Section 2.5.4.11 – page 64

[31] See the (1955) White Paper "*A Programme of Nuclear Power*" (Cmd. 9389) page 4 (para 16) – plus discussion in this document of the RadWaste costs associated with the decision to extend the **Military** practice of applying Plutonium Extraction to RadWaste to the RadWaste produced from the Electricity Reactor fleet.

[32] Citigroup '"*New Nuclear – The Economics Say No*" – Nov 2009
Risk Five' page 3
https://www.citigroupgeo.com/pdf/SEU27102.pdf

[33] Washington Post 14th June 2010
http://www.washingtonpost.com/wp-dyn/content/article/2010/06/13/AR2010061304143.html

[34] See 'Methodology' document - page 18 – page 3.2.7

legacy and bits of other things," Huhne told the Guardian.

Guardian 2nd June 2010
http://www.guardian.co.uk/politics/2010/jun/01/chris-huhne-black-hole-nuclear-power-budget

FT 2nd June 2010
http://www.ft.com/cms/s/0/64a7629c-6ddd-11df-b5c9-00144feabdc0.html

ii) EdF - £100M hole in Pension Fund

THE £4 billion auction of Britain's biggest electricity distribution network could be delayed by a dispute over how to fill a hole of £100m or more in its pension fund. EDF Energy, the French power group, put the business — which provides power to 7.8m homes in southeast England — up for sale a year ago. Final bids are due on June 21. Sources close to the auction, however, said bidders were warned last week that the process could be pushed back because of the pension issue.

Sunday Times 13th June 2010

http://business.timesonline.co.uk/tol/business/industry_sectors/utilities/article7148999.ece

SECTION TWO

Sellafield

Context

What Sellafield Does

Sellafield is a military site set up immediately Post War to provide plutonium for nuclear bombs.[35,36] The plutonium is obtained by chemically separating it from waste nuclear fuel rods, and the process used for the separation is known as '*solvent extraction*' [37] When using this technique it is essential that the solid rods of radioactive waste are converted to liquid.[38] As a result the radioactive wastes left

[35] Margaret Gowing and Lorna Arnold – "*Independence and Deterrence – Britain and Atomic Energy, (1945-1952) – Volume I Policy Making*" pp 166-8, p144
(A volume commissioned by the United Kingdom Atomic Energy Authority – as part of the Historical Account of the UK Nuclear Weapon Project)
[36] Alwyn McKay – "*The Making of the Atomic Age*" pp 124-125 – NB – this reference points out that '**Windscale**' was the original name for the '**Sellafield**' site
[37] The technique used is 'Plutonium Uranium Refining by Extraction' – or 'Purex' - see Gmelein Handbook – Transuranium Chem (x30) AI II p209
[38] This is achieved by dissolving the rods in acid.- see Gmelein Handbook – Transuranium Chem (x30) AI II p209

over from the plutonium extraction are liquid. Because they are intensely radioactive they are known as '*Liquid High Level Waste*' (or Liquid HLW) [39,40]

Sellafield continues to separate plutonium from other nuclear wastes even though [41] the military requirement has been met.[42]

The HLW Gestalt

'High Level Waste ' (or HLW) consists of 'Fission Products' in a concentrated form. 'Fission Products' are the fragments of the original atoms that have released their 'nuclear energy' by breaking into two much smaller atoms (which are roughly half the size). These fragments are fiercely radioactive and extremely dangerous.

Initially the' fission products' are held in the actual fuel rods used in the nuclear reactor. After a while.the waste fuel rods are taken out of the reactor. This **'Solid HLW'** is sent to Sellafield in Cumbria, where the plutonium that the rods contain is removed. The method used for plutonium removal is a chemical technique known as 'solvent extraction' which demands that the waste fuel rods are turned into a **liquid** form.

The solid waste fuel rods are changed into a liquid form by dissolving them in nitric acid. Once the plutonium is removed from the acid solution, the waste stream **'liquid High Level Waste'** is created. This comprises of the nitric acid (which was used to dissolve the fuel rod) plus the fission products.

Liquid High Level Waste is extremely dangerous – some indication of the hazard that it presents is set out below. Sellafield has a set of equipment that is meant to return the fission products to a solid form (as they were prior to removal of plutonium from the mixture). The method used for this re-soldification is known as 'vitrification' The **'Solid HLW '** that results is in the form of a type of glass.
Hazard due to Liquid Wastes

> Sellafield converts solid waste rods into a liquid solution.
>
> However, in a June 2006 NDA document on Radiological Hazard Potential, the NDA Engineering Directorate [43] wrote:

---

[39] F R Farmer "*The Problem of liquid and gaseous effluent disposal at Windscale*" J.Brit Nucl.Energy Conf. Jan 1957 pp 26 – 39 – esp see p28 'Direct effluent from the chemical plant' - first para
[40] Nuclear Installations Inspectorate – March 2009 Newsletter (pp15 – 16) http://www.hse.gov.uk/nuclear/nn45.pdf
[41] Nuclear Installations Inspectorate – March 2009 Newsletter - pp14 + p16 (NB – within the nuclear industry the plutonium separation technique is known as 'reprocessing') http://www.hse.gov.uk/nuclear/nn45.pdf
[42] *"The United Kingdom's Defence Nuclear Weapons Programme - A Summary Report by The Ministry of Defence on the Role of Historical Accounting for Fissile Material in the Nuclear Disarmament Process, and on Plutonium for the United Kingdom's Defence Nuclear Programme*" http://www.mod.uk/NR/rdonlyres/C4840896-90AD-4A8C-BF8D-C2625C7C1DD8/0/historical_accounting.pdf)
[43] Nuclear Decommissioning Authority *"The "Radiological Hazard Potential" - Helping to make sense of cleaning up the UK's nuclear sites*" [Engineering Directorate Document No: EGR003 Revision: Rev 1] 13th June 2006

"*Materials which are liquids or gases could all escape if all storage protection was removed*" (page 6)

Such an escape could be caused by an accident/ attack.

The Hazard Presented by Sellafield - Summary

At Sellafield in Cumbria there is a very large amount of highly radioactive waste. Most of the waste has come from liquidising used nuclear fuel rods - a process that is carried out to extract plutonium.

Liquid wastes are extremely vulnerable to release. Release could be caused by site emergency or terrorist attack. Following 9/11 many organisations warned the Government of the degree of threat that Sellafield presented.

In particular an American security expert described Sellafield as: "*a weapon for an enemy*".

An attack at Sellafield could:

- contaminate two million people with a fatal dose of radioactivity; and
- spread as far afield as Glasgow to Liverpool

The Labour Government did not respond to these warnings in any way, and did nothing to address the urgent programme of work necessary to reduce the threat. (ie by turning the wastes from liquid to solid)

The extraordinary degree of negligence that was shown has meant that the problem has become worse and worse. It is now acute. In October 2009 the Government watchdog (the NII) described the risks at Sellafield as "*far too high*".

In March 2010 it was announced that £400 million will be spent on a waste 'Steamer' ('Evaporator' D) which will only serve to make the waste more concentrated, and will do nothing to change the fact that the waste is liquid. This means that it will make no difference to the threat presented.

In April 2010, Barack Obama hosted an international conference in Washington to highlight the risks of Nuclear Terrorism.

Possibility of Hydrogen 'Explosion and Deflagration'

In 2007, British Nuclear Groups published a 'Technical Baseline Study' [44] that referred to the possibility of explosion and deflagration due to the hydrogen that had

[44] 'British Nuclear Group' (March 2007)

build up in the 'Magnox' [45] swarf silos at Sellafield; and in October 2009, the Whitehaven News [46] reported that the NII had stated that the risks at Sellafield are far too high.

The NII inspector Mark Foy was quoted as follows:

> "*We are concerned that the risk of a major event caused by further degradation of legacy plants, or increased time at risk due to deferrals, is far too high.*"

Similarly Andy Mayall, from the Environment Agency, was reported as stating that a visit to Sellafield's legacy ponds and silos in May 2009

> "*reinforced the serious nature of the hazards and that clean up and risk reduction remain absolute priorities.*"

Possible Consequences of an Accident / Attack at Sellafield

Summer 2001

> A report for the European Parliament concluded that an accident / attack at Sellafield could kill two million people. [47]

July 2004

> The Parliamentary Office of Science and Technology (POST) reported that an accident / attack at Sellafield could release a cloud of nuclear contamination whose fall-out could spread as far afield as Glasgow and Liverpool. [48]

Summer 2008

'*Technology Baseline and Underpinning Research and Development*' '*Sellafield 2007/08 Lifetime Plan*'
pp 77-78 and 223

[45] 'magnox' is a magnesium aluminium alloy

[46] Alan Irving - Whitehaven News - "Sellafield's risks are too high – NII"
Weds 7th Oct 2009
http://www.whitehaven-news.co.uk/news/sellafield_s_risks_are_too_high_nii_span_style_color_red_add_your_comments_span_1_620879?referrerPath=news

[47] See STOA Report ["STOA Study Project" on the "*Possible Toxic Effects from the Nuclear Reprocessing Plants at Sellafield (UK) and Cap de la Hague (France')*" (page 45)
Mycle Schneider et al
Commissioned by the European Parliament, Directory General for Research
Scientific and Technological Option Assessment (STOA) Programme
Contract No EP/IV/A/STOA/2000/17/0 - Final Report - August 2001]
http://www.nualaahern.com/publications/wysestoa.pdf
+ E-mail from Shelly Mobbs (Health Protection Agency) to Rachel Western - 26 Nov 2008 (Re: - Comversion form 'man-Sieverts' to number of fatalities.

[48] '*Assessing the risk of terrorist attacks on nuclear facilities*' Parliamentary Office of Science and Technology Report - Report 222, (July 2004) page 81

The Nuclear Installations Inspectorate (NII) reported that the High Level Waste facilities at Sellafield were in a chronic state of disrepair – and that replacement equipment was needed as a matter of "***utmost urgency***". [49]

Replacement Equipment was not installed

Contract Journal

Weds 10th June 2009

http://www.contractjournal.com/Articles/2009/06/01/68289/with-13bn-to-spend-per-annum-nuclear-decomissioning-work-has-a-long-half-life.html

Contractors warm up for £1.3bn Sellafield clean-up

Nuclear Management Partners has a brief to clean up Sellafield, the largest and most hazardous UK nuclear site. With £1.3bn to spend annually, the work available should have a long half life.

Late last year Amec, in consortium with Washington International Holdings and Areva, clinched a lucrative £22bn contract to oversee the decommissioning of Sellafield, the UK's biggest nuclear facility. The contract runs for an initial five years, with an option to renew for a total of 17 years.

With an annual spend of £1.3bn, the winning consortium, known as Nuclear Management Partners (NMP), has a brief to clean up what is the largest and most hazardous of the Nuclear Decommissioning Authority's (NDA) 20 nuclear sites. So large and urgent is the brief that Sellafield has cornered almost 70% of the NDA's decommissioning budget.
ADVERTISEMENT

Keith Case, Sellafield's commercial director, says Sellafield's decommissioning programme offers a "massive" opportunity for suppliers. "Of our £1.3bn annual budget, more than 60% is spent with suppliers. That's a spending of £700m this year alone. At a time when there is a downturn in many sectors, the nuclear market is a huge opportunity for suppliers."

Case was seconded onto Sellafield's board by NMP in October as its commercial and contract management executive director. Case is one of 10 seconded executive directors, tasked with overseeing the management and operation of the Sellafield sites.
Cultural change

[49] Nuclear Installations Inspectorate – July 2008 Newslettter – pp 15-17 (for quote see p16 top of right hand column)
http://www.hse.gov.uk/nuclear/nsn4308.pdf

Five months into NMP's contract, it is clear a cultural change is happening at Sellafield. NMP is like a new broom, sweeping away old and inefficient systems, and opening up Sellafield's doors to new ways of working.

The aim, says Case, is to develop more efficient, economic and innovative ways of delivering Sellafield's decommissioning programme. Suppliers are key to this process and Sellafield is keen to talk to as many suppliers and potential suppliers as it can, holding frequent supplier forums. Case explains: "We are trying to have open dialogue and transparency with suppliers, giving as much information as we can to them about what Sellafield needs from them in order to deliver good value to the NDA."

He is also keen to bring in new blood, encouraging newcomers to use the supplier database along with the supplier forums to break into the loop. And if that fails, Case says suppliers can contact Zoe Whittle, Sellafield's supply chain ombudsman, who is there to help new entrants to the market and act as a first point of contact for the supply chain.

So what does Sellafield need from its suppliers? Innovation is crucial, says Case. "Focus on bringing value, focus on bringing good ideas about how things can be improved here and focus on bringing innovation into the programme," he says.
Procurement processes

For its part, Sellafield is intent on improving its procurement processes, which contractors complain can be time consuming, costly and unreliable. Acknowledging these concerns, Case says: "There have been quite a lot of projects out in the market which funding has been pulled from or at least never been there," he explains. "So there has been an element of prequalification or even tendering of work that does not come to fruition."

In addition, the procurement plan "is far from being 100% accurate," says Case, explaining that this is largely because Sellafield's Life Time Plan, which the procurement plan is based on, is also inaccurate.

But change is on its way with plans for a new, accurate Life Time Plan by the end of this year, alongside a fully funded site execution plan, which will allow potential bidders to plan with more confidence.

Sellafield also wants to tackle costly tendering practices. Case cites frameworks as an example. "Despite the fact we have already competed the frameworks, we still ask the suppliers to compete with each other for chunks of work. I think the extent to which we do that is probably too great and we should reduce that and hopefully that will increase the volume of successful tenders and qualifications that suppliers put in."

Case says Sellafield will also "break the mould" by ending the unpopular yearly breaks on contracts which it currently exercises - another practice he sees as time consuming and wasteful. He estimates that more than 80% of Sellafield contracts will be affected by this change.

"We do agree budgets every year, but that is no reason to break all the contracts at each year-end," he says. "If funding does not materialize as we expect from year to year we can have a sensible discussion about it and modify the contracts."

New procurement methods are also on the cards. Sellafield managers have met with the BAA Terminal Five procurement team and Highways Agency officials to learn about how they procure their major contracts.

The Highways Agency's use of Early Contractor Involvement (ECI) design-and-build contracts is of particular interest and has prompted Sellafield to hold a number of workshops with its decommissioning and major projects contractors to discuss how the ECI model can be applied at Sellafield.

Case believes the ECI model could play an important part in procuring some of Sellafield's projects. He comments: "I can see at least two areas where ECI will pay big dividends. One is in formulating the options for major projects including innovative ideas from the supply chain before we put the project strategy to bed."

He adds: "The second area is in the commercial delivery strategy. How do we formulate that strategy? I would like to see more of an open discussion with suppliers and potential contractors to make sure we are tailoring it not just to the solution, but to the marketplace as well."

However, the nature of Sellafield's contracts may still pose a challenge, Case says. "It is easier in an environment with repeat business. Sellafield is an organization with a lot off one-off, really difficult and interesting projects, but the strategy and solutions need some innovative thinking."

Sellafield is also looking to engage with key members of the supply chain to develop more "fit for purpose" delivery mechanisms. Case points to one example, explaining: "We have recently worked on the Evaporator D project with lead contractor Costain to very good effect to deliver an integrated project team on a partnering basis where we have negotiated changes in the delivery fee model which gives more reward on successful outcomes."

But with a forecasted squeeze on public spending and the NDA under Treasury pressure to keep a tight lid on decommissioning costs (which have escalated from £61bn to £75bn over the past four years) can Sellafield guarantee a good flow of work in the future?

Case remains sanguine. He says: "Sellafield is not immune from the pressure that will undoubtedly be brought to bear on public sector finances in the next three or four years, but the work that needs to be addressed is of such a high hazard nature that the money will still need to be spent, even if Sellafield's budget comes under pressure."

With a decommissioning programme that appears recession proof, Sellafield makes an attractive option for contractors looking for a port in the economic storm.
Evaporator D Sellafield

The construction of Sellafield's fourth evaporator is an example of the sort of innovative solutions NMP is looking for from its contractors.

Costain is using off-site and modularized construction solutions, making significant cost savings.

The design of the Evaporator facility consists of 15 separate modules, the largest of which is 27m high. The modules are being manufactured off site or near site and then shipped in by sea and transported onto site across the River Ehen and the Barrow to Workington rail lines.

Key to the success of this approach is a detailed logistics programme, which marries in the delivery of the modules with Evaporator D's civil construction programme.

Using off-site construction and delivery by sea not only speeds up the construction programme, but also ensures better quality construction and a safer environment. Sea delivery also reduces the impact of such a major project on the local community. Costain believes this form of major project delivery could play a key role in the delivery of the UK's new build nuclear programme.

Evaporator D Fact File

* The housed building will consist of 15 in-cell modules, the largest of which will be 27m high.
* Over 21km of pipework, bound together by over 10,000 welds.
* 300t of specialist steel used to make the key highly active equipment.
- 396 major plant items.

Sellafield and Terrorism Threat

2000 – BNFL - Risk of Plane Crash – one in 100 million

British Nuclear Fuels (BNFL) – who then ran the Sellafield site - estimated that the likelihood of a plane crashing into the tanks of Liquid HLW [50] was one in 100 million per year.[51]

Because, the risk of a plane crash risk had been estimated to be so extraordinarily low, the HLW tanks were not designed to withstand aircraft impact. [52]

Sept 2001 – 9/11

The '9/11' tragedy took place – showing that BNFL's '*one in a million*' estimate of the risk of a Plane Crash was wildly inaccurate.

Jan 2002 – Sellafield – 'Weapon for an Enemy'

The American Security expert Gordon Thompson described Sellafield as:

'A *Weapon for an Enemy*' [53]

April 2010 – Washington Summit on Nuclear Terrorism

World leaders acknowledged for the first time the risk that lethal nuclear materials could trigger mass destruction if allowed to fall into terrorist hands.[54]

The terrorist threat presented by attack on *in situ* nuclear facilities – and in particular Sellafield – does not appear to have been addressed.

---

[50] HLW – 'high level waste'

[51] '*Assessing the risk of terrorist attacks on nuclear facilities*' Parliamentary Office of Science and Technology Report - Report 222, (July 2004) page 79 http://www.parliament.uk/documents/upload/POSTpr222.pdf

[52] '*Assessing the risk of terrorist attacks on nuclear facilities*' Parliamentary Office of Science and Technology Report - Report 222, (July 2004) page 79 http://www.parliament.uk/documents/upload/POSTpr222.pdf

[53] "Civilian Nuclear Facilities as Weapons for an Enemy" - A submission to the House of Commons Defence Committee by Gordon Thompson (3 January 2002) http://www.irss-usa.org/pages/documents/UKDefCttee01_02_000.pdf, p2

[54] Independent 14th Apr 2010 http://www.independent.co.uk/news/world/politics/the-nuclear-family-world-unites-against-terror-threat-1944050.html

Incidents – Sellafield's Recent Track Record

2009 – Sellafield - Serious Failures including two Emergencies

Serious Failures at Sellafield - including two Emergencies - are reported:

High Level Waste Failures – reported 2009

- Emergency due to Tank Cooling Failure [55, 56, 57]
- "Evaporator" – shut-down in an emergency [58]
- Serious Problem with "Vitrification" [59] Plant [60]

Jan (2010) – Sellafield Near Emergency

On 28th Jan it was reported that Sellafield had had to:

"act quickly to deal with a potential emergency" [61]

NMP – Refusal to Accept Insurance Liability for Sellafield (Nov 2008)

The fact that a very serious accident / attack at Sellafield is a realistic probability is illustrated by the fact that when the new management company NMP – 'Nuclear Managemement Partners' took over the running of the site in November 2008 – they point blank refused to take on the Insurance Liabilities.

NMP is a consortium made up of URS of the USA, Amec of the UK and France's Areva. From 24 November 2008, it took over the operational and decommissioning work at Sellafield, one of the largest nuclear sites in the world. The contract is worth

[55] "Cooling Water Supplies" - Note from Sellafield Press Office – 14th April 2009
[56] 'Sellafield News' Wednesday 8th April 2009 – Issue 1101 (page 2)
http://www.sellafieldsites.com/UserFiles/File/Sellafield%20News/Sellafield%20News%2008_4_09.pdf
[57] See also "*Nuclear Installations Inspectorate – March 2009 Newsletter*"page 15
http://www.hse.gov.uk/nuclear/nn45.pdf
[58] Whitehaven News - Weds 20th May 2009
http://www.whitehaven-news.co.uk/news/thorp_threats_1_557207?referrerPath=home
[59] 'Vitrification' is a technique designed to turn liquid wastes into a solid form – as a type of glass.
[60] "*Nuclear Installations Inspectorate – March 2009 Newsletter*"page 15
http://www.hse.gov.uk/nuclear/nn45.pdf
[61] Whitehaven News - Thurs 28th Jan 2010
http://www.whitehaven-news.co.uk/news/sellafield_water_worries_span_style_color_red_add_your_comments_span_1_665366?referrerPath=home

£1.3 billion ($2.3 billion) per year, with scope for a £50 million ($88 million) bonus for performance and efficiency. [62]

However, in order for the Consortium to agree to accept the Sellafield contract – NMP insisted that the Government gave an indemnity against future accidents. The previous Administration accepted this arrangement - an arrangement that could cost the taxpayers multi-billion pound amounts – and did so without allowing the House of Commons to debate whether such a decision was appropriate.

On the 5th October 2008 Paul Flynn MP [63] (Newport, West) (Lab) wrote to Ed Miliband (Secretary of State for Energy and Climate Change) as follows: [64]

> "*What is being proposed can only be seen as an open-ended commitment that the public purse will bail out the Sellafield operators should a major accident involving radioactive contamination, or a terrorist attack involving the theft of nuclear explosive material or nuclear material useable in a dirty bomb be perpetrated. The social, environmental and economic costs would be very large, and will, under the proposed arrangement, fall entirely with the taxpayer, which is a clear subsidy* "

and on the 22nd Oct 2008[65]

Paul Flynn spoke to the issue in the House of Commons. He stated:

> *"On a point of order, Mr. Speaker. May I raise a matter of the greatest importance affecting your role as the defender of the interests of Members of Parliament?* ***A decision has been taken and, sadly, Members have been denied an opportunity to comment on it.*** *It was a decision to give an indemnity to an American company against future accidents that could cost the taxpayers multi-billion pound amounts. Information was given only to the Chairs of two Select Committees, while the minute informing Members arrived at the House only last week, 75 days after the date that was laid down for us to comment on it.* ***That means there is no opportunity for us to comment on what appears to be a reversal of Government policy in subsidising the nuclear industry. It is a matter of great importance, which could lead in future to a very big bill for taxpayers.***"

---

[62] See World Nuclear News article

[63] Dr David Lowry of Nuclear Waste Advisory Associates (NWAA) was the Parliamentary Researcher who worked with Paul Flynn on this issue

[64] FAO Rt Hon Ed Miliband MP,
Secretary of State for Energy and Climate Change
From Paul Flynn MP
5th October 2008
Re: Ref.AU/92200
Insurance cover for Sellafield under the new private management contractor

[65] (1.17 pm) - Hansard - Column 318 - Point of Order

Funding Issues

Risks at Sellafield – cf - Available Funding (2009)

June '09

Keith Case, Sellafield's commercial director, says [66]

"the work that needs to be addressed is of such a high hazard nature that the money will still need to be spent, even if Sellafield's budget comes under pressure."

Oct '09

NII inspector Mark Foy warns [67] that the risks at Sellafield are:

"*far too high.*"

Nov '09

The Times report that the Government is drawing up plans for large spending cuts at Sellafield.. [68]

Extensive HLW Refurbishment Required

There are three main facets of the high level waste treatment on the Sellafield complex. Firstly the evaporators, then the storage tanks and finally the vitrification lines. The July 2008 edition of the Nuclear Installations Inspectorate Newsletter indicates that there are problems associated with each of these aspects of high level liquid waste storage treatment.

Evaporators:

Sellafield already has three evaporator (A,B and C). In addition to the planned Evaporator D

---

[66] 'Contractors warm up for £1.3bn Sellafield clean-up' Contract Journal, Weds 10th June 2009 http://www.contractjournal.com/Articles/2009/06/01/68289/with-13bn-to-spend-per-annum-nuclear-decomissioning-work-has-a-long-half-life.html

[67] '*Sellafield's risks are too high – NII*' Whitehaven News, Weds 7th Oct 2009 http://www.whitehaven-news.co.uk/news/sellafield_s_risks_are_too_high_nii_span_style_color_red_add_your_comments_span_1_620879?referrerPath=news

[68] 'Cuts loom over UK's nuclear clean-up budget' **The Times**, Nov 25th '09 http://business.timesonline.co.uk/tol/business/industry_sectors/natural_resources/article6930592.ece

"*Sellafield Limited is also considering the need for further evaporative capacity (Evaporator E)*" (page 17)

Storage Tanks

"*Recent HAST* [Highly Active Storage Tanks] *cooling coil failure rates and, specifically, the location of recent failed coils has led to uncertainties over the ability of the newer HASTs to continue to service the needs of the HAL stocks strategy.*

……

"***Replacement HASTs should be progressed with the utmost urgency.*** *We are currently awaiting the submission of Sellafield Limited's document on their strategy for the safe storage of HAL* .[High Active Liquor]" (Emphasis Added) (page 16)

Vitrification Lines

"*Currently (end of May 2008) all three vitrification lines are shut down. Line 1 suffered a plant malfunction in February 2008 which resulted in the need to undertake significant repair work: planned work will be undertaken coincidentally with the result that Line 1 is expected to return to HAL feed in late summer 2008. Lines 2 and 3 have operated fairly consistently in recent weeks though both are currently undergoing outages. WVP also suffered a shut down of operations caused by the loss of site steam supplies.*" (page 17)

Sellafield Funding Problems (Autumn 2008)

On the 8th October the Whitehaven News reported:

"Both the NII and the Environment Agency have expressed concern that "funding shortfalls" for the operation of Sellafield could undermine regulatory standards.

Evaporator D has been described as "politically sensitive" at a time of escalating costs."[69]

This funding issue was referred to extensively in the July 2008 issue of the Nuclear Installations Inspectorate Newsletter. For example:

"*Funding constraints are restricting the licensee's ability to deliver major projects and safety improvements on the site"* (page 11)

69 Multi-million pound bill for Sellafield by Alan Irving, Whitehaven News, Wednesday, 08 October 2008
http://www.whitehaven-news.co.uk/news/1.251885

"*Sellafield Limited has now shared the content of Lifetime Plan 2008 (LTP08) with us and it does indicate a significant shortfall in funding between the costs of the in-year programme of work identified by the licensee for the Sellafield site and the level of funding available from NDA.*". (page 12)

Estimated Cost of Required Work on HLW Facilities

From the information above it is possible to estimate that approximately **five** new 'HLW treatment units' are required . (Evaporator D + E, Tanks (plural), plus the need for additional vitrification facilities – given the technical problems with the current facilities.)

The December 2008 NDA Board Meeting set out an indicative total project cost for the Steamer '*Evaporator D*' in the range £360 million - £380 million.

(360 + 380) / 2 = 370

this indicates an average cost of £370 for the HLW projects
(assuming that 'Evap D' is representative)

5 x £370 = £1,850

= **£2 Billion**

Estimated cost of Required HLW work (approx)

NDA (March 2010) Business Plan - Sellafield Funding not agreed

On the 31st March 2010 the NDA published it's 2010 / 2013 Business Plan [70]

In this 43 page document, it is not reported until page 39, and then in the fifth footnote at the bottom of the page [71] that:

"***Sellafield funding is currently being reviewed*** *in line with revised LTP10 Build.*"

NDA & Sellafield - Job Cuts Announced (June 2010)

This week (the week of Mon 21st June 2010) the NDA began a month long consultation with its staff over a proposed reduction of 30% in its current staffing of

[70] NDA – "NDA confirms £2.8 Billion Plan for 2010" – 31st March 2010
http://www.nda.gov.uk/news/business-plan-2010-2013.cfm
[71] "*NDA Business Plan - 2010–2013*" (March 2010)
www.nda.gov.uk/loader.cfm?csModule=security/getfile&pageid=38406
Appendix 5 – "*2010/2011 Planned Income and Expenditure Summary*"
page 39 - Footnote 5

just under 300 [72] and today (Thurs 24th June) it was reported that Unions at Sellafield have warned that 1,200 jobs are at risk. [73]

Thus, despite the (June 2009) Contract Journal article [74]

"*Contractors warm up for £1.3bn Sellafield clean-up*"

which stated that

> "***with a forecasted squeeze on public spending*** *and the NDA under Treasury pressure to keep a tight lid on decommissioning costs (which have escalated from £61bn to £75bn over the past four years) can Sellafield guarantee a good flow of work in the future?*
>
> *Case* [Keith Case, Sellafield's commercial director] *remains sanguine. He says: "Sellafield is not immune from the pressure that will undoubtedly be brought to bear on public sector finances in the next three or four years, but* ***the work that needs to be addressed is of such a high hazard nature that the money will still need to be spent, even if Sellafield's budget comes under pressure.***"

[72] "*NDA begins consultation on new organisational structure*"
22nd June 2010
http://www.nda.gov.uk/news/consultation-structure.cfm?renderforprint=1&
[73] The Guardian – Thurs 24th June 2010
http://www.guardian.co.uk/environment/2010/jun/24/huhne-renewable-energy-security/print
See also Telegraph - 21st Apr 2010
http://www.telegraph.co.uk/finance/newsbysector/energy/7612427/Jobs-risk-to-Sellafield-and-Lindsey-refinery.html
[74] Weds 10th June 2009
http://www.contractjournal.com/Articles/2009/06/01/68289/with-13bn-to-spend-per-annum-nuclear-decomissioning-work-has-a-long-half-life.html

SECTION THREE

Plutonium

WW II – The Creation of Plutonium

Plutonium is a synthetic chemical element. It is synthesised in nuclear reactors when uranium is bombarded by small particles known as 'neutrons'.

The process of synthesising plutonium was begun in the midst of the Second World War due to the fact that plutonium can be used to make nuclear weapons.

On 20th August 1942, Glenn Seaborg, the American War chemist, wrote in his diary:

> *"Perhaps today was the most exciting and thrilling day I have experienced since coming to the Met Lab. Our microchemists isolated element 94* [plutonium] *for the first time!*
>
> *It is the first time element 94 (or any synthetic element, for that matter) has been beheld by the eye of man.*"

Flowers Report (1976)

In 1976, the Royal Commission on Environmental Pollution [75] wrote – in the so-called '*Flowers Report*'

> "*Plutonium appears to offer unique potential for threat and blackmail against society because of its great radiotoxicity and its fissile properties*" (page 202 - para 22.)
>
> "*The construction of a crude nuclear weapon by an illicit group is credible. We are not convinced that the Government has fullv appreciated the implications of this possibility*" (page 202 - para 23)

Management of Current Plutonium Stocks

[75] Royal Commission on Environmental Pollution – Sixth Report
"Nuclear Power and the Environment" (1976)
Chairman – Sir Brian Flowers
Presented to Parliament by Command of Her Majesty - September 1976 [Cmnd.6618]
HMSO (London)
http://www.rcep.org.uk/reports/06-nuclear/1976-06nuclear.pdf

The cheaper option for plutonium management is storage – it is also the option that presents the least risk of diversion of the plutonium to weapons use.

However, in the longer term (beyond fifty years) no plausible approach for plutonium management has been put forward.

Under the previous Administration DECC Consulted [76] on the Optimal Management of the Plutonium stocks that have accumulated over the last sixty years – plutonium that has built up due to the UK practice of applying a **Military** technique to RadWaste management. In this Consultation DECC made numerous references to the NDA 'Credible Options' document (Jan '09). However, although this document is entitled the '*Credible*'options paper – it does not in fact refer to options that are Credible. This is discussed below.

Given that the risks at Sellafield are so high – and that the impact of an accident / incident at Sellafield would be so devastating; it is imperative that DECC ensures that its work is prioritised to ensure the protection of public safety.

This requires:

iii) the cessation of further plutonium separation; and

iv) focussing work on hazard reduction at Sellafield

Wasting time on the option of using plutonium of as a fuel – which is:

- both more expensive, and
- also more of a threat wrt diversion risks;

would be seriously negligent

NDA – Pu Storage Options - Cheaper + 'No Regrets'

Appendix 'B' [77] of the NDA's (Jan 2009 Options Doc) which is an 'Economic External Review ' - carried out by John Brook, who had previously carried out work for the NDA on the Sellafield MOX Plant. [78] - concludes that storage is the cheaper option and probably the '*no regrets option*' (page 139)

---

[76] See for example:
DECC (Department of Energy and Climate Change)
"Long term Plutonium management: Pre-consultation discussion paper covering decision methodology and timetable for decision making " October 2009
URN 09D/735
http://decc.gov.uk/media/viewfile.ashx?filepath=what%20we%20do/uk%20energy%20supply/energy%20mix/nuclear/plutoniummanagement/1_20091007112758_e_@@_preconsultationdiscussionpaperdecisionmethodology.pdf&filetype=4

[77] Appendix B: Economic External Review - Assurance of the Plutonium Disposition Cost Modelling - Report to the Nuclear Decommissioning Authority Reference : NDA / Pu-Disp - 1 / JB December 2008 - (Appendix B – pp 135 – 139)
[78] page 136

The word 'Credible' + its Role in Decision Making

The word '*credible*' is used sixteen [79] times in the (Oct '09) DECC Pre-Consultation document carried out under the previous Adminstration. However, the text contains no rebuttal of the arguments that I put forward in my (Oct '09) '*Comparison Factors*' response – which indicated that the proposals put forward by the NDA in their (Jan '09) '*Credible Options*' document – were not in fact '*credible*'.

The ( )ct '09) Consultation is meant to be concerned with the principles of good decision-making. - one very basic principle of good decision-making is that the repetition of a mantra does not itself create truth.

Requirements for Good Decision Making

A procedure to ensure adequate rigour and scrutiny is essential to good decision-making. There must also be independent input.

Plutonium as Fuel

Fast Reactors – After 60 Years – no Commercial Model Found

In 1950, Sir John Cockcroft – Director of the Harwell Nuclear Research Establishment – wrote in 'Science News' [80] that the 'first' type of nuclear was the plutonium based 'fast breeder reactor'. [81]

However – as it has turned out – after sixty years and the expenditure of tens of billions of dollars, the promise of 'breeder' reactors remains largely unfulfilled. [82]

Failure of the Sellafield Plutonium Fuel (MOX) Plant

In April 1994 the construction of the 'Sellafield MOX Plant' was started. [83] 'MOX' is 'mixed-oxide' fuel that is meant to be used in ordinary reactors, rather than 'fast reactors'.

---

[79] - (including in the links)

[80] Chapter Four – Sir John Cockcroft, (CBE, FRS)
'Nuclear Reactors' (pp 71 95)
"*Atomic Energy*"
'Science News' 2 – Completely revised and enlarged
Edited by J L Crammer and R E Peirls (FRS)
Penquin Books (May 1950)

[81] page 74

[82] Greenpeace Nuclear Reaction 19th Feb 2010
http://weblog.greenpeace.org/nuclear-reaction/2010/02/fast_breeder_reactors_60_years.html?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+nuclearreaction-greenpeace+%28Nuclear+Reaction+-+a+Greenpeace+blog%29
FT 18th Feb 2010
http://blogs.ft.com/energy-source/2010/02/18/fourth-generation-nuclear-power-may-not-be-the-clean-energy-silver-bullet/

However, in February 2008, Energy Minister Malcolm Wicks admitted that the plant had only managed 2.6 tonnes of production in 2007 – and a total of only 5.2 tonnes since opening in 2001. This can be compared to a design capacity of 120 tonnes of MOX fuel a year. [84]

Although it was announced in May 2010 [85] that the NDA had secured agreement from Japanese Utilties to support significant engineering changes to the 'MOX' facility at Sellafield – the NDA themselves expressed some doubt that this work would deliver the increase in out-put sought.

Thus, the NDA Press Release states

> "*We will progressively establish if the changes made have resulted in improved performance*"

The Fuel Option [86] Presents a Greater Risk of Diversion

The Nuclear Control Institute have stated that:

> *"The MOX option presents a greater risk of diversion primarily because of the fuel-fabrication stage, a process that is difficult to safeguard effectively. Such uncertain verification could severely limit the trust nations place in an international nuclear arms-reductions and non-proliferation regime predicated upon recycling warhead plutonium as fuel for reactors. "* [87]

DECC Proposal to Ship Plutonium – cf - UN Security Council (Sept 2009)

One option put forward by DECC [88] was:

---

[83] "*MOX Case Between Ireland and the UK*" (2003) http://www.pca-cpa.org/upload/files/MOX-Day%20One.pdf (page 42, line 13)

[84] Paul Brown "Voodoo Economics" (Published by Friends of the Earth) May 2008, http://www.foe.co.uk/resource/reports/voodoo_economics.pdf

[85] NDA – "*The Future of the Sellafield MOX Plant (SMP*")
12th May 2010
http://www.nda.gov.uk/news/sellafield-mox-plant-future-2010.cfm?renderforprint=1&

[86] ie 'MOX' – 'mixed oxide' – Plutonium / Uranium Oxide fuel

[87] Nuclear Control Institute - "*Comments on the [US] Department of Energy's Storage and Disposition of Weapons-Useable Fissile Materials Draft Programme Environmental Impact Statement* " – Executive Summary - June 7, 1996***Non-****Proliferation Issues – Fifth Bullet Point*
http://www.nci.org/i/ib6796a.htm

[88] UK Department of Energy and Climate Change (DECC)

"*Pre-consultation discussion paper on the key factors that could be used to compare one option for long term plutonium management with another.*"
(July 2009)
URN 09D/697

"*to sell MOX* [89] *fuel to overseas utilities*." (para 2.3 - page 5)

This may be compared to the unanimous agreement of the UN Security Council (24th September) [90] to a Resolution [91] expressing grave concern over the risk of nuclear terrorism. (See Box)

Text From UN Resolution
(Thursday 24th September 2009)

The Security Council ,

"*Resolving to seek a safer world for all and to create the conditions for a world without nuclear weapons*"

.....

"*Gravely concerned about the threat of nuclear terrorism, and recognizing the need for all States to take effective measures to prevent* ***nuclear material*** *or technical assistance becoming available to terrorists,*" (Emphasis added)

Clause 13.

"*Calls upon States to adopt stricter national controls for the* ***export of sensitive goods*** *and technologies of the nuclear fuel cycle;* " (Emphasis added)

Plutonium Storage + Disposal Options – also not 'Credible' NDA (Jan '09)

It will be shown below that although storage represents the optimal approach for plutonium management in the interim; the Nuclear Decommissioning Authority (NDA) have not been able to put forward any robust and plausible long term strategy for plutonium management.

Thus, despite the title of the NDA (Jan 2009) document:

"*NDA Plutonium Topic Strategy - Credible Options Technical Analysis*" [92]

---

http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/issues/plutonium/plutonium.aspx
[89] MOX' (mixed oxide nuclear fuel) is plutonium based.)
[90] 24th September 2009
[91] BBC - Thurs 24th Sept 2009 - http://news.bbc.co.uk/1/hi/8272396.stm
UN Resolution - http://news.bbc.co.uk/nol/shared/bsp/hi/pdfs/24_09_09draftresolution.pdf

the report does not in fact outline '*Credible*' options.

The problems with the fuel option ('MOX' or mixed plutonium / uranium oxide fuel) were set out above. Below the problems with storage and disposal are outlined.

Lack of Work on Storage Beyond 50 Years

The NDA (Jan '09 Options Doc) notes that:

> "*little work has been done to support storage in the very long term, in the region of 50 years plus into the future*." (page 51)

In comparison Plutonium–239 has a 'half-life' of the order of 20 000 years.

Pu Disposal not Proven

Although the end-point for each of the various plutonium proposals put forward in the NDA options document is '*disposal*' [93] – the main report states that:

> "*A better understanding needs to be established of the safety case criteria for the disposal concept, this is key to establishing whether the durability of the waste forms proposed is acceptable and in establishing the optimum incorporation rates of plutonium within the waste form. This work must include a consideration of the criticality safety aspects from the fissile materials.*" (page 43)

Plutonium Management and Financial Considerations

Author of NDA (Jan 2009) Cost 'Assurance' Doc – does not accept Liability for his own Work

Appendix 'B' [94] of the NDA's (Jan 2009 Options Doc) is an '*Economic External Review* '. The author of this document (John Brook) goes to great lengths to wash his hands of any responsibility for decisions taken as a result of his analysis.

Thus, on the first page of the '*Assurance of the Plutonium Disposition Cost Modelling*' (ie Appendix B of the NDA Options Doc [p 135]) John Brooks set out a notice as follows:

Notice

---

[92] http://www.nda.gov.uk/documents/upload/NDA-Plutonium-Topic-Strategy-Credible-Options-Technical-Analysis-January-2009.pdf

[93] See for example page 26 – para 5.4.2

[94] Appendix B: Economic External Review - Assurance of the Plutonium Disposition Cost Modelling - Report to the Nuclear Decommissioning Authority Reference : NDA / Pu-Disp - 1 / JB December 2008 - (Appendix B – pp 135 – 139)

"*This report was commissioned by the Nuclear Decommissioning Authority on terms* ***specifically limiting the liability of John Brook Enterprises Ltd.*** *The conclusions are the results of the exercise of our best professional judgement, based in part upon materials and information provided to us by the Nuclear Decommissioning Authority.* ***Use of this report by any third party for whatever purpose should not, and does not, absolve such third party from using due diligence in verifying the report's contents.*** "

"***Any use which a third party makes of this document, or any reliance on it, or decisions to be made based on it, are the responsibility of such third party. John Brook Enterprises Ltd accepts no duty of care or liability of any kind*** *whatsoever to any such third party, and no responsibility for damages, if any, suffered by any third party as a result of decisions made, or not made, or actions taken, or not taken, based on this document.*" (page 135)

[Emphasis added]

NDA (2007) – 'Macro-Economics' Report

In June 2007 the NDA published the "*Uranium and Plutonium – Macro-economic Study*". Primary authors of this document included Gregg Butler and Grace McGlynn – both previous employees of British Nuclear Fuels.

Given their experience within the nuclear industry – perhaps one would have been led to assume that the documentation that they produced would be well informed. However – a cursory analysis of the June 2007 document indicates that that was far from being the case.

The June 2007 '*Macro-economics*' document is seriously flawed in two major respects:

(i) it is concerned with 'tonnages' of plutonium – and does not take into consideration that only certain isotopes are fissile (and therefore capable of being used to release energy).

(ii) it does not mention the extraordinary problems that have been experienced with the industrial aspects of the release of energy from plutonium. For example use of fast breeder technology has long been abandoned in this country (largely due to the reactivity of the coolant used [liquid sodium]). Furthermore the facility built at Sellafield to manufacture mixed plutonium/uranium (MOX) fuel [the Sellafield MOX Plant – SMP] essentially 'doesn't work'.[95]

NDA Misplace '*Macro-Economics*' Report

Para 4.5 (page 19) of the (Jan 2009)

[95] Though this issue is addressed in the Aug 2008 NDA Plutonium Consultation Document (eg see page 14)

"*NDA Plutonium Topic Strategy - Credible Options Technical Analysis*" [96]

refers to the '*Macroeconomic*' study (as Ref 7). However - on page 16 (of the Jan '09 Options Doc) - which holds reference (7), the text states:

> "*The authors have been unable to find a reference to this report although it is frequently cited in the PuWG* [97] *report*"

The New Plutonium Store (May 2010)

In May 2010 Sellafield opened a new store for plutonium. [98] Somewhat unhelpfully, the store has been named the '*Sellafield Product and Residues Store*' (SPRS). One of the key purposes of the store is to store plutonium already at Sellafield which needs to be retrieved from older facilities, repackaged and placed in a modern facility. [99]

It is the first major project to be completed by Sellafield Ltd, under the ownership of Nuclear Management Partners (NMP)

NMP is a consortium made up of URS of the USA, Amec of the UK and France's Areva. From 24 November 2008, it took over the operational and decommissioning work at Sellafield, one of the largest nuclear sites in the world. The contract is worth £1.3 billion ($2.3 billion) per year, with scope for a £50 million ($88 million) bonus for performance and efficiency. [100]

The NDA Press Release indicates that the store comprises:

> "*over 36,000 cubic metres of concrete, the same amount of steel as the Eiffel Tower*"

and took nearly 2 million man hours to build.

Work began on the project in September 2005 and employed over 450 construction workers. [101]

The 'World Nuclear News' article on the plutonium store states that:

> "*The facility is a heavily reinforced concrete nuclear storage facility forming part of the nuclear decommissioning strategy for Sellafield. The SPRS*

---

[96] http://www.nda.gov.uk/documents/upload/NDA-Plutonium-Topic-Strategy-Credible-Options-Technical-Analysis-January-2009.pdf
[97] ?? – Plutonium Working Group ??
[98] NDA – '*New Storage Facility opens at Sellafield*'
21st May 2010
http://www.nda.gov.uk/news/sprs-project.cfm
See also – '*New storage facility at Sellafield*'
(World Nuclear News)
24th May 2010
http://www.world-nuclear-news.org/WR-New_storage_facility_at_Sellafield-2405105.html
[99] See World nuclear News article
[100] See World Nuclear News article
[101] See NDA Press Release

> [Sellafield Product and Residues Store] *structure is approximately 90 metres long, 50m wide by 20m high, split internally into four defined areas each of which has various intermediate floor levels. Construction of the passively-cooled facility began in September 2005. In total, it includes some 36,000 cubic metres of concrete, 9500 tonnes of reinforcing steel and about 300 kilometres of cables.*"

Rebecca Weston, Head of Operating Unit, Plutonium Operations said:

> "*SPRS is a crucial element in the Sellafield site plutonium management strategy. As such, the SPRS operations team, within the newly formed plutonium operating unit, are excited about taking charge of this new facility and working towards safe active operations, which will enable continued safe and secure storage of plutonium materials on the Sellafield site*".[102]

New Plutonium Store – Inadequate Capacity

However, the new store does not have sufficient capacity to meet the requisite plutonium storage requirements.

For example in November 2009 Christopher Watson of 'Pugwash' [103] reported that [104]:

> "*A new store - the Sellafield Product and Residue Store (SPRS) – is nearing completion*
> *– Plutonium from the older stores will be transferred here in phases.*
> *– **It is not large enough (reported capacity 9600 cans) to hold the entire plutonium inventory (~17,000 cans)***" (slide 14)
>
> 9,600 / 17,000 = 0.56

On these figures an additional capacity of approximately 40% is required.

---

[102] NDA Press Release

[103] Pugwash - http://www.pugwash.org/uk/

"***What is Pugwash?*** *- An international movement of scientists and others with a professional concern about the social impact of science and seeking ways to prevent its misuse. Particular attention is given to banning weapons of mass destruction (nuclear, chemical, biological); to the solution of conflict without resort to force; to the creation of a sustainable environment; and to bettering the conditions of life of all people. The movement has its origin in the Russell-Einstein Manifesto of 1955, which called on scientists to meet to find ways to avert the threat to civilization created by the advent of thermonuclear weapons. It took its name from the venue of the first meeting in 1957 – the Canadian village of Pugwash. In 1995 it was awarded the Nobel Peace Prize, jointly with its then President, Joseph Rotblat.*"

[104] Christopher Watson – "*The Management of Separated Plutonium in the UK*"
Report of a Working Group of the British Pugwash Group
Meeting on Securing Fissile Materials: National and International Aspects
26 November 2009
http://www.pugwash.org/uk/documents/Pu_management_Presentation_Final_26-11-09.pdf

Sellafield Ltd reported in May 2010 that extensions to the new plutonium store were planned. [105] Similarly the (January 2009) NDA Plutonium Topic Strategy [106] document states that:

> "*Material* [ie plutonium] *is currently held in a number of stores on the Dounreay and Sellafield sites. To ensure that it remains in a safe and secure condition* ***the current plan is for a phased programme of store building, to replace the older stores in a timely manner.***" (page 4)

Plans and Funding for Plutonium Limited to 100 Years

In January 2009, the NDA wrote [107]

> "*The plutonium is currently treated as a zero value asset and as such* ***there are no plans in place for its ultimate recycling or disposal****. The current plan is to* ***store the material*** *until 2070 at Dounreay and* ***until 2120 at Sellafield, but limited provision, in lifetime plans, has currently been made for the long term infrastructure required to enable this to happen. The current default plans are not regarded as complete by NDA as there is no formal end state for the material. There are no costs in the lifetime plans associated with the immobilisation of plutonium, disposal or continued storage beyond the declared dates.*** *The inclusion of this scope is necessary for NDA to meet it's obligations under the Energy Act"*

Plutonium and Indefinite Storage at Sellafield

The NDA / British Nuclear Group 2006 / 07 Lifetime Plan for the Sellafield site [108] states that the overall programme for Sellafield extends until the year 2120. [109]

However, the document also states that:

> "*UK owned* ***plutonium*** *and uranium is assumed to remain in* ***indefinite storage at Sellafield***" (page 5); and
>
> "*Providing safe and secure custodianship*"

---

[105] See World Nuclear News article

[106] NDA – "*Plutonium Topic Strategy*" - Current Position
30th January 2009
EDRMS No. FPv1/ Doc No: SAF/171108/001
http://www.nda.gov.uk/documents/loader.cfm?url=/commonspot/security/getfile.cfm&pageid=27424

[107] NDA – "*Plutonium Topic Strategy*" - Current Position
30th January 2009
EDRMS No. FPv1/ Doc No: SAF/171108/001
http://www.nda.gov.uk/documents/loader.cfm?url=/commonspot/security/getfile.cfm&pageid=27424

[108] PSWBS Site Ref: 35
http://www.nda.gov.uk/documents/upload/Sellafield_Site_Summary_2006_07_Life_Time_Plan.pdf

[109] page 4 - see also pp 25 and 27

"*Our ongoing management activities will continue and expand to ensure the* ***safe and secure storage of Sellafield inventory for as long as is necessary***" (page 31)

"*Site end point*"
"*The successful delivery of this baseline will result in the site which will be subject to* ***indefinite institutional control***" (page 31)

APPENDIX

Technical Issues associated with Disposal

What is Nuclear Waste - Nuclear Reactors and the Creation of Radionuclides

In a nuclear reactor uranium is pounded by small particles called '*neutrons*' and as a result a vast number of '*radionuclides*' are formed.

When uranium (chemical element '92') is exposed to neutrons in a reactor there are three different processes that result in the creation of radionuclides.

These are:

the uranium [110, 111] may:

absorb a neutron and turn into a heavier element such as neptunium (element '93') or plutonium (element '94'). These very heavy elements are known as '*actinides*'.

split into two separate atoms. The products of this split form two smaller atoms from the larger uranium. These smaller atoms are known as '*fission products*'.[112] They are particularly radioactive.

In addition, the **reactor materials** themselves

may take up neutrons. The radionuclides formed by this process are known as '*activation products*'. [113]

It may therefore be seen that nuclear waste production is an intrinsic part of the usage of nuclear fuel to produce electricity.

'Lethality' of Waste Nuclear Fuel

[110] See for example "*Radionuclide content for a range of irradiated fuels*" - Contractors Report to Nirex
Contractor: EEUK, Contract Number: TE2769/74 Doc No: Pcdocs395337v5 Reference Number: 17503/74/1 Rev. 2
3rd Sept 2002
Section 5.5 PWR, high burnup U fuel (pp 89 – 100)

[111] The plutonium – once created in the reactor – may also absorb neutron (s).or break up into two other atoms

[112] The initial fission products comprise the chemical elements zinc (element number 30) to dysprosium (element 66)

[113] Two particular activation products of concern are 'carbon-14' and tritium (a radioactive form of hydrogen.)

In a nuclear reactor huge quantities of radioactive atoms are created – to the extent that the waste fuel rod that is taken out of the reactor is so lethal that it would almost immediately kill someone if they were to be anywhere near it. [114]

The nuclear industry rely on 'shielding' in order to stop the wastes killing people in such a direct way. However some of the wastes will still exist one million years into the future and even though the wastes would be much less intensely radioactive after that time, people would still need to be protected from it.

RadWaste Burial and Resultant Harm

The Government propose that a future programme of RadWaste Burial would serve to keep the syntheised radionuclides from nuclear power out of harms way for timescales far into the future.

Such an approach has been advocated by the nuclear industry for many years. For example in November 1978 (just over thirty years ago) Dr L E J Roberts, Director of the Atomic Energy Research Establishment at Harwell in Oxfordshire gave a lecture to the British Nuclear Energy Society (BNES) on the issue of long term management of the most intensely radioactive wastes 'high level wastes' – (or 'HLW').

In April 1979 this talk was made available as a brochure. [115] On page 19 (Fig 4) a cutaway drawing of the 'conceptual' design of an underground RadWaste burial facility is shown.

The present-day idea for RadWaste Burial is more or less the same now as it was in the Seventies.

RadWaste, DNA and Cancer

In a nuclear reactor neutrons pound atoms and as a result radioactive atoms are formed. These are unstable and naturally transform in order to become stable. In the process they release particles and energy. Critically the particles and energy released are able to damage DNA

DNA [116] is the 'blue-print' for life and once DNA becomes damaged it can cause cancer or birth defects.

Damage to DNA caused by just **<u>one</u>** radioactive atom would be sufficient to cause cancer. Thus, the Health Protection Agency (HPA) state:

---

[114] See: Allan Hedin "*Spent nuclear fuel – how dangerous is it? A report from the project "Description of risk' "* SKB Report - Technical Report TR-97-13 (March 1997)
See Figures 3-8a and b (See pp 22- 23) and para 3.5.2 - (page 21)
[115] "*Radioactive Waste- policy and perspectives*" L E J Roberts,
Published by the United Kingdom Atomic Energy Authority (UKAEA) April 1979
[116] deoxyribonucleic acid

"*a single radiation track … has a finite probability, albeit very low, of generating the specific damage to DNA that results in a tumour initiating mutation.*" [117]

This statement does not mean that every individual radioactive atom that hits the body will cause cancer. It is saying that there is the potential.

Prediction of Degree of Harm

The February 2009 Environment Agency (EA) 'Criteria for RadWaste Disposal' document [118] sets out [119] the Environment Agency's view – in quantitative terms – of the risks associated with radionuclide exposure.

The Environment Agency start from a baseline [120] of a:

'*one in a million*' risk
(per year – to the person at greatest risk)

of developing either [121]:

- non-fatal cancer,
- fatal cancer, or
- inherited defect

and state that this level of risk would arise from an exposure of:

20 micro Sieverts per year [122 , 123]

(micro = one millionth)

Risk levels depend on the **chance** of something happening.

If the chance of being exposed to the radionuclides was less than one, then

the 'one in a million' baseline would be matched with

---

[117] "*Risk of Radiation-Induced Cancer at Low Doses and Low Dose Rates for Radiation Protection Purposes*"
NRPB (1995) (National Radiological Protection Board) – part of the Health Protection Agency (HPA)
Added/updated: 29 August 2008
Volume 6 , No. 1
ISBN 0-85951-386-6
http://www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb_C/1195733754925?p=1219908766891

[118] "*Geological Disposal Facilities on Land for Solid Radioactive Wastes. Guidance on Requirements for Authorisation"* (Feb '09)
http://publications.environment-agency.gov.uk/pdf/GEHO0209BPJM-e-e.pdf [Ref 111 in DECC doc]

[119] page 46 (para 6.3.10)

[120] page 47 (paragraph 6.3.1)

[121] page 47 (para 6.3.15)

[122] Environment Agency Disposal Guidance (Feb '09) page 47 – para 6.3.17

[123] (NB – 'micro' – means one millionth)

an exposure level that was higher than 20 micro Sieverts. [124]

Technical Terms

There are about ninety different chemical elements (for example Hydrogen element 'No 1' to Uranium element 'No 92')

Lumps of these elements may be broken down and broken down and broken down until an object about 10^{-8} centimetres big is reached that cannot be broken down any further in the same way. Breaking this object down any more would produce fragments that no longer shared the properties of the element.

The name for the smallest object that still retains the properties of the chemical element is an '**atom'**.

The number of the chemical element (see above) refers to the number of positive lumps (or 'protons') at the centre (or 'nucleus') of the atom.

The centre of the atom also contains neutral particles (or 'neutrons').

The centre ('nucleus') of an atom may be unstable – due to the 'wrong' balance of positive and neutral particles.

Such unstable centres (or 'nuclei') are known as

'Radionuclides'

In the process of becoming stable radionuclides release particles and / or energy. The particles and energy released are able to damage DNA (deoxyribonucleic acid.)

DNA is the 'blue-print' for life. If it is damaged, cancer (either fatal or non-fatal); or alternatively birth defects may result

The process of becoming stable through the release of particles and energy is known as 'decay'.

The term '*half-life*' refers to the time that it takes for 50% of the original quantity of a given radionuclide to break down

What is a "Sievert" ?

The harm caused by exposure to radionuclides is described in terms of:

the energy (per unit weight) of the exposure

[124] also para 6.3.17 – page 47

It can be thought of in terms of the overall '*punch*' associated with the radionuclide bombardment.

one joule [125] of 'harm' to one kilogram is called one **'Sievert'**

Problematic Nature of Harm Prediction

There are a number of reasons why the prediction of harm due to radionuclides is problematic/ For example:

Timescale

An obvious reason why it is difficult to calculate the levels of harm that would arise due to the synthesis of radionuclides in the proposed reactors is that many of the radionuclides will be dangerous for hundreds of thousands of years into the future. Clearly making predictions over this timescales would be extremely problematic.

Chemical Effects

It is the radionuclide that causes the harm. However, generally speaking [126] radionuclides do not 'travel solo' but exist in combination with other chemical elements to form chemical compounds.

The behaviour of these chemical compounds depends on:

- the chemical elements included
- how they are joined together
- the temperature
- the amount of electrically charged ('ionic') particles near-by
- whether the surroundings are watery or oily – or solid or gas
- whether the surroundings are simple or complicated
  (ie. is the compound just one amongst a 'smorgasbord' of others – or is the chemical system quite simple)
- the surrounding pressure

These chemical effects can result in extraordinary degrees of variation in predicted radionuclide behaviour.

(This phenomenon is discussed further below.)

Radionuclides Inside the Body

The '*Committee Examining Radiation Risks of Internal Emitters*' (CERRIE) was an independent Committee established by the Government in 2001, following concerns

[125] A joule is a unit of energy

[126] The exception would be radio nuclides that are part of the inert (or 'noble') gas series. One such example is 'radon'.

about the dangers to health associated with radionuclides once they were inside the body.

In October 2004, the Committee produced a final report and a Press Release. [127]

In the Press Release[128], the Chairman of the Committee, Professor Dudley Goodhead (OBE) [129] said:

> *"The main finding of the Committee's Report is that we have to be particularly careful in judging the risks of radioactive sources inside the body. The uncertainties in these internal radiation risks can be large"*

Radionuclides may be More Dangerous than Currently Assumed

The article

> "*A Brief History of Radiation Protection Standards*"
>
> William C. Inkret, Charles B. Meinhold, and John C. Taschner
> Los Alamos Science (1995) - No. 23 (pp 116 - 123)
>
> http://library.lanl.gov/cgi-bin/getfile?00326631.pdf

sets out how estimates of the risk levels associated with radionuclides changed over the 100 years from 1890 to the year 2000.

Fig 1 (page 121) in particular is a graph of what was thought to be **the limit** to the amount of radionuclide exposure that people should come across.

It can be seen that the range in the figures is over ten thousand, and that each time the levels changed - it is because radionuclides were realised to be more dangerous.

1990s Scrutiny of the Putative Disposal 'Evidence Base'

In the 1990s the predecessor to the Environment Agency, the 'HMIP' [130] had undertaken a considerable body of work [131] wrt the proposal of the then RadWaste

---

[127] See http://www.cerrie.org
[128] Press Release, 20th Oct 2004
http://www.cerrie.org/pdfs/cerrie_press_release_final.doc
[129] Professor Dudley Goodhead OBE
Director, Medical Research Council Radiation and Genome Stability Unit
(** Professor Goodhead served as Director of the MRC Unit until his retirement on 30 September 2003. **)
[130] 'HMIP' – 'Her Majesties Inspectorate of Pollution'
[131] This research has been written up and is available on disc from the Environment Agency (roger.yearsley@environment-agency.gov.uk).

body 'Nirex'. [132] Nirex planned to undertake excavation work near the Sellafield site in Cumbria, in preparation for the Burial of radioactive waste.

A Planning Inquiry [133] was held into the proposal in which the generic scientific arguments against the project were examined at some length. For technical reasons, HMIP were only able to participate in the Inquiry in a very limited manner; however the documentation that they had generated (over a period of approximately ten years) was submitted into the Inquiry system by Friends of the Earth. As a result the 'evidence base' wrt the credence of Nirex's proposal was able to be evaluated using as a base-line reference materials that had been produced to a high standard of 'QA'.

Specifically within this Inquiry arrangement:

- Witnesses produced 'Proofs of Evidence'
- These documents themselves also had supporting references
- Supplementary Proofs of Evidence were also produced
- The witnesses were Cross-Examined by 'the other side'
- The whole process was overseen by a Planning Inspector
- The Inspector could ask his own questions
- The Planning Inspector was assisted and this assistance included a Technical Assessor
- After the Inquiry was finished the Inspectors wrote reports to the Minister and made a recommendation

The Case that Friends of the Earth presented at the Inquiry can be found at:

[http://www.foe.co.uk/campaigns/climate/nirex_archive_19928.html]

and the report of the Technical Assessor, Mr Colin Knipe can be found at

[http://www.jpb.co.uk/nirexinquiry/nirex.htm]

The Nirex proposal to begin excavation was rejected by both the Inspectors and also the Secretary of State for the Environment. This was partially on the grounds of the scientific inadequacy of the documentation that Nirex had put forward.

For example, the Inquiry Inspector, Mr C S McDonald reported that the chemical containment system that the industry were proposing was:

> "*new and untried with more experimentation and modelling development indubitably required*" [134]

Overall, Mr McDonald concluded that Nirex should not be given the go-ahead to begin their planned programme:

---

[132] the 'Nuclear Industry Radioactive waste Executive'
[133] Sept 1995 – Feb 1996
[134] C S McDonald (1997) Inspector's Report following 'Nirex RCF' Inquiry, Cumbria County Council, File (APP/H0900/A/94/247019) pp 241-242 - para 6E.70

"*in [their] current state of inadequate knowledge*" [135]

The recommendation of the Inspectors was accepted by John Gummer, the Secretary of State for the Environment and the project did not go ahead.

In the mid 1990s , the work on RadWaste burial that had been carried out to datewas scrutinised at a Planning Inquiry in Cumbria – where it was planned to initiate excavation works for a RadWaste Burial facility.

This Inquiry was an extremely rigorous process, involving as it did 'Proofs of Evidence', supporting references, witnesses and cross-examination. The Inquiry lasted for 66 days (from Sept '95 to Feb '96) and was presided over by a Planning Inspector, who had the assistance of a Technical Assessor.

The Inspectors report was delivered in March 1997.

Overall, the Inspector concluded that the Nuclear Industry should not be given the go-ahead to begin their planned programme:

"*in [their] current state of inadequate knowledge*" [136, 137]

The Government accepted the Inspectors conclusions, and the planned Excavation programme did not go ahead. In the subsequent period very little additional research work was done.

Autumn 2009 – Problems with Disposal Remain Unresolved

In October 2009, the European Union – Joint Research Centre released the following Reference Report:

"*Geological Disposal of Radioactive Waste: Moving Towards Implementation*" [138]

Chapter Two of this Report (pp 10 – 21) - entitled: "*The Technical Concept of Geological Disposal*" identifies nearly forty outstanding research areas.

and in November (2009) Francis Livens, Professor of Radiochemistry at the University of Manchester and a Member of the 'Committee on Radioactive Waste Management' (CoRWM) [139] said:

---

[135] McDonald (1997) p277 para 8.56
[136] McDonald (1997) p277 para 8.56
[137] A very useful source of Background Information on the 'Nirex RCF' decision can be found in an article written by Tom Wilkie in Prospect Magazine (May 1997) http://www.prospect-magazine.co.uk/article_details.php?id=5050
[138] Authors - W.E. Falck and K.-F. Nilsson
http://ec.europa.eu/dgs/jrc/downloads/jrc_reference_report_2009_10_geol_disposal.pdf
[139] a Committee that advises Government.

"*In recent years we have recognised where we do not have relevant expertise,*
[concerning radioactive waste management]
and that is a first step towards dealing with these pressing problems. We are starting at a very low base along what will be a long and complex journey."

RadWaste Burial and the 'Radioactive Cauldron'

The significance of the RadWaste problem was first officially recognised in the mid 1970s in the so-called 'Flowers Report'; [140] and the immediate knee-jerk reaction was that all that was needed was a burial site. [141]

However, over thirty years later it is clear that the wishful thinking that led people to believe that wastes could simply be cemented up deep underground – and that they would stay put – is simply not born out by a technical analysis of the processes that would be likely to take place.

The most important point to recognise is that despite the nuclear industry's description of the magnitude of the problem in terms of the ***volume*** of the wastes, the heart of the matter lies in the quantity of radioactive atoms (radionuclides) – and in particular their chemical behaviour under the burial conditions.

Key to the nuclear industry's notion of the potential of burial as a means of ensuring long term protection from radionuclides is the idea that to all intents and purposes they would be held underground for hundreds of thousands of years into the future. This means that the possibility that they would chemically react to change into a mobile form – such as liquid or gas needs to be largely discounted.

However, the basis for this assumption rests on the idea that it is somehow possible to make predictions of radionuclide behaviour based simply on the chemical element concerned. For example for the isotope carbon-14, the nuclear industry base their calculations on an attempt to predict the behaviour of 'carbon' in the burial facility.

The absurdity of this approach can be appreciated by doing a simple thought experiment comparing the solubility of a diamond ring which contains a crystal of pure carbon, with the solubility of sugar, which contains crystals of carbon together with water ('carbo-hydrate').

Obviously diamonds do not dissolve – even over thousands of years – whilst sugar in hot tea or coffee will dissolve in its entirely almost immediately. Thus using data for these two forms of carbon to provide a figure for the 'solubility of carbon' would give a figure of somewhere between zero and infinity. Similarly, error ranges of 100 million can be cited for uranium.[142 , 143]

---

[140] Royal Commission on Environmental Pollution (1976). Nuclear power and the environment. Sixth report. ISBN 0101661800. Quoted at: http://www.no2nuclearpower.org.uk/reports/waste_disposal.php
[141] Roberts LEJ (1979). Radioactive Waste – Policy and Perspectives. United Kingdom Atomic Energy Authority.- page 30
[142] Cross (1991) NSS/R252

Clearly data spanning this range is essentially useless.for the task of predicting the degree of transference of radionuclides from a deep burial facility back to the surface. However it is indicative of the 'wrong-headedness' of the mechanical engineers, nuclear physicists and mathematicians who dominate the 'conceptual framing' of the risk prediction calculations that are used to argue that RadWaste burial would not result in dangerous leakage.

EA – Safety Case for Disposal – May not be Possible (Feb 2010)

In January 2010 the Environment Agency published it's (2008 / 2009) Annual Report on the NDA's work on waste disposal. [144] which concluded that there was the possibility that:

> "***fundamental environmental issues that could ultimately prevent us issuing an environmental permit for the GDF*** **[geological disposal facility]** "
> (page 13) [emphasis added]

The Environment Agency have made further statements regarding the possibility that the nuclear industry will be unable to develop sufficient evidence to enable it to obtain a licence to dispose of radioactive wastes.

See for example:

- an E-mail Clive Williams to Rachel Western and also to Adam Scott [CoRWM (ii) Secretariat] (16th November 2009) stating that: "*work may or may not indicate that an acceptable safety case can be made."*

- and also the (November 2008) EA response to the (Summer 2008) NDA Consultation on Research: "*Environment Agency, Response to Nuclear Decommissioning Authority Consultation on – Radioactive Waste Management Directorate Proposed Research and Development Strategy*" http://www.environment-agency.gov.uk/static/documents/Research/1976__RWMD_Proposed_RD_strategy.pdf]
  (November 2008)

Nuclear Waste Advisory Associates (NWAA)
Identify 100+ Problems with Disposal (March 2010)

J.E. Cross, D.S. Gabriel, A. Haworth, I Neretnicks, S.M. Sharland and C.J. Tweed"*Modelling of Redox Front and Uranium Movement in a Uranium Mine at Pocos de Caldas Brazil"* (NSS/R252) Nirex, 1991

[143] D Swan and C P Jackson (SERCO) 'Formal Structured Data Elicitation of Uranium Solubility in the Near Field - Report to Nirex' (SA/ENV/0920 Issue 3 - March 2007 – page 6 – provides a more recent reference

[144] *"Environment Agency scrutiny of RWMD's work relating to the geological disposal facility - Annual review 2008/09*" Issue 1, Jan 2010
http://www.environment-agency.gov.uk/business/sectors/37483.asp

As a result of the 1990s scrutiny of the proposed RadWaste burial project, it was realised that the proposal was not supported by a rigorous Evidence Base – and as a result, the project was shelved.

In March 2010 Nuclear Waste Advisory Associates (NWAA) compiled a register of current technical issues that remain to be resolved if a technical case for radioactive waste disposal is to be made. Over one hundred issues were identified [145] in areas including: inventory, gases, site considerations, construction, waste package and repository components, chemistry and contamination levels', plutonium and uranium-235 (nuclear energy issues), living things and microbes, limitations of further research, timescales and methodology for risk prediction.

Inventory

An idea of the problems with the official nuclear waste inventory is that the information is graded according to both the 'uncertainty' of the data and also its 'reliability'.[146] The possible adoption of new reactor types or changes in fuel design – which has been proposed for New Build reactors - would necessitate further research. For example, higher burn-up and MOX [147] fuel would require new waste container design and more research on how such containers would behave on disposal.[148] (Considerations include higher temperature and higher risks of brittleness due to increased exposure to radioactivity).[149]

Gases

It has been realised for some time (since at least 1987) [150] that a disposal facility would be likely to produce a large quantity of hydrogen gas.[151] Although this gas would not be radioactive, it would present a problem due to the large volumes involved and the resultant need to provide a release pathway in order to avoid a build up of pressure.[152] Such a release pathway would necessarily also provide an escape

---

145

http://www.nuclearwasteadvisory.co.uk/uploads/6901NWAA%20ISSUES%20REGISTER%20COMMENTARY%20letterhead.doc

146 the 'reliability' relates to whether the data was measured or estimated

147 'MOX' – stands for 'mixed oxide' fuel – which contains plutonium as well as uranium

148 W.E. Falck and K.-F. Nilsson - EU JRC (Oct '09) – page 12
"***Geological Disposal of Radioactive Waste: Moving Towards Implementation***"
European Union – Joint Research Centre – Reference Report – October 2009
http://ec.europa.eu/dgs/jrc/downloads/jrc_reference_report_2009_10_geol_disposal.pdf

149 EU JRC (Oct '09) page 12

150 Cooper MJ, Hodgkinson (ed) (1987). The Nirex Safety Assessment Research Programme: Annual Report for 1986/87. NSS/R101 Nirex. (page 113)
See also EU JRC (OCT '09) page 20

151 The gas would be produced due to the corrosion of iron within an atmosphere that doesn't contain oxygen. The steel would be used both for waste containers and also in structural components of the disposal facility.

152 Nirex, '*Viability Report*' (Nov '05)
'*The Viability of a Phased Geological Repository Concept for the Long-term Management of the UK's Radioactive Waste*' (Nirex Report N/122) November 2005 (page 55)

route for radionuclides. The provision of such an 'escape route' is contrary to the notion of a disposal facility as a sequence of '*barriers*'.[153]

Despite the fact that the hydrogen problem has been recognised for over twenty years, it is still not clear whether a hydrogen 'over-pressure' would lead to the opening of fractures and the resultant creation of fast 'migration pathways'. [154]

Radioactive Carbon – High Doses within Short Timescale

Radioactive waste stocks contain a large amount of 'carbon-14' which is radioactive. The nuclear industry had predicted that, following disposal, this carbon would be held underground due to a so-called '*carbonation*' reaction with repository cement. However in November 2005, the Environment Agency queried the extent to which such a reaction would take place.[155]

More recently, the nuclear industry has acknowledged that this radioactive carbon could instead react with hydrogen and form methane gas (CH_4). Due to its carbon-14 content, this methane would be radioactive. The presence of the carbon-14 as a gas rather than as a 'cement/carbon' chemical compound would make it much more likely to escape from the disposal facility. Thus, the nuclear industry has calculated that the escape of radioactive methane would result in a dose four thousand times greater than the dose considered 'tolerable' by the EA.[156] Furthermore, it has been calculated that this dose could arise just forty years after the proposed disposal facility was closed. [157]

[http://www.nda.gov.uk/documents/upload/The-viability-of-a-phased-geological-repository-concept-for-the-long-term-management-of-the-UK-s-radioactive-waste-Nirex-Report-N-122-November-2005.pdf]

[153] EU JRC (Oct '09) page 10

[154] EU JRC (Oct '09) page 20

[155] EA (Nov 2005) Environment Agency Comments on Nirex 'Viability' Report', (Nov '05)
a key assumption is that all C-14 labelled carbon dioxide does not escape from the repository, but reacts with backfill via a carbonation reaction. In our view, more confidence is needed that complete reaction of carbon dioxide will occur in cracked backfill or that the gas pathway would not lead to unacceptable consequences were this not to be the case." (see pp 10-11)

[156] EA (Feb '09)
"*Geological Disposal Facilities on Land for Solid Radioactive Wastes. Guidance on Requirements for Authorisation"* (Feb '09)
http://publications.environment-agency.gov.uk/pdf/GEHO0209BPJM-e-e.pdf
page 46 (para 6.3.10)

[157] Sources:
Nirex (Feb '06) page 1 – Tolerable Carbon dose = 2.4 x 10^{-3} units. (i.e TBq/year)
NDA (Mar '08) page 75 – Predicted Carbon Dose = 10 units. (TBq/year)
[10 / 0.0024 = 4,000 times]
Nirex (Feb '06) page 12 (Fig 1) – peak dose shown at 40 years post-closure
Nirex, (Feb '06) "*C-14: How we are addressing the issues"*
(Technical Note: Number: 498808)
NDA: (Mar ' 08) 'PAMINA Gas Report'
"*Uncertainties Associated with Modelling the Consequences of Gas*"
Deliverable (D-N°: D2.2.B.2)

Site Considerations

The gas issue presents a double dilemma for repository site selection. The traditional notion of an ideal disposal site is one that presents a 'barrier' [158] to radionuclide release. However, as discussed above, such a barrier would also prevent hydrogen release. This would result in a pressure build-up and must therefore be avoided. On the other hand, allowing the escape of hydrogen gas would also allow the escape of radioactive methane gas [159] which – as stated above – has been predicted to give rise to a very high dose on a very short timescale.[160]

However, the geological screening criteria set out on pages 74 –75 of the DEFRA White Paper [161] "*A Framework for Implementing Geological Disposal*" (June 2008), do not indicate any sign of cognisance of this issue.

Further site problems arise due to the simple fact that ascertaining the underground flow regime is not at all straight-forward. For example high permeability features may dominate water flow; however it is difficult to establish the frequency, spread and distribution of such features [162] and the interconnection of high-flow features over a regional scale "*cannot be known with certainty*".[163]

Contructability issues

It is becoming apparent that it may be necessary to compromise between measures needed to stabilise an excavation and the detriment caused to the safety case by the introduction of foreign material.[164] In addition the volume of rock around the excavation that is damaged, is expected to result in flow pathways.[165] Moreover a disposal facility would be a disturbance to the natural mechanical/flow/heat/and chemical processes at the site.[166] It is recognised that these processes would act to dissipate the disturbance but their interactions are not understood and require further investigation. [167]

Simon Norris (NDA) Nuclear Decommissioning Authority
26th March 2008
http://www.google.co.uk/url?sa=t&source=web&ct=res&cd=1&ved=0CAYQFjAA&url=http%3A%2F%2Fwww.ip-pamina.eu%2Fdownloads%2Fpamina2.2.b.2.pdf&ei=BECRS9T1IYn-0gT42Y3CBQ&usg=AFQjCNFIl8oPPbm0Vtv8MfZDxLG2ToOfSQ&sig2=jpi97Xa_9-Lzn21l2qU1FA

[158] EU JRC (Oct '09) page 10
[159] containing 'carbon-14'
[160] four thousand times the 'tolerable' dose at forty years 'Post-Closure'
see above for references
[161] http://www.defra.gov.uk/environment/radioactivity/mrws/index.htm
[162] EU JRC (Oct '09) page 15
[163] EU JRC (Oct '09) page 15
[164] EU JRC (Oct '09) page 14
[165] due to the opening of fractures – caused by stress release
[166] EU JRC (Oct '09) page 20
[167] EU JRC (Oct '09) pp 20-21

Worker Doses

In their (January 2010) Disposability Assessment [168], the NDA reported that it was unwilling to "*make any claim for the acceptability of* (Operational) *doses"* [169], stating, instead, that the estimates of worker dose were intended to *"provide insight into the key issues"*[170]. This indicates that, according to present estimates, worker doses would be unacceptable.

The Waste Package Itself

In October 2009, CoRWM [171] expressed concern over the level of R&D effort being devoted to determining the lifetimes of Intermediate Level Waste Streams [172]. CoRWM commented that, given the potential significance of waste form performance for 'disposability', the effort being devoted to resolving uncertainties over product lifetimes did not seem to be sufficient. [173] The influence of different possible waste forms on the design choices for the repository components is a '*major knowledge limitation*'.[174]

An indication of the problem may be given by the fact that 17,000 waste packages have been incorrectly conditioned using cement as the matrix and are due to fracture within 150 years due to an '*expansive*' chemical reaction.[175]

Research is also being carried out on both the mechanisms and the probabilities of canister failure.[176] There are particular concerns in respect of copper. The NDA refers to a copper canister wall thickness of 5 cm as a means of securing long-term durability.[177] However, according to research published (July 2009) [178], a copper wall

---

[168] "*Generic Design Assessment: Disposability Assessment for Wastes and Spent Fuel arising from Operation of the UK EPR*", Jan 2010 Part 1: Main Report.
[169] page 91
[170] page 91
[171] CoRWM – the Committee on Radioactive Waste Management
[172] ILW – intermediate level waste
[173] "CoRWM report to Government - on National Research and Development for Interim Storage and Geological Disposal of Higher Activity Radioactive Wastes and Management of Nuclear Materials" Report 2543 (Oct '09) (para 6.3 – page 8)
http://www.corwm.org.uk/Pages/Current%20Publications/2543%20CoRWM%20Report%20on%20RD%20Final%2030%20October%202009.pdf
[174] EA (Aug '09) page 141
[175] "*The longevity of intermediate-level radioactive waste packages for geological disposal: A review*" [NWAT Report: NWAT/Nirex/06/003] (Aug '08) page 25
Author: P K Abraitis
http://environment-agency.resultspage.com/search?p=R&srid=S8%2d2&lbc=environment%2dagency&w=longevity&url=http%3a%2f%2fwww%2eenvironment%2dagency%2egov%2euk%2fstatic%2fdocuments%2fBusiness%2fc%2epdf&rk=4&uid=802543385&sid=15&ts=ev2&rsc=IjCMVqGgQAWT95Na&method=and&isort=score
[176] EU JRC (Oct '09) page 12
[177] NDA - "*Geological Disposal - Generic Design Assessment: of Disposability Assessment for Wastes and Spent Fuel arising from Operation of the UK EPR*"
NDA Technical Note no. 11261814 – Summary

thickness of one metre would be required for long-term (100,000 year) durability. It is not clear how such a wall thickness would be either logistically or economically achievable.

High Level Wastes

The interaction of waste fuel with other repository components needs to be investigated.[179] Furthermore, the interactions between the glass matrix of vitrified high level waste (HLW) and 'clay-type' materials planned for repository use is also difficult to predict.[180]

HLW would be very hot and as such would affect the behaviour of the clay-based materials planned for repository use as a backfill. Specifically, the chemical, mechanical and flow behaviour of the clay would be affected.[181] The heat from the wastes would dry out the clay and alter its '*suction potentia*l'.[182] The EU is presently setting up a new work area on these issues. [183]

Examples of Chemical Effects

In 1989, the International Atomic Energy Agency (IAEA) identified a specific problem relating to the increase in the solubility of radionuclides caused by organic breakdown products that was sufficient to increase doses above the regulatory limit.[184] A likely source was thought to be decomposition products of 'cellulose', the woody compound used to make paper. Cellulose break-down products have been observed to increase radionuclide solubility by up to 10,000 fold [185 , 186] with plutonium being a particular problem.[187]

See - Figure B7 - Illustration of an EPR spent fuel disposal canister " (page 27)
[http://www.nda.gov.uk/documents/upload/TN-17548-Generic-Design-Assessment-Summary-of-Disposability-Assessment-for-Wastes-and-Spent-Fuel-arising-from-Operation-of-the-EPWR.pdf]
[Dated October 2009 - though published 9 Nov 2009

[178] "*Water Corrodes Copper*" G. Hultquist et al [July 2009 – (online)]
Catal Lett (2009) 132: 311–316:
Received: 29 June 2009 - Accepted: 19 July 2009 (Published online: 28 July 2009)
Springer Science+Business Media, LLC 2009
http://www.mkg.se/uploads/Water_Corrodes_Copper_-_Catalysis_Letters_Oct_2009_-_Hultquist_Szakalos_et_al.pdf

[179] EU JRC (Oct '09) page 11
[180] EU JRC (Oct '09) pp 11-12
[181] EU JRC (Oct '09) page 13
[182] EU JRC (Oct '09) page 13
[183] EU JRC (Oct '09) page 13
[184] IAEA in – D. George (1989) NSS/R199 "*The Response to an IAEA Review of Deep Repository Post-Closure Safety R&D and Site Assessment Programmes of UK Nirex Limited*". (p 3)
[185] Cross (1989) NSS/R151
J E Cross et al "*Modelling the Behaviour of Organic Degradation Products*" p(ii)
[186] Ewart (1988) NSS/G103
F T Ewart et al, "*Chemical and Microbiological Effects in the Near Field: Current Status*" p19
[187] Cross (1989) NSS/R151p3

Another chemical consideration that points to the extreme difficulties associated with attempting to predict the degree of leakage from a nuclear waste dump is provided by the attempts to quantify 'sorption'. Sorption is the process of radionuclide take-up by solid surfaces. It has been studied for many decades.[188] However, the 'batch' technique which has largely been used relies on crushed samples to obtain data values. [189] This technique is very far removed from the actual uptake mechanisms that would be relevant.[190] Nevertheless, despite the recognition that the measured values "*do not have any predictive capabilities*",[191] they are still widely used in risk estimates.[192] Equations are available that would more closely represent reality but these are not used due to the lack of data and also the computer capacity that would be required. [193]

Possible Impact of Nuclear Energy Chain Reaction

Nuclear wastes contain plutonium and uranium-235, which are able to initiate a nuclear energy chain reaction (or '*criticality*'). Both the probability and impact of such an event are not known.[194] The UK nuclear industry has built up 100 tonnes of separated plutonium, which is not currently incorporated into the repository risk estimate.[195] Long-term management of this plutonium will need to be considered at some stage, either in the separated form or as 'waste MOX' [196] or in some other form.

The Nuclear Weapon Dilemma

Quite apart from the fact that plutonium and uranium-235 are the raw materials for 'State' nuclear weapons, it would also be possible to make a 'dirty bomb' out of more general radioactive wastes. This introduces an additional dilemma into long-term waste management.[197] On the one hand, these potential bomb materials should be put

---

[188] EU JRC (Oct '09) page 18

[189] as compared to solid 'block samples' which are used in the 'through-diffusion' measurement technique
See "*Using Thermodynamic Sorption Models for Guiding Radioelement Distribution Co-efficient (Kd) Investigations – A Status Report*"
Nuclear Energy Agency Oxford workshop (May 1997)
Published by the OECD in 2001.
See also Keita Okuyama et al
"*A method for determining both diffusion and sorption coefficients of rock medium within a few days by adopting a micro-reactor technique*"
Applied Geochemistry
Volume 23, Issue 8, August 2008, Pages 2130-2136
http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VDG-4SHVSV9-1&_user=10&_coverDate=08%2F31%2F2008&_rdoc=1&_fmt=high&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=1241073903&_rerunOrigin=google&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=9ab3699e2fd11664e4a83b8da56bf3e6

[190] EU JRC (Oct '09) page 18

[191] EU JRC (Oct '09) page 18

[192] EU JRC (Oct '09) page 18

[193] EU JRC (Oct '09) page 18

[194] EA (Jan '10) page 16

[195] EA (Jan '10) page 16

[196] 'MOX' – refers to fuel rods that contain both plutonium oxide and uranium oxide.

[197] See also the 'gas dilemma' considered above

out of reach; on the other hand, they should be kept at hand in order to be sure that they have not somehow been accessed by potential bomb makers.

Living Things and Microbes

In addition to all of the problems cited above better understanding of the long-term implications of the impact of radionuclides on living things [198] is required. The potential importance of microbes, which can be found deep underground [199] has long been underrated.[200] This is of concern as microbes may well be the determinant factor in the outcome of a reactive chemical system.[201] The role of microbes in proposed disposal systems is not fully understood [202] yet despite this, only a few laboratories are undertaking research on microbe/radionuclide interactions. [203]

Further Research will not necessarily provide desired outcomes

It is intrinsic to scientific method that the outcome of a research programme cannot be predicted – otherwise there would be no need to carry out the research. This means that simply allocating time and money to the issues that challenge the disposal programme will not guarantee that the issues will be resolved. Thus the Environment Agency has pointed out that it is possible that the results of disposal research programmes may not actually indicate that disposal would be safe.[204]

---

[198] NEA Contribution to the Evolution of the International System of Radiological Protection (2009)
[199] EU JRC (Oct '09) page 20
[200] EU JRC (Oct '09) page 19
[201] EU JRC (Oct '09) page 20
[202] Strand et al (2004) page 20 ## check
[203] EU JRC (Oct '09) page 20
[204] EA "*Environment Agency, Response to Nuclear Decommissioning Authority Consultation on – Radioactive Waste Management Directorate Proposed Research and Development Strategy*" (Nov '08)
[http://www.environment-agency.gov.uk/static/documents/Research/1976__RWMD_Proposed_RD_strategy.pdf]

Sellafield's risks are too high – NII

7th October 2009

Whitehaven News
Weds 7th Oct 2009
By Alan Irving

http://www.whitehaven-news.co.uk/news/sellafield_s_risks_are_too_high_nii_span_style_color_red_add_your_comments_span_1_620879?referrerPath=news

RISKS of something serious happening in Sellafield's old plants are far too high, the Nuclear Installations Inspectorate has warned.

The NII and the Environment Agency are worried about the potential for a "major event" arising from part of Sellafield's "high hazard, high risk" area.

Eliminating hazards is said to be a national priority.

One of the high risk plants is B30, the original fuel storage pond which is open and known among workers as "Dirty 30".

NII inspector Mark Foy gave the warning at a meeting of Sellafield's independent community watchdog group. He said: **"We are concerned that the risk of a major event caused by further degradation of legacy plants, or increased time at risk due to deferrals, is far too high.**

"We have written to Sellafield Ltd to advise that every effort should be given to addressing and reducing the risks at the earliest opportunity.

"We are currently in discussions with the licensee on how this will be achieved recognising our concerns on previous performance regarding repeated programme slippage."

Much of Sellafield's £1.3 billion from the Nuclear Decommissioning Authority this year has to be spent on reducing hazards.

MP Jamie Reed said yesterday: "I am confident the NDA is managing these hazards properly and the new management team understands the pressing nature of these problems. However, the whole of our community wants to see quicker progress on

hazard reduction and so does the workforce – there are no blank cheques from the community when it comes to being vigilant about nuclear hazards."

Mr Reed said he was against any public spending cuts affecting Sellafield: "It needs more money, not less. There is only so long any organisation can do more work with less resource. Sellafield should undertake more commercial work: to make money to spend money."

Sellafield Ltd said yesterday its mission was to speed up high hazard reduction.

"We are committed to doing that as quickly and effectively as possible. We, the NDA and the regulators, are in agreement that high hazard risk reduction needs to be attacked and accelerated. We are pursuing ways in which we can accomplish this safely and swiftly."

After the stakeholders meeting in Cleator Moor, Mr Foy stressed: "The potential is there for something untoward occurring which we wouldn't wish to see."

Sellafield Ltd had been carrying out risk impact assessments. The inspector added: "We felt some of those impacts weren't desirable. We want some re-prioritisation to make sure that work which has been delayed is done sooner.

"Earlier this year we did a joint inspection with the Environment Agency looking at containment issues to prevent and detect leaks.

"Although the report has not yet been written, some of the conclusions are that they (Sellafield Ltd) did find a good approach from the licensee in this respect."

In his report to stakeholders, Mr Foy pointed out: "Our over-riding objective remains unchanged in that we wish to ensure the earliest practicable safe reduction of risk from the high hazard legacy plants at Sellafield."

Andy Mayall, from the Environment Agency, said a visit to Sellafield's legacy ponds and silos (last May) "reinforced the serious nature of the hazards and that clean up and risk reduction remain absolute priorities."

He warned that "high level commitment for the clean up programme is needed to ensure continued funding."

But at the same time he was impressed by "the great strides" taken by the operators in recent years to prevent any continued increase in site contamination or leakages.

The NDA revealed that this year £500million of the £1.35billion allocation was for the high hazards areas.

An NDA spokesman said: "Tackling the reduction of risk from high hazards and legacy waste at Sellafield is a key priority for us and all involved at Sellafield."

First published at 15:51, Wednesday, 07 October 2009
Published by http://www.whitehaven-news.co.uk

NDA – Lack of Credibility of its Evidence Base for Radioactive Waste Policies

See Appendix for Full Exchange

In the autumn of 2008 the Planning Inspector for the Cumbria County Council's Hearing concerning their draft *'Minerals and Waste Core Strategy and Development Control Policies'* – (abbreviated here to the 'Waste Planning Framework') identified the following 'key issue' as central to the 'Test of Soundness' of Cumbria County Council's draft waste framework.

Key Issue:

(i) "*What is the* ***basis and justification*** *for the approach to radioactive wastes, including the specific policies for storage/disposal of high/intermediate and low-level wastes, and* ***is the strategy based on a robust and credible evidence basis?***"

(Emphasis added)

In response the NDA generated the following text:

NDA Comment

> "*The repository has a new Parent Body organisation with seconded management team, not a new operator, and the proposals do not* ***demonstrate*** *that wastes will be managed elsewhere, just that strategically, every effort will be taken to apply fit-for-purpose management to wastes that are currently expected to be disposal [sic] at the Repository to make optimum use of the national asset, as per Government Policy.*" [205]
>
> (Emphasis in original)

It can be seen that this text makes no sense in terms of the request for information concerning whether or not the Policy rests on a '*robust and credible evidence basis'* referring instead to fit-for-purpose management.

'Evidence-base' and 'management' are not the same thing.

Phil Davies of '*Nuclear Waste Advisory Associates*' (NWAA) has pursued the matter through correspondence with the NDA following a meeting that was held in September 2009.[206]

---

[205]

[206] The meeting was for NGO stakeholders and was held at the NDA Offices in Buckingham Gate. It was held on Tuesday 22nd September 2009.

At this meeting Bill Hamilton of the NDA stated the note was submitted in error. Phil Davies followed this statement up with a letter (also on September 22nd) – in which he requested that Bill Hamilton:

- confirm in writing, his statement that the document was submitted by mistake, and also

- inform Phil Davies of any steps that he would take to rectify the situation – ie to provide the documentation that would indicate that the NDA's radioactive waste policies are founded on '*a robust and credible evidence base*'

In October the NDA responded to a further E-mail from Phil Davies – to indicate that: Bill Hamilton could be quoted as saying that an error had indeed been made in the (Nov '08) NDA document – and that Bill Hamilton was following this matter up with the originators of the document.

On December 30th 2009 Phil Davies contacted the NDA again as he had not heard further from Bill Hamilton. The NDA responded (4th Jan 2010) that the October response was **the** response. However the October E-mail contained no information at all on the NDA's view of what comprised the '*robust and credible evidence base'* for their policies on Radioactive Waste. This was the information that the Planning Inspector had originally requested.

Phil Davies replied (4th January 2010) to Judith Holland of the NDA:

> *"I would suggest to you that a response is called for since the NDA' s "Comment"* ***in no way answers the question****, and appears to be* ***virtually devoid of meaning"***

Phil then went on to enquire:

- whether a corrected version of the document would be issued; and

- whether such a corrected version would be made available to Cumbria County Council

The NDA response (5th January) was as follows:

> "*you have had a response to your original question. That is the end of the matter as far as I am concerned.*"
>
> (E-mail from NDA Information Access Manager)

It is clear from this response that the NDA do not possess a '*robust and credible evidence basis*' for their policies on radioactive waste management – or at least one that they are prepared to share with the Public in order to enable critical scrutiny.

NDA (2010) - Severe Problems Associated with Spent Fuel Disposal

This year (2010) the NDA have released two reports that refer to severe problems with the disposal of spent fuel/

i) Worker Doses during SF Emplacement – May be Too High (Jan 2010)

Currently the NDA are not sure that worker doses would be low enough to allow workers to be able to put waste into a nuclear dump in the first place.

Source:

> NDA - "*Generic Design Assessment: Disposability Assessment for Wastes and Spent Fuel arising from Operation of the UK EPR*" (Jan 2010)
> Part 1: Main Report. – page 91

The precise wording is as follows:

> "*Although the Operational Safety assessment calculated doses, given the current status of the design of the facility and the assessment of spent fuel emplacement operations, the purpose of the calculations is to provide insight into the key issues affecting operational safety* ***rather than make any claim for the acceptability of the doses.***"

ii) Fundamental Research issues remain to be addressed (March 2010)

The fact that the NDA are not confident their Evidence Base for disposal was confirmed in March 2010 in statements that they made concerning the development of a strategy for the management of oxide fuels.

Source:

> NDA - "*Strategy Management System - Topic Strategy – Oxide Fuel*"
> Doc No SMS/TS/C2/G0/001
> http://www.nda.gov.uk/documents/upload/Draft-Oxide-Fuel-Topic-Strategy-gate-0.pdf
> 16th March 2010

Quotes:

> "*The NDA considers it very important to* ***undertake work to understand the potential disposal and disposability of UK-owned spent oxide fuels. Constraints imposed by disposability aspects will have major impacts on the analysis and evaluation of the credible options.*** *A description of the technical and engineering option for disposal of spent fuel is required.* ***Projected costs for the disposal of spent fuel are required.***" (page 13)

"***The uncertainties around the disposal concept***, *the disposability and volumes of the different waste forms, including AGR fuel, are key aspects to making decisions on the project.*" (page 16)

"***R&D activities*** *related to the mitigation of key strategic risks, underpinning key skills and supporting credible options evaluation will be required to underpin strategic option selection.* ***This will cover … disposal and disposability of spent fuel***" (page 17)

The Potential for Retrieval – cf 'Contingency Allowance'

In addition to DECC's failure to consider a realistic figure for 'Optimism Bias', DECC's figure for 'Contingency Allowance' [207] is also wholly inadequate. In particular, it is considered that ninety years is a sufficient period of time for any substantial problems to be identified. [208] Ninety years may be compared to the period of over one million years for which radioactive waste will be in existence - furthermore this period may be put in the context of the 100 plus problems identified in the NWAA issues register discussed above. It may be seen that given the significant range of problems associated with disposal it could easily be longer than 90 years before a significant problem becomes apparent.

More to the point – NewBuild waste could necessarily only be emplaced in an existing facility if the facility was open. This means that problems associated with **Post-Closure** conditions would not have come to light. This is of particular importance as such problems are likely to be especially onerous. [209] Therefore the contention of the DECC waste subsidy consultation does not need to consider the possible retrieval of wastes is not rigorously founded.

It is clear that there is a strong possibility that if radioactive wastes were to be disposed of, the disposal facility would leak to an unacceptable degree which would necessitate the retrieval of the wastes.

As indicated above in their (January 2010) Disposability Assessment [210], the NDA reported that it was unwilling to "*make any claim for the acceptability of* (Operational) *doses*" [211], This indicates that, according to present estimates, worker doses would be unacceptable. Clearly following an unacceptable radionuclide leakage – which necessitated the recovery of the wastes – doses would be considerably more severe.

These doses could easily be unacceptable – and the compensation figures resulting from the radioactive contamination of a region's water supplies and agricultural land

[207] pp 29 – 31 plus Annex C – pp 80 - 93
[208] Annex C, para 24 page 85
[209] as is indicated by the NWAA issues register
[210] "*Generic Design Assessment: Disposability Assessment for Wastes and Spent Fuel arising from Operation of the UK EPR*", Jan 2010 Part 1: Main Report.
[211] page 91

would be likely to be huge. At the time of writing BP is facing a multi-billion dollar bill for the oil release in the States.[212]

The Dounreay waste shaft from the 1950s provides a precedent for the need to retrieve wastes. Following disposal of radioactive wastes up to the 1970s the waste shaft exploded and the decision was taken to recover the wastes. Estimated lifetime costs of the project are in the region of £240 million. [213]

It has also proven necessary to retrieve wastes from facilities at the Sellafield site. [214]

[212] See for example, the Guardian, Monday 7 June 2010
http://www.guardian.co.uk/environment/2010/jun/07/bp-oil-spill-fines-government
[213] http://www.dounreay.com/decommissioning/shaft-and-silo
[214] See for example "*West Cumbria Sites Stakeholder Group:- Sellafield, Calder Hall and Windscale*" - Quarterly report for: 1st January 2010 to 31st March 2010
http://www.hse.gov.uk/nuclear/llc/2010/wcssg1.htm
2.1.2 Legacy Silos Projects