Initial Specialist Workshops

CoRWM Members' Summary

Doc Number: 1255.1

Contents

Specialist workshop summary

To be completed by CoRWM Member.

1. Date, place and title of meeting:

Socio-economic

15/16 Jun 05, Gray's Inn, London

2. Who attended - name, organisation and capacity (e.g. specialist, facilitator &c):

Bob Kitchen, Catalyze, Facilitator
Prof Gordon MacKerron, CoRWM (first day only)
Fiona Walthall, CoRWM
David Collier, CoRWM Independent Evaluator, Observer
Dr Iain Williams, Prof Dalton's Scientific Panel, Observer
Kathy Hillis, NNC, Recording information needs
Sam Usher, NNC, Project Manager (second day only)
Mike Egan, Catalyze, Observer (second day only)

Dr Elizabeth Atherton, Nirex, Specialist
Prof Steve Fothergill, Sheffield Hallam, Specialist
Prof Sir Laurence Hunter, Specialist
Rev. John Hetherington, Cumbria County Council, Specialist
John Knox, Westcroft Consulting, Specialist
Dr Peter Wilmer, OECD, Specialist
Paula Orr, Environment Agency, Specialist
Dr Beth Taylor, UKAEA, Specialist
Fergus McMorrow, Specialist
Phil Richardson, Enviros, Discussion Paper Author, Specialist

3. Summary of the event (i.e. agenda annotated to show broadly what discussion took place):

15 Jun
0900 – 1000 Plenary briefing from Gordon MacKerron, Mark Dutton, and Larry Phillips

1030 – 1300 Initial Discussions – exploring the issues, particularly whether anything could be done without having specific sites where the facilities would be implemented, and whether to use generic site descriptions. (Decision not to use generic site descriptions). The discussion highlighted that lots of economic and social issues depend on the current situation at the sites being considered to host a facility. Therefore at this stage of considering generic options it is difficult to

evaluate some of the criteria as the score will depend on the sites considered rather than the particular option being considered. The group decided to only attempt to score those criteria that will distinguish between options at this generic stage in the process, but they recognised that others would be important later in the process, particularly when sites were being identified, therefore they should not be lost.

1345 – 1630 Produced outline scoring scheme for Local Employment, identifying top and bottom of scale, and info needs. Started discussing Blight.

1630 – 1700 Plenary report back

16 Jun
0900 – 1300 After lengthy discussion on blight, decided no scoring scheme was possible, but acknowledged that 1 site v 34 sites needed to be picked up somewhere.

1345 – 1630 Discussed Investment and changed it to 'Spin-Off'. Created and tested a scoring scheme. Created a scoring scheme for each of 4 sub criteria under Local Amenity – Noise, Traffic, Footprint, Visual Impact. Agreed that the historical and archaeological aspects of 'local culture and heritage' were too site specific and could not be assessed at this stage, but could be placed under 'damage to amenity' for a site selection phase. The effect on population aspect of 'culture and heritage' was already taken into account under the economic sub criteria relating to employment, so would not be assessed again. Agreed that local feeling of well being was site specific and no scoring could be done at this stage. Re-organised criteria as follows:

Headline	**Sub Criteria**
Socio-economic	Local Employment
	Spin-Off
	Blight
	Local Feeling of Well-being
Damage to Amenity	Visual Impact
	Footprint
	Traffic
	Noise
	Effect on Historical and Archaeological Sites

Italics = not scorable without knowledge of potential sites

4. Highlights (i.e. your observations on items of particular significance):

i. Initial discussions about how to tackle the criteria and whether CoRWM was even asking the right questions, took at least 2 hours. Initial feeling that it was not possible to score options against some of the criteria without having identified potential sites. Once the group agreed which criteria could be assessed at this stage in the process and a criterion was tackled, the mood changed as everyone began to see how progress could be made.
ii. Some questioning of whether social and economic impacts should be split – by the end of the workshop all except one participant agreed that there should be a single 'socio-economic' category.
iii. There was disagreement over whether damage to amenity was a socio-economic issue or whether it was more to do with planning, environment etc. It was moved up to be a headline criteria partly because there was no consensus over where it should sit, and partly because it had 4 sub-criteria under it.
iv. The first criterion took a lot of time (local employment) as people tried out various measures which were changed as a better understanding of the process and the criterion evolved. It was very much an exploration of the criterion and what it meant, as well as how it could be measured.
v. Timescale was an ever present issue throughout the workshop in the following ways:

- The need to have a profile of each option showing what would happen if it were to be implemented
- Over what timescale people care about issues – for local employment 50 years was initially agreed, but the reality of how long some of the options would take to implement and when that might start, lengthened the time to anything up to 300 years.
- Some types of employment do not guarantee jobs over the long term (e.g. construction jobs), so how important are sustainable jobs for this issue?

vi. Are new jobs necessarily a good thing? Are migrant workers necessarily a bad thing? (what is a good ratio between local and migrant workers). These sorts of questions indicate the importance of making assumptions clear.
vii. Nirex volunteered to provide much of the information needed in relation to job profiles or to identify potential sources of information.
viii. **Blight.** It was initially felt that blight could be scored by considering 1 central site compared to the total blight created in 34 local sites. This would need to be done over 300 years. The extent of blight was not measurable as it was too site specific (current conditions and historical experience). There was concern that 1 site versus 34 sites was already being taken into account in other criteria (risk of double counting). It was agreed that evidence of any difference in blight between size and type of facilities would be nice but not essential. It was also felt unlikely that this information exists.
ix. **Spin-Off**. It was felt that the original criterion 'Investment' had connotations of blight and would be taken into account in that criterion. Discussion of possible positive impacts led to the feeling that there might be spin-offs from the technical skills needed for implementing an option. (Other business spin-offs would be taken into account as a multiplier under local employment). The extent of the spin-off is likely to be linked to the innovativeness of the option, its complexity, and its scale/size.

x. **Damage to Amenity**. The 4 sub criteria under damage to amenity each need a scoring scheme that takes into account the 3 phases of construction, operation, and post-closure. Again a profile of what happens when is needed for each option. Once the data has been obtained, an actual value for the top and bottom of each scale can be selected. Nirex believes it has some of the data, UKAEA or BNG could provide information on some of the options. For some/all of these issues it might be worth seeing how an EIA or SEA deals with them.
xi. Even within one location there are mixed views on many issues, for example, whether a store or a disposal site would create the greatest feeling of unease.
xii. Intragenerational Equity should be renamed 'Fairness between communities'.
xiii. Compensation must be something that benefits the whole community.

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5. Lessons or actions for CoRWM (e.g. what we need to do differently at the next such event) and implications for future PSE:

i. Apart from knowing that they need to fill in this form, CoRWM observing members have no other guidance on what they are there for. It is suggested that they should be asked to try and note the rationale for important decisions as this was not captured well. It would also be useful if the CoRWM members could note main areas of consensus and disagreement as this is not being captured elsewhere.
ii. It is difficult to take notes as a participating member.
iii. Even the observing member is encouraged to sit within the group so inevitably gets drawn into the discussion. The advantages of this probably outweigh the disadvantages.
iv. There may be links/similarities between the information needs generated by different groups e.g. profile over time of the options.
v. It would have been useful to have had an example of an EIA and/or SEA.
vi. For those criteria that can be scored at this stage, scoring schemes were only designed in very broad outline. Once the necessary data has been collected, however, it should be a relatively simple task to create the full scoring schemes. It is possible that this could be done by re-convening the group for just one day. It is not anticipated that the data collection will take very long, Nirex having much of it.

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6. Outcomes: attach / refer to separate reports on
- information needs arising from the workshop (NNC will write this up)
- scoring systems (Catalyze will write this up)

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7. This note written by:
Fiona Walthall 18 Jun 05

Specialist workshop summary

To be completed by CoRWM Member.

1. Date, place and title of meeting:

Burden On Future Generations

15/16 Jun 05, Gray's Inn, London

2. Who attended - name, organisation and capacity (e.g. specialist, facilitator &c):

Larry Phillips, Catalyze, Facilitator
Mike Egan, Enviros, occasional recorder and observer
Dr Mark Dutton, CoRWM participating member
Pete Wilkinson, CoRWM observing member
Nigel Pacey, NNC recorder
David Collier, CoRWM Independent Evaluator, Observer (second day only)

SPECIALISTS
Samantha King, Nirex
Mark Hannan, N-ovation Ltd
Marion Hill, consultant
Tim McEwen, Safety Assessment Management Ltd
Grace McGlynn, Integrated Decision Management, discussion paper author
Martin Dobson, BNFL
Prof Steve Sparks, Bristol University, representing Prof Dalton's committee

3. Summary of the event (i.e. agenda annotated to show broadly what discussion took place):

15 Jun
0900 – 1000 Plenary briefing from Gordon MacKerron, Mark Dutton, and Larry Phillips

1030 – 1300 Introductions, expressions of bias sight and given. General discussion around the issues. Agreed the working premise that 'earlier was better than later' in respect of minimising burden being passed to future generations. Agreed that this group's task was to look at the distribution rather than the magnitude of cost, detriment and radiological dose. Agreed that 1 was poor performance and 9 was good.

1345 – 1630 Proposal from Mark Dutton to score all storage options as 1 to reflect that high proportion of the costs are passed on (the material still remains and future generations will have to decide its ultimate fate such as disposal), that all of the radiological burden will remain after 300 years and that the detriment will likewise be passed on as handling will be required. In short, the option defers cost, dose and detriment to future generations and does not represent a solution. Disposal options were therefore scored at 9 although some debate about this ensued. There was discussion as to the merits of allowing future generations to make their own decisions through storage and it was pointed out that disposal options are not a panacea for obviating future burden: disposal was not the end of the story, despite the impression that it was. It was also agreed that whatever was decided, we would *de facto* pass on a burden to *a future generation* as even if we began managing the waste now, it would be 30 - 50 years before all the waste was conditioned and stored/disposed. It was agreed, however, that this generation had an obligation to lessen the burden going forward as much as it could. There was discussion as to the split between the issues captured by different criteria and it was stressed that the collective detriment must be picked up by the safety debate. A long debate centred around the 'phased disposal' option and its actual differences from 'disposal' in that all were de facto 'phased'. The difference with phased is that there is an intention to ensure regulatory and institutional control for the period of phasing, up to 300 years. As a result of the agreement that there would be a delay in conditioning and emplacing all the material, as well as in acquiring the site, licensing it and constructing facilities, the prompt (good) score of 9 was interpreted as being those options which managed the detriment, cost and dose within 50 years (two generations) and as a consequence, the late (bad) score of 1 was redefined as 350 years.

1630 – 1700 Plenary report back

16 Jun

0900 – 1300 Overnight, Larry interpolated the scores between 50 and 350 years to arrive at the median figures for the other scores. These were calculated as being

Less than 50 years scores 9
Less than 70 years scores 7
Less than 100 years scores 5
Less than 150 years scores 3
Greater than 350 years scores 1

There was a lot of discussion about how to capture 'uncertainty' and some felt it deserved a separate criterion due to the fact that prompt action reduced the uncertainty of the future. This was argued against by way of pointing out that uncertainty remained a constant to which all future actions were subject. Others argued for other issues to be captured such as 'resistance to societal change', wars and climate change impacts but after consideration, it was agreed that these aspects were captured under different criteria. It was agreed, however, that how the options performed *over time* against the criterion was important and this was captured as an information need. Much discussion also took place about the provision of funds into the future with which future generations could manage the burden we passed onto them. The issue of liability was also discussed in respect

of passing this onto future generations and it was noted that liabilities in respect of disposal could not be ruled out although overall the issue reinforced the 'sooner rather than later' premise. It was pointed out that if the storage options assumed institutional control for 300 – 350 years, after which point it is assumed to collapse, there is an implicit assumption that on year 301 or 351, society is in good enough shape to begin planning a repository.

1345 – 1630 Discussion in the final session revolved around the options themselves, the ability or otherwise of specialists to score disposal (perceived short term implications) with storage (perceived long term implications). Some asked if a store was designed only to 100 years, but was nevertheless a long-term storage option, would it score differently? It was felt that the institutional control issue would be the determining factor and therefore makes the period arbitrary. However, it was pointed out that, as the store designed for a shorter period of time would need to be refurbished more often that one designed for 300 years, the former should score lower than the latter. Thus the view that all storage options should score 1 may actually be a distortion.

The discussion them went onto another aspect of comparison which is the suitability of options to different waste streams/materials. It was argued that only disposal and long term storage could realistically be compared as they were the only two options which could accommodate all waste streams. The concept of using heat generating, long and short-lived wastes as the materials to use in the assessment was discussed and it was felt this approach could be useful although it might mean three separate MCDAs. Shallow disposal also presented some problems in that we argue it is for short-lived wastes but at the same time indicate that it is for stage 2 and 3 decommissioning wastes which include graphite, a long-lived ILW. This discussion resulted in an agreement that we would make clearer the descriptions of the options in 1064. The group then notionally scored the options, an exercise which underwent iteration and which is not captured here as it was not definitive and as it is a task for future workshops to undertake with more consideration than the group was able to give it.

4. Highlights (i.e. your observations on items of particular significance):

I think most is captured above. What I found most noticeable was the fact that we were able to reach consensus quite quickly (admittedly the issue is not the most taxing to discuss) but also that there are several areas which need attention:

- Amending 1064 (brief descriptions of the options) – done
- Resolving the three waste streams across the options approach to scoring
- The on-going issue of scoring like with like and how the 300 – 350 year comparison can be explained more coherently
- Making it clear that the non-geological disposal options are 'forever' options and that there is confusion about whether inventories in this category will be restricted to 'short-lived' wastes
- Timelines work – particularly for worker dose for the options which require repackaging of wastes, replacement of crane rails etc - see information needs (CORWM to distribute Nirex paper)
- How different wastes and materials are applicable at different times for different options – Nirex work again
- Challenge Nirex on the 150year package claim
- Making it clear the assumptions are that we look at options under current technology levels and that the value of money does not change
- Ensuring that the design of repositories to accommodate assumed/desired properties of retrievability and monitorability is used as a key factor when considering implementation and siting issues – this must be picked up in implementability along with the geological restrictions issue
- NDA information needed on effort issues across the non-geological range
- The need to ensure on-going contact with specialists between now and the next workshop
- Deep boreholes – we have to assume this option is viable but we need more detail on it to carry it forward with conviction
- Is the distinction between phased deep and deep clear enough?

5. Outcomes: (attach / refer to separate reports on

– information needs arising from the workshop (NNC will write this up)
– scoring systems (Catalyze will write this up)

6. This note written by:

Pete Wilkinson 22 Jun 05

Specialist workshop summary

To be completed by CoRWM Member.

7. Date, place and title of meeting:

Implementability and Flexibility
22/23 June 2005, Gray's Inn, London

8. Who attended - name, organisation and capacity (e.g. specialist, facilitator &c):

Facilitator
Larry Phillips, LSE, organisational management

Specialists
Dr Andy Baker, Environment Agency
Ian Jackson, consultant, regulatory and licensing
Dr Mathew White, consultant, radioactive waste management
Bruce McKirdy, Nirex, phased disposal
Stewart Kemp, Nuclear Legacy Advisory Forum (formerly NFLA)
David Nicholls, BNG, former BNFL, Sellafield clean-up
Trevor Summerling, consultant, physicist
Dr Enese Lieb-Doczy, Deloitte and Touche, economist
Grace McGlynn, IDM, former BNFL, public affairs
Deborah Tripley, Fenners, environmental barrister, former Greenpeace
Steven Brown, consultant, former civil servant DoE radwaste
Wendy Le-Las, environmental consultant, land use planning

CoRWM Members
Prof Andy Blowers,
Dr Mark Dutton

NNC
Lynn Mulelly
Lisa Albino

Two observers from Dalton Panel (one each day)

9. Summary of the event (i.e. agenda annotated to show broadly what discussion took place):

- Declaration of motivations and value positions to ensure openness as to values, objectives and beliefs. Agreement to produce unattributable views of meeting.

- Discussion and development of criteria for implementability/Flexibility. Altogether seven sub-criteria were discussed as follows,

Implementability –	Technical
	Regulatory Requirements
	Legal and Planning Consents
Flexibility-	Adaptability
	Monitorability
	Retrievability
	Proximity

- Consideration of scoring scheme for revised criteria and test of feasibility of scheme

- Identification of further information needs

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10. Highlights (i.e. your observations on items of particular significance):

Firstly, it must be said this was a highly successful workshop. The group chemistry was good and the whole meeting was conducted in a cooperative, productive and generous manner. The facilitation was responsive and ensured objectives were reached by light touch steering. Despite a very heavy workload the group managed to achieve the required outputs.

Taking each sub-criterion in turn these are the key issues that arose from the discussion.

Technical

The criterion was developed as follows: 'The extent to which the option is expected to employ currently established, tested and proven technical systems for the design, construction and operation of the option including decommissioning (if relevant)

Some important issues were raised including whether the option was licensable (but see below), would achieve the SEA directive, what would be appropriate institutional controls etc. A distinction was made between implementability (i.e. could it proceed technically?) and implementation (i.e. what is necessary to ensure it proceeds?) which is being dealt with through CoRWM's Implementation WG. But, it was agreed the linkage between the two must be recognised. Another problem was the difficulty of dealing with technical issues through a generic rather than specific siting process. However, it was accepted that, at the siting stage, further application of technical criteria would be necessary.

The scoring scheme ranged from established, tested and proven technical system at 9 to novel, largely untested and unproven system at 1. An unworkable system would score 0.

Regulatory Requirements

It was felt that the sub-criteria (22 and 23) should be reorganised. Thus legal issues should be included with regulatory requirements leaving land-use planning as a separate sub-criterion.

'Legal and Regulatory Requirements' covers national, EU and international levels. The problem was deciding what hurdles had to be overcome and whether they were discriminatory. In the event the group decided to put forward a coarse scoring scale of 9-5-1 without intermediate points. To achieve 9 an option would be 'demonstrated to be fully compliant with current international, EU and national law and regulatory requirements'. At 5 there would be 'expectation of compliance but not yet demonstrated' while 1 would have 'high non-compliance'.

It was recognised that the amended criterion applied only to 'current' law and that the scales reflected expected not actual performance.

Land-use planning requirements

It was considered that planning requirements would include both existing planning law and the policy, processes and procedures of planning as set out in guidance notes, structure and other plans. The key issue was the need to achieve planning consent and options would be expected to perform differently in this regard. There was some discussion of the need to reflect 'national' differences (e.g. Scotland has devolved planning powers) but it was felt this was embraced in the scoring scheme. Thus, at 9 an option would be 'demonstrably consistent with existing law, policy, processes and procedures (i.e. would achieve planning consent)' whereas at 1 an option would be 'unlikely to achieve planning consent'.

Flexibility

The definition of flexibility gave rise to a long and interesting discussion. Conceptually, flexibility is about two things. One is the ability to provide for future choice, the other is the need to avoid imposing burdens on the future. The latter is covered in the workshop on burdens on future generations. For this workshop it was proposed that flexibility should be conceived in terms of an option's ability both to provide for choice (in terms of availability of resources and opportunity for decision making) and to respond to changing circumstances. This is the positive aspect of intergenerational equity by comparison to the negative aspect of passing on burdens.

Within this context three further issues were debated.

One was the use of a 300 year time span. While it was recognised this was arbitrary and problematic it was conceded that a common scale was necessary for comparing unlike options.

Second, is the question, once again, of siting. Clearly certain aspects of flexibility can only be applied to specific sites. However, it was accepted that the workshop could only go so far and would have to work within the generic siting framework.

Third, there were three sub-criteria (adaptability, monitorability, retrievability) under flexibility. There was much debate over whether retrievability and monitorability should be criteria in their own right (as had been pressed at some of the PSE meetings). But, a majority came to the view that these were means to achieve flexibility and not criteria. Indeed it might be argued that retrievability was an option and should not be privileged over other options.

In conclusion it was agreed to bring the three sub-criteria together under one criterion leaving the scoring system to underline the vital role of retrievability and monitorability (as well as adaptability) in determining flexibility. The criterion is now rendered as: 'to allow for future choice and to respond to unforeseen or changed circumstances' (with a note on the 300 year time-scale).

In terms of scoring, a 9 signifies a system that is fully monitored, is fully adaptable and waste is easily retrievable using existing systems. At the bottom end, a 1 is accorded where waste retrieval is very difficult, the system not adaptable and monitoring options severely restricted.

Proximity

While it would be simple to identify whether options indicated many or few actual sites it would be impossible to reach a consensus on whether proximity was a good or a bad. It was essentially an ethical issue. There were interesting questions as to whether it was more ethical to provide a site in a remote location and whether it was unethical to place wastes in densely populated areas. There were ethical issues about the non-human environment also to be considered. However, it is not possible to achieve a consensus on what is right or wrong since proximity is an incommensurable value. Consequently, it was agreed to drop proximity as a criterion for the purposes of MCDA and to leave it to be dealt with within the ethical/implementation discussions on intragenerational equity.

Some trial scoring was undertaken which demonstrated the need to recognise that the numerical intervals in scoring schemes do not necessarily reflect the level of difference in value (i.e. 1 to 3 may be a bigger difference than 3 to 5 and so on). There was acceptance of the utility of numerical analysis but only as an aid to decision making. The valuable contribution of the specialist workshops is to identify key issues and to provide a consistent basis for judging the performance and validity of options.

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11. Lessons or actions for CoRWM (e.g. what we need to do differently at the next such event) and implications for future PSE:

Most of the relevant points are covered above. Two further observations.

The role of CoRWM members is important but needs to be clear. They are not there as specialists (though they may have specialist expertise). Primarily they

are there to listen, to offer information and to ensure that deliberations are relevant to our purpose. Apart from the requirement of writing a report like this there doesn't seem to be any point in differentiating roles since both members can observe and participate. However, the observer role of the Dalton appointee needs to be clarified. It might be helpful to invite them to make some observations on the process during the course of the meeting.

As to future PSE there will be value in identifying key outcomes but it will be necessary to avoid overloading with detail. What would be interesting is to identify those areas where ethical aspects have emerged and which will require deliberation in CPs and stakeholder events.

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12. Outcomes: (attach / refer to separate reports on

- information needs arising from the workshop (NNC will write this up)
- scoring systems (Catalyze will write this up)

The important outcomes are the reformulated criteria and scoring schemes from this workshop. Reference is made to these in 4 above with a full outcome to follow. It was felt that any information needs arising would be relatively easy to compile.

Since the workshop completed its task there is no immediate need for a workshop beyond what is anticipated for the MCDA process.

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13. This note written by: Andrew Blowers

Specialist workshop summary

To be completed by CoRWM Member.

1. Date, place and title of meeting:

Cost

22/23 Jun 05, Gray's Inn, London

2. Who attended - name, organisation and capacity (e.g. specialist, facilitator &c):

Participants:
Prof Gordon MacKerron, CoRWM (Day 1)
Dr Roy King, UKAEA
Gordon Bryan, Nexia Solutions
Brendan Breen, Nirex
Nick Edmunds, Wardell Armstrong
Dr Mark Crawford, Galson, DPA
Dr Les Mitchell, LAM Consulting
Fred Barker, CoRWM

Observers – 2 from DEFRA (Dalton Panel)

Facilitators – Mike Egan and Bob Kitchen

3. Summary of the event (i.e. agenda annotated to show broadly what discussion took place):

Development of costs scoring scheme, and identification of information needs through review of DP (which was used heavily).

4. Highlights (i.e. your observations on items of particular significance):

a) The scoring scheme is simply total costs in £. There's no need to tie specific costs to the numbers 1-9.
b) The view was expressed that cost should be considered as a consequence not the driver of option selection, but that cost estimates should be used to inform discussions/decisions about what it might be worth paying for.
c) A need to identify total costs led the group to focus on the key building blocks required to develop cost models. This raised questions about key assumptions re building blocks e.g. to get 300 years of storage you wouldn't build 50 year stores and replace them 6 times as currently

assumed in the DG. Instead you'd seek to design a store with a life of 300 years. This is an example of how the discussion of costs can help identify significant improvements to option descriptions.

d) This approach also led to a perceived need to identify and cost more variants ("alternative realisations") than currently identified by CoRWM. These additional variants include (i) storage over three specific time periods 50 years, up to 300 years, and up to 1000 years, and (ii) co-deep disposal of ILW/SF/VHL, and separate repositories for ILW and SF/VHLW.

e) The need to identify total costs also provides a strong driver to look at option combinations, so that all wastes/materials are covered, and so that a long-term management strategy is taken through to completion. The latter raises the question of what costs to add on for whatever might follow long-term interim storage. The view of the group was that deep geological costs give you a rough, but very uncertain handle on this.

f) The group is very concerned to make cost estimate ranges as robust and comparable as possible (but recognise there will always be significant uncertainty). We reviewed how to do this, including what to take into account to establish equivalent bases for cost estimation across options, what the major uncertainties were and how these might be reduced through further information provision.

g) The group were unsure about how to treat the project risk categories in the DP (high, medium and low) and wondered whether these were in essence being addressed through discussions on implementability, or needed to be turned into potential additional cost ranges.

h) The group felt that once cost estimate ranges had been improved, it would be useful to focus on key cost differentials e.g. what's the increased cost of dispersed storage v centralised storage, 300 year storage v 50 year storage, separate deep repositories v co-disposal etc.

i) A specific point about the need to try to avoid having to re-package wastes came up. This carries a substantial cost detriment and worker dose challenges.

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5. Lessons or actions for CoRWM (e.g. what we need to do differently at the next such event) and implications for future programme, including PSE:

Implications for CoRWM are:

a There's no need for a September cost w/s

b Non-CoRWM participants in the cost w/s are entirely from the industry or consultants to the industry. This means that the only participants with a track record of informed external criticism of industry costings are from CoRWM. Although this is not necessarily problematic, it does mean that Gordon and I need to maintain a close involvement in the work of the group.

c We should view the specialist strand and MCDA process as helping to inform our thinking on developing/optimising option definitions and combinations. This presents challenges for the audit trail, transparency and coordination across the programme, but is a valuable output.

d The cost w/s wants CoRWM to clarify/develop its thinking on option combinations, including how to tackle the issue of post storage costs when deriving total cost estimates.
e The w/s wants CoRWM to test its assumptions for 'protected' storage options with OCNS – are they realistic, are they comprehensive enough, difference between centralised/dispersed requirements?
f The w/s wants more accurate terms than 'unprotected'/protected
g one participant developed a decision tree approach to help CoRWM think about how to identify preferred options. This needs to be fed into the proposed integration group.
h once cost estimate ranges are available, profiles of estimated expenditure over time could be developed, as long as CoRWM has developed its thinking on key steps in option combinations over time. The sooner work is progressed by CoRWM on the latter the better (see 5c as well).
i There is a need to iterate between the different criteria workshops to avoid double-counting. We need to devise a process to tackle this.
j Larry has suggested a September w/s for 'representatives' from each w/s to take an overview of progress to date, including overlaps/synergies between groups, and identify how to move forward in an integrated way. This suggestion needs careful review. In particular, is this the role of 'representative' from each w/s or for CoRWM participants/observers with the facilitation team?
k we need to decide whether and if so to expose provisional scoring schemes to wider stakeholder comment.

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6. Outcomes: (attach / refer to separate reports on
- information needs arising from the workshop (NNC will write this up)
- scoring systems (Catalyze will write this up)

Sam Usher attended day 2 of the cost w/s and has devised an appropriate process for developing the cost DP, which will then inform the option scoring in December.

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7. This note written by: Fred Barker

Specialist workshop summary

To be completed by CoRWM Member.

1. Date, place and title of meeting:

Safety

6/7 July 05, Gray's Inn, London

2. Who attended - name, organisation and capacity (e.g. specialist, facilitator &c):

Participants:

Prof Maxwell Irvine – Manchester University
Dr Mike Thorne – Consultant
Dr John Cooper – HPA (formerly NRPB)
Dr Dudley Goodhead
Bruce McKirdy – Nirex
Dr Ian Fairlie
Dr Adrian Bath - Intellisci
Dave Bennett – EA
Prof Neil Chapman – Consultant (Day 1)
Ian Barraclough – Enviros
Prof John Mather – University of London
Prof Rae MacKay
Prof Gregg Butler – IDM (Day 1)
Glyn Davies – NII
Dr Roger Coates – BNG
Clive Young – DfT
Dr Doug Parr – Greenpeace (Day 1)

CoRWM Participants: Dr Mark Dutton and Dr Wynne Davies

Observers: Dr Mike Tas DEFRA (Dalton Panel)
David Collier CoRWM Independent Evaluator

Facilitator: Larry Phillips

Recorder Lynn Mulelly - NNC

3. Summary of the event (i.e. agenda annotated to show broadly what discussion took place):

Day 1:
a.m. Plenary session to introduce the process
H&S discussion group introductions and statements of positions/motivation
Presentations on discussion papers from Gregg Butler and Ian Barraclough

p.m. Development of scoring scheme for Public Safety criterion (<300 years)
Presentation of draft scoring scheme to Plenary

Day 2:
a.m. Testing of initial scoring scheme using "Macbeth" software

p.m. Combined session of H&S specialists with Security specialists to clarify boundaries between the two groups. (following lunchtime discussion between the two facilitators)

Note: Day 2 (7 July) was disrupted by the tragic bombings in London. Several members had to leave early .

4. Highlights (i.e. your observations on items of particular significance):

- Waste should be assumed to be conditioned (in an appropriate way to its disposition). There is pressure for some materials to be conditioned "early". Spent fuel would need significant conditioning before it could be disposed.
- Is safety a "discriminator"?
- Best to try to avoid the term "Risk" in communication. There are 3 dimensions 'dread' vs. controllability; unknown vs. known; and number affected.
- In discussing the Public Safety Criterion, routine events in the period < 300 years are not likely to be discriminating. Focus should be on non-routine events and uncertainties.
- Example given of Yucca Mountain where emplacement now was conditional on action to be taken in 200 – 300 years.
- Assuming a 300 year period of institutional control may be optimistic (e.g. Civil War 300 y ago) but total collapse not thought feasible – i.e. some ability to regain control likely. Need a paper on "Institutional Control".
- Distinction between Safety and Security seen to be –
    i. (Safety) internal property of system – mechanical/people
    ii. (Security) – perturbations external from system – malicious.

5. Lessons or actions for CoRWM (e.g. what we need to do differently at the next such event) and implications for future programme, including PSE:

Implications for CoRWM are:

Need for follow up session to develop schemes for remaining sub-criteria (Additional workshop of (say) 2 days in September)

Need to check for overlaps/loss of information by reviewing all workshop criteria together

Need clear definition of all assumptions and a consistency of them across all criteria

Need for facilitator to have knowledge or support in technical areas

Need for CoRWM members to distinguish when acting as "specialist" or giving a judgement on behalf of CoRWM

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6. Outcomes: (attach / refer to separate reports on
- information needs arising from the workshop (NNC will write this up)
- scoring systems (Catalyze will write this up)

This note written by: Wynne Davies

Specialist workshop summary

To be completed by CoRWM Member. .

7. Date, place and title of meeting:

Security Workshop

6/7 July 2005, Gray's Inn, London

8. Who attended - name, organisation and capacity (e.g. specialist, facilitator &c):

Bob Kitchen, Catalyze, Facilitator
Pete Wilkinson, CoRWM
Fiona Walthall, CoRWM
Jen Barnes, NNC
Professor Bill Gelletly, Prof Dalton's Scientific Panel, Observer, joined day 2
Dr Roger Howsley, Director of Security and Safeguards, BNFL
Roy Millard, Facilities & Security Manager, Nirex
Mycle Schneider, World Information Service on Energy and Consultant
Professor Gordon Thompson, MIT
Dr Frank Barnaby, Oxford Research Group
Ian McNair, HSE
Dr John Reynolds, Deputy Director, OCNS
Dr Matt White, Galson Consultant and discussion paper author

9. Summary of the event (i.e. agenda annotated to show broadly what discussion took place):

NB The 7th July was the day on which three bombs were detonated on the London tube network and one on a London bus. The latter was close to the venue and some specialists in above ground meeting rooms heard the explosion. Events were, understandably, somewhat overtaken by external events on the 7th and while this report seeks to give an accurate account of what occurred in the workshop, it should be bourn in mind that the latter stages of the workshops were disrupted and disjointed.

6 July
0900 – 1000 Plenary briefing from Gordon MacKerron, Mark Dutton, and Larry Phillips

Matt White presented his discussion paper and made the following points:

- nuclear plants are not particularly attractive targets for terrorists in that they are not 'spectacular' in the way that, e.g. chemical plants might be perceived.

- There is uncertainty about what 'protection' means in the CoRWM waste management options.

- The security threat and hence the protection which should be afforded is different for different waste streams.

- Disposal options still require safeguards to prevent retrieval by terrorists.

- There is vulnerability in the transport phase across the options.

In open discussion, specialists agreed that the concept of 'terrorist attack' was too narrow and that the considerations of the group should embrace the effects of war. Furthermore, overall bounding conditions on the issue were difficult to identify and agree, e.g. what weaponry would we require a facility to withstand? It was agreed that the assumption was that the time perspective was 'now' and that rather than look specifically at weaponry, we would use 'energy input' as the means by which, in the case of direct terrorist attack, radioactivity could be released. There was much discussion about the possible use of LPG tankers as a weapon in this respect. Further discussion went on to agree that the larger the explosion the lower the probability of attack which lead to the question, are we confident we can keep in place mitigating processes to guard against attack over a 300 year period?

It was suggested that a 'deeper the safer' approach might help with developing a scoring system but this was rejected as being too simplistic. The rationale for this was somewhat explained by a long debate as to the conditioning of wastes for storage. It was felt that the different ways of conditioning spent fuel in particular would have very important impacts on the way in which the material was secured from terrorist intrusion. This lead to an information need captured elsewhere. Essentially, specialists required to know the technical specifications for conditioning for all CoRWM waste/material streams.

The group eventually agreed on the following assumptions:

- We are only considering future legacy wastes from current reactors but would be required to be aware of other CoRWM scenarios

- Spent Magnox fuel may be part of the CoRWM inventory

- LWR fuel will be around in unconditioned form for 100 years

- The group would assume a Nirex LOC standard for waste going to a repository as a guarantee of suitability of conditioning.

It was agreed that the condition in which spent fuel in particular would be made acceptable for a repository was important and that the scenarios envisioned should be made consistent with the scenarios explored in the cost workshop.

It was finally agreed that this information would only be relevant for the scoring phase and that it did not materially affect the ability of the group to develop a scoring system.

1345 – 1630

There was a long debate about criteria and sub-criteria and it was agreed that the measure to be used to determine the scoring scheme would be confidence in the security system. The agreement was characterised as 'high to low confidence of protection against foreseeable scenarios of a large/sophisticated attack. 'Confidence' could be broken down into a number of constituent parts:

Hitability
Survivability
Accessibility
Dispersability
Inventory (how big and nasty??)

And on this basis, the score of 9 would give 'high' confidence and the score of 1 would give 'low' confidence. However, it was agreed that only the 'confidence' element of the problem had been addressed and that the scale of the attack and how to measure it had not been discussed. Neither had the issue of 'misappropriation'.

1630 – 1700 Plenary report back

7 July
0900 – 1300 After lengthy discussion it was agreed that the identification of the sort of threat facilities should be robust enough to withstand was a vexed area around which no consensus could be reached. It was suggested that the group used the Design Basis Threat approach in which the OCNS would require of an operator assurances that facilities would be robust enough to withstand a range of threats contained within the DBT. Some specialists felt that this approach was too opaque and did not give sufficient visibility to the sorts of threats envisioned. It was agreed that the phrase 'all conceivable and foreseeable threats' would be used. A brief discussion took place as to the importance of the regulatory view as use as a discriminator but it was agreed to apply the regulatory yardstick after the options had been ranked in December and that it did not affect the ability for long the scoring scheme to be developed.

One key issue which had surfaced several times in the discussion was that of whether the group was looking at a scoring scheme which took into account the possible effects of a breach of security in terms of radiological impact or whether the group's remit should stop at the review of how robust the options were to terrorism and misappropriation of material. At lunch on the 7th, the two facilitators of the security and safety workshops met and as a result of their discussion decided to bring the two groups together to ensure there was no

double accounting taking place and no overlap in terms of the issues being taking individually into account. As a result of this meeting, it was agreed that security would concern itself with 'malicious' acts leading to 'harm' and 'public disquiet and fear', while safety would look at 'non malicious acts' leading to 'public and worker harm' and 'public disquiet and loss of confidence.' Non-malicious was defined as 'human error, design failure and accidents' while 'malicious' was defined as 'any purposeful action designed to cause harm.'

Fiona Walthall and Pete Wilkinson agreed a way forward subsequent to the workshop and all attending specialists have been contacted.

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10. Highlights (i.e. your observations on items of particular significance):

Insufficient time available to complete this section

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11. Lessons or actions for CoRWM (e.g. what we need to do differently at the next such event) and implications for future PSE:

In sufficient time to complete this section.

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12. Outcomes: (attach / refer to separate reports on

- information needs arising from the workshop (NNC will write this up)
- scoring systems (Catalyze will write this up)

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13. This note written by:

Pete Wilkinson 18 July 05

Appendix to Security Report

Email from Fiona Walthall to Security Specialists

From: Fiona Walthall
Sent: 08 July 2005 19:14
To: Matt White; John Reynolds; Iain McNair; Frank Barnaby; Gordon Thompson; Mycle Schneider; Roy Millard; Roger Howsley
Cc: Gordon MacKerron; David Collier; Sam Usher; Lisa Albino; Sue Sadler; Bob Kitchen; Pete Wilkinson; Mark Dutton; Wynne Davies
Subject: CoRWM Security Workshop

Dear Matt, John, Iain, Frank, Gordon, Mycle, Roy and Roger,

Thank you all for attending CoRWM's Security workshop over the last 2 days. We put in an enormous amount of work over the 2 days, wrestling with some very tricky areas. The fact that our thinking changed as we progressed showed the real value of having a mixed group of people contributing their knowledge and expertise. I certainly felt that we were really beginning to focus on something meaningful by lunchtime of the second day. Although the afternoon discussions were something of a hiatus, it was critical to bottom out what the boundaries of Security and Safety were in relation to each other. It was precisely for this sort of reason that we had grouped Safety and Security together when we organised the criteria workshops.

We thought it important to make contact with you as soon as possible so that you are not left wondering what the situation now is in view of the fact that neither group managed to complete the scoring schemes. We are also conscious that some people had to leave before 5 pm, and are not aware how the joint discussion ended. We did eventually agree that the Security group should continue to look at malicious attack, as defined in our group, and that the Safety group should consider all other potential causes of harm. There is still a small area of uncertainty about how far the Security group should go in examining the consequences of malicious attack, but I don't believe this affects the way we were proceeding with our scoring scheme. Both groups will consider both the physical impact of any event, and the political and social impact, and both will take temporary loss of institutional control into account.

At this stage we believe this means little, if any, change for the work of the Security group. We therefore have a fairly well developed scoring scheme for the attack criterion which we were in the process of testing. Pete and I hope that he and I can do some work on behalf of the whole group to tidy up the loose ends for this criterion, and perhaps even try testing it ourselves. We also think that the misappropriation criterion may be able to be tackled with a very similar scoring scheme. We will therefore try working one up and see how far we can get. When we have gone as far as we feel able to do, we will pass the results to all of you for comment. There is absolutely no intention of trying to steer the group in any particular direction, or of leading the process. The scoring scheme MUST be something developed by the whole group of specialists, and not by CoRWM

members - that is the whole point of asking you to contribute to this stage of our work. We merely hope to consolidate on the excellent thinking that we were privy to in the Security group to ease the future work of the group.

The result of this process will govern what should happen next. We will see whether the group feels it needs to meet again in order to complete the scoring schemes, and if so for how long. It is conceivable that we may be able to complete the process by e-mail or telephone conferencing. If we do need to meet again, it will probably be in September so that there is still time to gather together any information needs identified before the actual scoring of options in December.

In the meantime, if anyone has any comments or suggestions, either for Pete and I, or for the whole group, please let us know. Indeed it might be rather useful to have an e-mail group so that we can all feed thoughts and ideas to each other as things occur to us. It would also be good if you could circulate any reading material that you feel other members of the group would find useful.

It was an extraordinary day yesterday, but one of the most impressive things was the way you all managed to continue to focus on the work we were undertaking despite the tragic events occurring outside. Thank you so much for that, and I hope you all got home safely.

Best wishes

Fiona and Pete

Specialist workshop summary

To be completed by CoRWM Member.

8. Date, place and title of meeting:

Environment

6/7 July 05, Gray's Inn, London

Due to circumstances outside of CoRWM's control, it has not been possible to produce a CoRWM Member's report of the full workshop.

An abbreviated account will be included in this report when available.

Doc 14

CoRWM(03)1st

COMMITTEE ON RADIOACTIVE WASTE MANAGEMENT (CoRWM)
MINUTES OF FIRST MEETING, 17-18 NOVEMBER 2003

1. **Present**: Katharine Bryan (Chair), Mary Allan, Keith Baverstock, David Ball, Fred Barker, Andy Blowers, Wynne Davies, Gordon MacKerron, Lynda Warren, Jenny Watson (17 November), Pete Wilkinson.
   Secretariat: Steve Mansfield, Katherine Mondon, Caithriona Porter, Adam Scott (Secretary).

Item 1 - Apologies

2. Mark Dutton and Brian Clark sent apologies for absence.

Item 2 - Introduction by the Chair

3. The Chair congratulated Members on their appointment and welcomed them to CoRWM. In her introductory remarks, the Chair explained that CoRWM must fulfil as many as possible of stakeholders' expectations. It must deliver on its remit; it must also be seen to be independent. It would need to agree its work programme with Ministers in the next few months. Its foundation would be teamwork and a strong sense of shared purpose. Meetings should be conducive to good decision making, so if any Member had a concern they should say so.

Item 3 - Introduction of Members

4. Members introduced themselves, describing their skills and experience of relevance to CoRWM.

Item 4 - Introduction of the Secretariat

5. The Secretariat introduced themselves: Steve Mansfield, Katherine Mondon, Caithriona Porter and Adam Scott. Chris Harvey and Tarsam Bains would join in December. Their roles would depend on the programme and structure decided by the Committee.

Item 5 - Discussion of "housekeeping" issues (Guidance notes 3-5)

6. Members had accepted CoRWM's Terms of Reference and Code of Practice on taking up appointment. The Secretariat presented 3 further guidance notes on

   – Registration of interests and conflicts of interest;

   – Hospitality and gifts; and

   – Travel and subsistence costs.

7. **Registration of interests and conflicts of interest**: Members are required to declare their interests which will then be published. The Committee noted the guidance. It agreed that Members should also declare an interest, at the start of a meeting, in any issue in which a conflict of interest might arise or be perceived. They should do this even if they had previously entered the interest in the register: they should not assume that other Members would remember and so be aware of the potential risk of conflict.

8. Members declared the following interests in the November agenda. Fred Barker declared his interest in as an Associate with Enviros, Andy Blowers declared his interest as a Nirex Board Member, and Pete Wilkinson declared his involvement in environmental NGOs and his interest as a consultant.

9. **Action: the Secretariat would write to all Members asking them to declare their interests.**

10. **Hospitality and gifts**: the Committee noted the guidance.

11. **Travel and subsistence costs**: the Committee noted the guidance. It agreed that the Secretariat would not arrange travel unless this was part of a trip which it was already organising. It also agreed that road travel or taxis could be more cost effective than public transport in certain circumstances but these should be justified in each claim.

12. **Action: the Secretariat would amend the guidance to reflect the Committee's suggestions.**

Item 6 - CoRWM's programme: the Government's perspective (Paper from Defra)

13. Robert Jackson (Defra) gave a presentation on Ministers' requirements of CoRWM, and answered questions from Members. CoRWM's co-sponsors in England, Scotland, Wales and Northern Ireland had commissioned ideas (see next item) on how CoRWM could go about its work, but it was for the Committee to decide its own plans. Its budget would be agreed

with Ministers together with its detailed work programme. Robert Jackson would be sponsor Ministers' point of contact with CoRWM.

Item 7 - Why CoRWM needs to engage with the public and stakeholders

14. Jacquie Burgess (Professor of Geography, University College London) and Stewart Holderness (WS Atkins, on contract to Defra to provide project management advice) attended for this item.

15. Jacquie Burgess said that CoRWM's public and stakeholder engagement (PSE) programme should be open and transparent, have clear objectives, and combine intensive and extensive engagement methods. The PSE programme also needed to be carefully integrated with the provision of information, research and expert input.

16. Defra had commissioned a public and stakeholder engagement workshop, held in March 2003 in Manchester, to develop criteria to define the effectiveness of any engagement programmes, to outline 3 possible 2-3 year programmes with different budgets (£300,000 per year, £500,000 per year and £750,000 per year), to recommend how they could operate alongside the more technical elements of CoRWM's programme, and to highlight risks and opportunities. The workshop report was on Defra's website. It found that the £300k programme presented many risks, the £500k presented fewer risks, but the £750k programme did not significantly reduce the number of risks further.

17. Defra had then commissioned UCL to prepare an outline PSE programme for CoRWM assuming a £500k / year budget. This too was on Defra's website. It included intensive and extensive engagement, opportunities to reflect and adjust the programme, and a "front end" preparation stage, a proposal that resulted from the workshop.

18. Stewart Holderness said that there were key project management issues and steps. These were relatively constant whichever programme CoRWM decided. Time, cost and quality were fundamental elements. Reducing any one affected the others - e.g. reducing the amount of time available might increase the risks or lower the quality of the output. In any project, there were limits on all of these. It was a relatively simple process to convert (say) the UCL outline into a programme plan that could be agreed with Ministers.

19. A number of points were made in discussion:
    - The project itself would be complex and there were a number of risks which should be registered at the start. For example:
    - There were significant uncertainties e.g. about where engagement will lead and how supporting technical inputs could be integrated. It could run out of time or money.
    - We would need to combine intensive and extensive processes of engagement, but relevant experience of doing this was limited.
    - The UCL PSE programme implied a final report in 2006. This could perhaps be shortened; for example, by investing in the early (framing)

stages of the programme, it might be possible to save time on the main options-assessment and reporting stages. The programme should not be too long as it could be harder to sustain public and stakeholder interest.

20. The two presenters then left the meeting.

Item 8 - Discussion of the two presentations

21. The following points were made:
    - Robert Jackson's presentation was instructional, describing Government's wishes for CoRWM. The second presentation was illustrative and designed to generate debate on how the PSE programme might be achieved.
    - However, it might have been better to have an un-charted discussion of what CoRWM should do before being presented with a plan of how it might do it. The Committee should step back and look at its whole task.
    - CoRWM also needed to be clear about its objectives, and define the boundaries of its remit and how to deal with issues that did not fall within its terms of reference.
    - There were various approaches to PSE, such as those used in British Nuclear Fuels' National Dialogue and the Ministry of Defence project ISOLUS on nuclear submarines; CoRWM would need to consider what could be learnt from such approaches.
    - Once CoRWM had considered these issues, it could look more closely at the UCL proposals to see how fit they were for its purpose.
    - CoRWM should define the right process then ensure that its sponsor Ministers were committed to supporting its programme and timescale.

22. CoRWM had an indicative total budget of £850,000 for the financial year 2003/4, £1,285,000 for 2004/5 and £825,000 for 2005/6; though confirmation of this would depend on CoRWM agreeing a work programme with Ministers. Delays in Ministers appointing CoRWM meant that the programme and budget would need to be spread over a different timescale.

23. The Committee decided that it would discuss its remit and objectives, including success criteria and risks, and looking at alternative PSE models, with advice from the Secretariat, before considering what work programme or structure might best achieve those objectives. It would do this at the next meeting on 8-9 December 2003. It should hold an early discussion on the nature of wastes and potential wastes, and also public concerns about these.

24. The Committee also discussed the role of individual Members. It would take time to get to know one another and how Members could work together and control the process. The process would be dynamic and rigid structures should not be set in place at an early stage. Members had many skills, including for example drafting papers and communicating with

the public. A first step would be to register Members' individual skills. All Members must be equally valued with no "inner circle", and any working groups must communicate well with the rest of the Committee.

25. The Committee agreed that all Members had a shared responsibility to ensure that CoRWM delivered its objectives, and that once decisions had been taken all should share a corporate view. At the same time, each should have an individual role which would evolve over time.

26. Action: the Secretariat would arrange for a discussion of CoRWM's remit, principles and objectives at the December meeting.

Item 9 - Issues for approval at this meeting

27. The Secretariat presented proposals on

- dates for future meetings;
- location, format and length; and
- recording, presentation and publication of minutes.

28. Dates for future meetings : the Committee agreed to meet on 8-9 December 2003, 14-15 January, 9 February, 1-2 March, 1-2 April, 6-7 May, and 10-11 June 2004.

29. Location, format and length : the Committee agreed that the next meeting should take place in London; thereafter meetings should be held in different locations in the UK accessible to the public. Some meetings might be held over two days and some might be concluded within a day. Until the Committee's work programme was clearer, Members should keep all these dates clear in their diaries.

30. The Committee would also consider how many of its meetings could be held in public, and how the public could be encouraged to attend. The Secretariat should prepare proposals for the December meeting.

31. Recording, presentation and publication of minutes: the Committee agreed that the draft minutes of one meeting should be circulated for agreement at the next meeting then published, for example on the CoRWM website. The Secretariat would prepare a draft of the November meeting for Members to decide at the December meeting what style and content was appropriate. A brief summary of the outcome of each meeting could also help people to follow CoRWM's work.

32. The Committee did not decide whether minutes should be attributable (summarising who said what) or whether they should just summarise what points were made and conclusions reached. Some felt that attribution would make the Committee's decision making more transparent; and if meetings were held in public, people would know anyway who said what.

Others felt that attribution could inhibit some Members from expressing their views freely and undermine the quality of decision making.

33. **Action: the Secretariat would plan for meetings on the dates agreed by the Committee; draft proposals for some meetings to be held in public; prepare a summary of each meeting; draft the minutes of the November meeting for Members to decide at the December meeting whether the style and content were appropriate; and arrange for their publication once approved by the Committee.**

Item 10 - Overview of Items for next day

34. The Committee met over two days. There was a brief discussion at the end of the first day about how to take items on the second day.

Item 11 - Items for discussion, with decision at the next meeting

35. The Secretariat presented proposals for preliminary discussion, and for decision at the next (8-9 December) meeting on

- options for managing the CoRWM programme * (**paper CoRWM(03)1/1**);
- a CoRWM publications scheme * (**paper CoRWM(03)1/2**); and
- CoRWM values and principles.

36. Options for managing the CoRWM programme. The secretariat suggested various options for managing the CoRWM programme. The following points were made in discussion:
    - The Committee should retain ownership of the programme but could benefit from expert help in managing it.
    - Having technical and PSE subgroups could work against an integrated process; it might actually be less divisive to have several smaller groups, each running until its purpose was achieved.
    - These would need to be well co-ordinated to ensure that the Committee kept its focus.

37. The Committee agreed that the Secretariat should develop further proposals to follow CoRWM's discussion of its objectives and work programme.

38. A CoRWM publications scheme. The scheme had to be lodged with the Information Commissioner by February 2004. It had been sent to him in draft and the Secretariat anticipated that it would meet his requirements. There would be another opportunity in December to consider the draft. The Committee might also discuss what would be needed to generate a comprehensive policy on transparency. That discussion would probably not be completed by February but, if the result was a combined paper on transparency and publications, a revised scheme could be lodged later.

39. Members suggested a number of changes to the draft publications scheme, including more information about making publications accessible to people with a disability or people with English as a second language.

40. The Committee decided that the draft scheme should be lodged subject to a number of amendments: the Secretariat should prepare a revised draft to be agreed at the December meeting. The Secretariat should design a system for numbering key documents for early adoption by the Committee.

41. CoRWM values and principles. The Chair said that CoRWM was expected to have a number of guiding principles, noted in its Code of Practice. It should consider whether additional policies were needed. The Committee decided to include this as part of its discussion on its objectives and work programme.

42. Stakeholder concerns. The Committee noted that a number of difficult issues could come up very early in its work programme. For example, there were concerns among some stakeholders about the decision-making and selection processes followed by Ministers in setting up CoRWM. It was agreed that this was not a matter that CoRWM should comment on as it was not privy to the selection process. Others were concerned about representation of individual parts of the UK on CORWM; while others were concerned about the types of waste falling within CoRWM's remit.

43. The Committee agreed that it should be informed of stakeholder concerns at the earliest available meeting so that it could judge how best to respond. In doing so it would need to take account of which issues were within its terms of reference, and which were matters for Government. It decided that the Secretariat should prepare a regular correspondence return so that Members knew what issues were being raised. And the Committee would discuss, at the December or January meeting, how it wished to proceed with discussions of what types of waste fell within its remit.

44. Action: the Secretariat would prepare proposals for managing CoRWM's work programme for Members to consider following their discussion of its remit and objectives at the December meeting. Members would consider values and principles as part of the discussion of its remit. The Secretariat would present a revised draft of the publications scheme for the December meeting as well as a correspondence return and proposals for numbering key documents. It would arrange for a discussion, in December or January, of how it wished to proceed with discussions of different types of waste.

Item 12 - Items for information

45. The Secretariat presented reports on:
   - Department of Trade & Industry (DTI) regional stakeholder workshops;
   - the Royal Geographical Society (RGS) *Environment and Society* event on 14 January 2004;

- the Radioactive Waste Management Advisory Committee (RWMAC) report on partitioning & transmutation;
- a communication strategy; and
- a forward look.

46. DTI regional stakeholder workshops: Katherine Mondon reported on recent stakeholder workshops to help the DTI draw up a draft stakeholder engagement framework for the proposed NDA. It would also be important for CoRWM to engage with communities near nuclear sites. The Chair and Secretariat members had attended several of these workshops, to tell people about CoRWM and to learn whether and how they and their communities would like to be involved in its work.

47. DTI's Liabilities Management Unit had asked for a meeting with the Chair which would be held on 2 December. The Committee agreed that the meeting should also include DTI's policy team who were setting up the NDA and its stakeholder strategy. Those Members interested in attending would contact the Secretariat. It would be important for CoRWM and the DTI to avoid duplication of effort PSE.

48. RGS event: Katherine Mondon described the RGS proposals for an evening meeting and dinner on 14 January to discuss issues relating to PSE on radioactive waste. Such RGS meetings were normally sponsored. Defra had provided £4,000, partly to facilitate attendance by a wider range of stakeholders including NGOs. RGS hoped that most CoRWM Members could attend: several had already agreed to speak, and Wynne Davies agreed to table a background paper on radioactive wastes on behalf of CoRWM.

49. RWMAC report on partitioning & transmutation (P&T): Steve Mansfield reported on the paper, commissioned by the former Minister Michael Meacher, which RWMAC had presented to Ministers and proposed to publish shortly. P&T - one option for dealing with some radioactive waste - depended on a long-term nuclear power programme. The UK Government had neither opted for or against such a programme in its recent Energy Review: Gordon McKerron agreed to provide a background note on energy policy. BNFL were giving a P&T presentation to Defra on 24 November and any Members interested in attending could contact the Secretariat.

50. Communication strategy: Katherine Mondon reported on plans for setting up CoRWM's website and for commissioning advice on using the media in support of CoRWM's PSE work.

51. The first phase of the website was complete: it had been set up by W S Atkins under contract to Defra. It contained basic information about CoRWM and could go "live" if the Committee agreed. It also contained enough supporting software to run a range of facilities once CoRWM had time to decide what it wanted. The second phase, therefore, was for the Committee to discuss what facilities and information it wanted to appear on the website and how it should be managed. The Secretariat would be

taught how to post material on to the site, with the contractor helping them to tackle any problems. Mary Allan, Wynne Davies and Lynda Warren offered to help develop the next phase.

52. The Committee agreed that the website should go live later that day, and that other Members interested in helping develop the next phase should contact the Secretariat.

53. Katherine Mondon said that the Secretariat had also prepared a specification for a media adviser. It proposed to ask the Central Office of Information (COI) to seek expressions of interest from among the 26 approved contractors on its list, all of which had experience of providing advice to public bodies.

54. The Committee suggested a number of changes to the draft specification. This should make clear that the media role would be logistical and advisory - helping CoRWM to publicise its work, reach more people, and provide factual information. The media work must support CoRWM's PSE programme.

55. The Committee agreed that it needed professional advice, and that the Secretariat should send COI a revised specification so that a list of potential contractors could be submitted to the Committee. The Committee itself had a range of skills and individual Members could play a leading role in communicating with the public. The Secretariat should provide a note proposing a communications strategy covering work with the media.

56. <u>Action</u>: the Secretariat would ensure a report back from the meeting with DTI/LMU. Several Members would speak at the RGS event and some might attend the P&T presentation. The Secretariat would make the website operational immediately and organise a meeting to help prepare the next phase. It would send COI a revised specification for a media adviser and ensure that a list of potential contractors was submitted to the Committee. It would also prepare a note on a communication strategy.

Item 13 - Forward look

57. Katherine Mondon reported on some events:

- The OECD Nuclear Energy Agency's Forum for Stakeholder Confidence (FSC) was currently holding a workshop in Belgium. Keith Baverstock was attending and would report back to CoRWM.

- The FSC would hold another annual meeting in Paris, in early 2004. This would provide the opportunity to update Members on its work. Any Member interested in attending should contact the Secretariat.

- The FSC had also invited the Chair to a meeting, in January 2004, of Chairs of radioactive waste management bodies.

- Enviros had been commissioned to prepare two reports for CoRWM, on international progress on radioactive waste management, and on international best practice in public and stakeholder engagement in relation to radioactive waste. The Secretariat was investigating the Enviros website on international developments with a view to taking out a subscription for CoRWM.

58. Fred Barker said that the Committee should also be aware of two other European Commission supported research projects (COWAM and RISCOM) on radioactive waste and PSE. The Chair asked Members to tell the Secretariat of any other relevant projects or events.

59. Action: the Secretariat would arrange for CoRWM representation at the NEA meetings in 2004. Members would inform the Secretariat of other relevant events or projects.

Item 14 - Draft agenda for the December 2003 meeting

60. The Committee agreed that the agenda should be revised in particular to incorporate the discussion about CoRWM's objectives and success criteria. The meeting would be extended, starting at 11.00am on the 8th until ending around 4.00pm on the 9th.

61. Action: the Secretariat would circulate a revised agenda beforehand.

Item 15 - Possible programme of briefings and visits

62. The Committee considered a Secretariat note listing possible meetings which CoRWM might undertake, many in its first few months. The main purpose was to brief members about relevant issues, rather than initiate the PSE programme.

63. The Committee agreed that the Secretariat should develop this into an outline programme. Many issues could be dealt with by presentations to CoRWM rather than visits. Among the events that should be arranged in the short term were meetings that would help prepare for CoRWM's early tasks - such as defining the inventory of wastes to be managed - and a visit to the main waste storage sites. The programme should include relevant sources of experience including France and Germany. This could involve part-time Members in a lot of work; so in some cases, individual Members could give presentations or make visits. Some early events would need to be decided and prepared soon; the rest of the programme could be developed later as part of CoRWM's main programme of work. The purpose of any visit should be clearly relevant to the work programme.

64. Issues which CoRWM could discuss soon included the question of future energy supply, which could affect the review of waste management options, and alternative decision-making processes.

65. Action: the Secretariat would propose a programme for the December meeting, and consider items for discussion at future meetings.

Item 16 - Any other business

66. The Committee considered a range of designs for a letter-head. Members each indicated which design they preferred and left the Chair and Secretariat to decide the final design.

67. Action: the Secretariat would agree a design with the Chair.

Close of meeting

68. The Chair thanked the Members for their strong contribution and lively participation. The Secretariat would circulate a summary of action points within a day or so, and draft minutes before the next meeting.

69. Action: the Secretariat would draft action points and minutes.

CoRWM questions arising from the Nirex Viability Report

1. Time Period

   We asked what period of time Nirex would justify as the time period that should be covered by a post-closure safety case and why? Paragraph 6 on Page 52 suggests that Nirex is addressing up to one million years but that predictions up to 50 million years can have little basis. What is the answer to our original question?

2. Worst and Best Case Scenarios.

   We asked for an indication of the annual dose for best and worst case scenarios. The Viability report does not do this apart from the gas pathway. On Page 53, it points out that the peak risk from the daughter products of Uranium-238 is dominated by a small number of 'realisations' in the probabilistic assessment. For each one of these, the contribution to the risk is presumably calculated from the dose associated with each 'realisation' multiplied by the estimated probability of each realisation. What is requested is the annual dose that is estimated from the best and worst realisation. It would also be helpful to have the same information for the annual dose for Cl-36 and I-129.

   The same information is requested for the HLW and spent nuclear fuel waste streams that are discussed in Section 7.

3. Isolation of depleted uranium and spent nuclear fuel from ILW complexants.

   We asked about the extent of isolation of uranium and ILW that would be required to ensure that the ILW did not have a material impact on the mobility of the uranium. The last paragraph on Page 53 does not provide any more information on this aspect than the previous version. Do we know that the co-disposal of depleted uranium and spent nuclear fuel is practicable without significantly increasing the potential annual dose?

4. Research into C14

We asked about the timescales associated with the ongoing research into the mobility of C-14. However, no information is given on Page 58 or in any other part of the report on this or any of the other research that is in progress to reduce uncertainties.

5. The Dose due to Human Intrusion

   We asked for the predicted doses due to human intrusion. This information is not given on Page 59.

6. Stability .of Pores and Fractures

   We asked for evidence on the extent to which Q, T & F can be predicted for very long times into the future and the associated uncertainties. At the top of Page 63, Section 5.1 helpfully addresses some changes that could alter the magnitude of these parameters. However, there is no discussion on the potential magnitude of these changes over the timescales of interest and how these have been taken into account in the values that have been given to the BGS, and thus on the available area that is suitable, or in Nirex, 97.

   The fact that areas are known where Q, T and F have been stable for long periods does not, in itself, preclude the possibility that there are other areas where this may not be the case. This aspect is not addressed.

7. The Sedimentary Rock Cover

   We asked about the extent that credit be taken for the sedimentary rock cover in the groundwater pathway and the uncertainties associated with the stability of this rock over many ice ages. This does not appear to be addressed in the viability report.

8. Acceptable UK Geological Systems

   We asked about the extent that uncertainties in the methodology and data could impact on the proportion of the UK that would have a suitable geology. The third paragraph from bottom on Page 78 in

Section 6.4, addresses how some uncertainties can be reduced by the appropriate choice of geology, but the report does not address the extent to which existing uncertainties impact on the proportion of the UK that is suitable.

9. The Biosphere

   We asked about the extent that creditable uncertainties can be obtained from current studies on the biosphere. This does not appear to be addressed in Section 6.5. Thus, the paper does not address the extent that uncertainties associated with the biosphere would impact on predictions for the long-term safety of the repository.

10. Copper Canister Integrity

    We asked about the current status of SKB's programme to demonstrate that the canisters can be manufactured to below the required failure rate. This is not addressed on Page 85 nor is any figure given for the design basis failure rate.

11. Reversible Concepts such as CARE

    We asked about reversible concepts. These are not mentioned on Page 86 of the report although there is a reference to CARE in the response to Q2 on retrievability in Ann's letter of 02.12.05. However, this does not answer the points raised in our earlier query namely; if a reversible concept were to be incorporated into UK policy, how much delay would be introduced into the programme for an HLW repository and do any of the stainless steel concepts, other than CARE, allow reversibility?

12. The Suitability of the Sellafield Site

    The last paragraph on Page 91 in Section 8.4 states that Nirex and the BGS believe that Sellafield is a suitable site for a repository. How does this relate to the statements in the third paragraph from the bottom on Page 78, which refers to the advantages of a site hat is simple and can be easily characterised, has a low groundwater colloid population and a low concentration of naturally-occurring complexants?

United Kingdom Nirex Limited
Nirex Report no. N/122
November 2005

Nirex Report

The viability of a phased geological repository concept for the long-term management of the UK's radioactive waste

nirex

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Bibliography

If you would like to see other reports available from Nirex, a complete list of published documents can be viewed at our website www.nirex.co.uk, or please write to Corporate Communications at the address below, or e-mail info@nirex.co.uk.

Feedback

Readers are invited to provide feedback to Nirex on the contents, clarity and presentation of this report and on the means of improving the range of Nirex reports published. Feedback should be addressed to:

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LIST OF CONTENTS

1 EXECUTIVE SUMMARY AND INTRODUCTION

Radioactive waste exists in the UK now. Some of it will remain hazardous for hundreds of thousands of years. Regardless of any decision on future nuclear energy, steps need to be taken now for its safe long-term management.

This report sets out why Nirex believes that the UK's long-lived radioactive waste should be placed in a Phased Geological Repository located between 300 and 1000m deep in stable rock. This would allow the natural process of decay to take place before radionuclides reach the surface in sufficient amounts to exceed the stringent safety requirements set by UK regulators.

The report takes the form of an Executive Summary and Introduction, followed by increasing levels of detail as we lay out the reasoning behind our views.

Viable solutions have been developed for long-term radioactive waste management. Many countries have high activity, long-lived radioactive wastes to manage. Geological disposal is the preferred option of all countries that have made a decision for the long-term management of such wastes. Most of these are now developing concepts that also incorporate retrievability and a phased approach to implementation.

In the UK, Nirex has carried out extensive development work on geological disposal of radioactive waste and more recently on its Phased Geological Repository Concept and a concept for the UK's high level waste and spent fuel. Retrievability and monitoring are essential requirements for many stakeholders and are now an integral part of the Nirex concept. The incorporation of monitoring and retrievability into a phased approach combines the flexibility of storage with the long-term passive safety of geological disposal.

Whilst technical solutions have been available for many years, there has never been successful implementation of those solutions in the UK. This report summarises why Nirex believes that its Phased Geological Repository Concept (PGRC) is the viable technical option for the long-term management of the UK's higher activity radioactive waste that can and should be implemented now.

The concept is viable in that:

- The repository system is entirely based on tried and tested technology routinely used in the mining, construction and nuclear industries.

- Its system of multiple barriers can be relied upon to provide long-term isolation and containment of the waste and hence assure long-term safety and environmental protection.

- The long-term performance has been evaluated using well established assessment tools and the results show that all relevant UK regulatory criteria can be met.

- Whilst there is further work to be done, none of the remaining issues present a fundamental threat to the viability of the concept.

- It provides a monitored, retrievable underground storage system as a positive step towards the provision of a long-term management solution that will not require continuing actions or intervention by future generations.

The UK can proceed now with implementation:

- The geological characteristics required from a site are well understood and are afforded by a significant proportion of the deep geology in the UK.

- Repository concepts are based on well developed science and technology in the UK and overseas.

- Lessons learned from past experience, extensive dialogue and links with overseas programmes that are gaining acceptance within their communities have now provided the UK with a good understanding of the overall requirements for implementation.

The repository concept should be implemented now because:

- The waste exists. It is an ethical issue and the technology to implement a solution is available now.

- Existing storage arrangements for radioactive wastes are vulnerable to terrorist attack and natural disasters and many of the facilities are unsatisfactory and long past their design life.

- The skills, resources and experience needed to implement the PGRC are available now but would need to be re-established in the future if no action were to be taken now.

This report is the product of a major review (Appendix 1) undertaken by Nirex to review the status of the PGRC as a viable option for the management of the UK's radioactive waste. This concept review included analysis of:

- Our own safety and environmental assessments of the concept.

- Regulators' scrutiny of our work and ongoing dialogue with a broad range of stakeholders including feedback on our programme under our Transparency Policy.

- Previous reviews and criticisms of our work such as the 1997 Rock Characterisation Facility Local Planning Inquiry Inspector's report, the report of the 1994 Royal Society Study Group and other related information, e.g. reviews by the House of Lords' Committee on Science and Technology (1999) and by UK Centre of Economic and Environmental Development (UKCEED, 1999).

The results of this concept review are recorded in a series of around 30 'Context Notes'. These underpin this report. They describe the current status of all aspects of the concept and reflect the hundreds of millions of pounds invested in developing this concept.

This report also identifies, and aims to be transparent about, the remaining scientific and technical issues that will require further work. Whilst this work is necessary, we believe there are no outstanding issues that fundamentally threaten the viability of the concept.

This report sets out Nirex's views based on 20 years of experience on the development of long term radioactive waste management options. We emphasise, however, that we fully support the necessity for the current Government review of radioactive waste management policy and the work of the Committee on Radioactive Waste Management (CoRWM). This

report has been prepared as an input to CoRWM and to provide information for other interested parties.

We invite and would welcome feedback and further discussion on any aspects of this paper.

2 THE WASTE

2.1 Introduction

Radioactivity was discovered at the end of the nineteenth century and radioactive materials have been in use ever since then. During the Second World War the development of nuclear weapons led to the production of uranium purification facilities, various reactor systems and nuclear fuel reprocessing capabilities. In addition the UK developed a number of reactor types for the generation of electricity using nuclear energy. Because of the type of fuel selected and the development of a number of reactor systems, the UK has a large volume and diverse range of radioactive waste.

Radioactive materials are hazardous because of the emissions associated with radioactive decay. The risk from radioactive materials reduces over time as the total activity decays. Some radioactive materials will remain hazardous for hundreds of thousands of years and therefore require long-term isolation. Other radioactive materials will decay to harmless levels in a matter of a few years and therefore require isolation for a shorter time period.

The UK has signed the IAEA Joint Convention on the Safety of Spent Fuel and on the Safety of Radioactive Waste Management and thus has obligations to provide regular updates on stocks and future arisings of spent fuel and radioactive waste. To meet its obligations, data on waste are collected via the UK Radioactive Waste Inventory. Information on spent fuel and other radioactive materials is gathered separately by DTI.

Since its formation in 1982, Nirex has been responsible for compiling the UK Radioactive Waste Inventory on behalf of the Government. The first Inventory was published in 1984 and has been progressively refined and improved since then. The UK Radioactive Waste Inventory is recognised as a model which is now being followed by other countries, such as France.

The quantity of waste declared as a volume of conditioned waste in the 2004 UK Radioactive Waste Inventory[1] is 2.3 million cubic metres (m^3). However the scope of the Inventory is limited to those materials which have been declared as waste by the waste producers. The total quantity of radioactive materials in the UK is estimated to be of the order of 20 million m^3 of unconditioned material. Details of these other materials potentially requiring long-term management have been compiled by Nirex in a separate report [1] and are summarised in section 2.2.4.

2.2 Quantities of radioactive materials

Of the total conditioned waste volume reported in the 2004 Inventory (2.3 million m^3) only about 4% (100,000m^3) would be prevented from arising if all nuclear activities had stopped on 1 April 2004 (see Figure 1). The remaining 96% (2.2 million m^3) of waste consists mainly of contaminated soils, building structures (e.g. concrete and metals), and reactor components (e.g. graphite and metals).

[1] To be published by early 2006.

Figure 1
Total radioactive waste in 2004 inventory

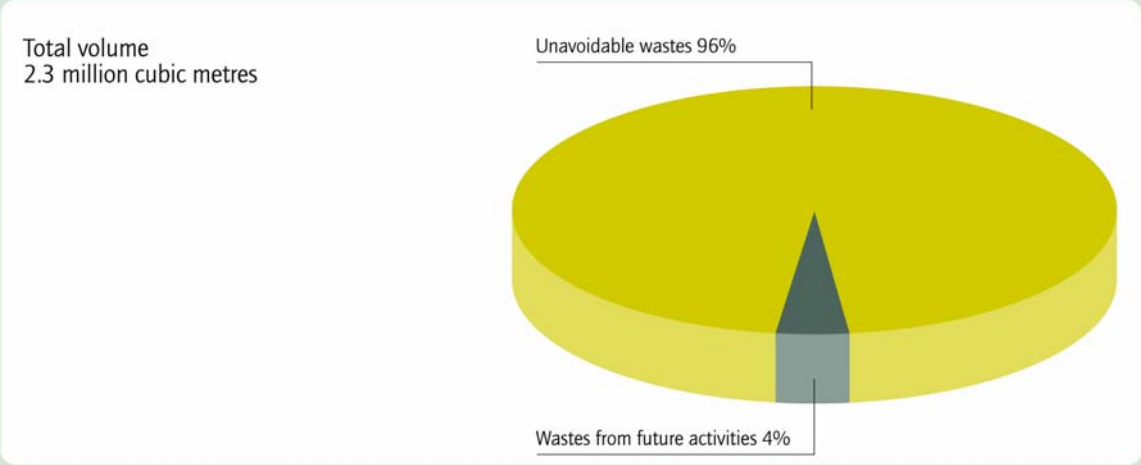


Table 1
Categories of radioactive waste in the UK

High Level Wastes (HLW)	Intermediate Level Wastes (ILW)	Low Level Wastes (LLW)	Very Low Level Wastes (VLLW)
Wastes in which the temperature may rise significantly as a result of their radioactivity, so this factor has to be taken into account in the design of storage or disposal facilities.	Wastes exceeding the upper boundaries for LLW, but which do not need heat to be taken into account in the design of storage or disposal facilities.	Wastes other than those suitable for disposal with ordinary refuse, but not exceeding 4GBq (gigabecquerels) per tonne of alpha, or 12GBq per tonne of beta/gamma activity.	Wastes that can be disposed of with ordinary refuse, each 0.1 cubic metre of material containing less than 400kBq (kilobecquerels) of beta/gamma activity or single items containing less than 40kBq.

2.2.1 High Level Waste

HLW is produced initially as nitric acid solutions containing the highly radioactive waste products of reprocessing spent nuclear fuels. Historical HLW continues to be stored in the liquid form in old stainless steel tanks, which require constant surveillance. Some HLW has been converted to glass in stainless steel canisters of 150 litre capacity, which are stored in an air-cooled modern engineered store and require less surveillance. The total volume in store on April 2004 was 1.890m^3, comprising 1,430m^3 of liquid HLW and 456m^3 of waste conditioned as glass (equivalent to 3,037 packages). Based on current plans, when all the liquid HLW has been conditioned, there will be 1,340m^3 of waste.

The nuclear safety regulator, the Health and Safety Executive's Nuclear installations Inspectorate (HSE – NII) has imposed a programme to convert stocks of liquid HLW to

glass. New HLW is blended with existing liquid and vitrified. The backlog of stored liquid HLW is slowly being worked through.

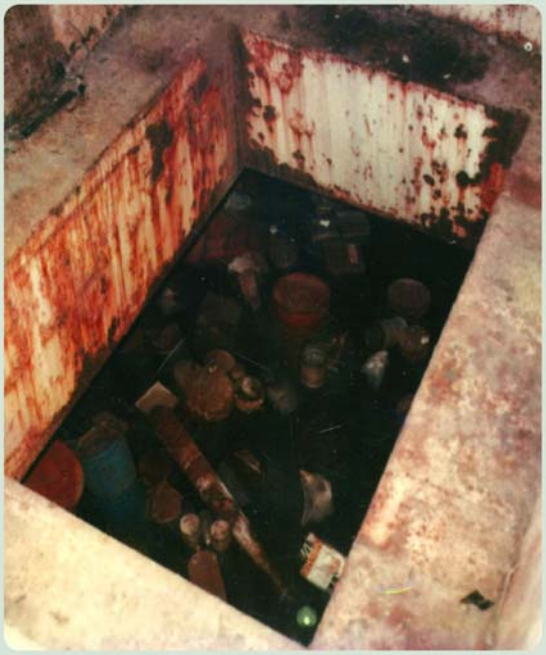
2.2.2 Intermediate Level Waste

ILW consists of metal items such as nuclear fuel casing (from nuclear fuel elements) and nuclear reactor components, graphite from reactor cores, and sludges from the treatment of radioactive liquid effluents. There are smaller quantities of organic materials, soil, glass and ceramics. The volume of ILW in store on 1 April 2004 is 82,500m^3, most of this waste is at Sellafield. A particular concern is the significant volume of ILW created in the 1940's, 1950's and 1960's that has been loose tipped into old facilities. Most of this waste is kept under water and requires continuous surveillance. Many of these facilities (see Figure 2, showing a storage facility with the protective cover removed) have long passed their design life, have deteriorated and some are leaking. The recovery and packaging of these wastes needs to be progressed urgently. Since 1990, most ILW arisings at Sellafield have been packaged and stored.

Packaging of UK ILW wastes typically consists of encapsulation in 500 litre stainless steel drums, 3m^3 stainless steel containers or large concrete boxes. These are specified by Nirex. On 1 April 2004, there were 16,400m^3 of conditioned waste.

When all ILW in store and predicted to arise has been packaged and conditioned there will be 241,000m^3 conditioned volume.

Figure 2
An existing ILW store



2.2.3 Low Level Waste

Most LLW is disposed of to the Drigg shallow disposal facility as it arises. Overall the LLW in the Waste Inventory consists of soil, building rubble and steel items such as ducting, piping and reinforcement produced from the decommissioning of nuclear reactors and other nuclear facilities and the clean up of nuclear sites. Organic materials also arise,

including discarded protective clothing, paper towels and plastic wrapping, and current LLW arisings consist mainly of paper and plastics. Historically LLW was dumped in pits. Since 1959 most LLW has been loose tipped at Drigg and Dounreay. Approximately 1 million m^3 of waste has been sent to Drigg or Dounreay. The predicted remaining capacity of Drigg is 750,000 m^3, which is less than half the reported volume of waste suitable for disposal to Drigg. The Government is currently reviewing options for managing this waste.

The volume in store on 1 April 2004 was reported to be 20,900 m^3 conditioned volume. When all LLW in store and predicted to arise has been packaged and conditioned there will be 2,040,000$m^{3.}$ conditioned volume.

2.2.4 Other Radioactive Materials and VLLW

Plutonium

There are currently 93 tonnes of separated plutonium in the UK, most of this material is held in store at Sellafield in oxide form as a powder. A small quantity may be returned to overseas countries. Some plutonium is held for military purposes. The total quantity of separated plutonium will increase to approximately 140 tonnes under current reprocessing assumptions. In addition there is plutonium within spent fuel.

Uranium

There are currently 100,000 tonnes of separated uranium held in a number of stores, principally at Springfields, stored in a number of forms including powder. A small quantity may be returned to overseas countries. Some uranium is held for military purposes. The total quantity of separated uranium will increase to approximately 150,000 tonnes under current reprocessing assumptions. In addition there is uranium within spent fuel.

Spent fuel

Approximately 5,000 tonnes of UK spent nuclear fuel are currently held in stores at Sellafield, Dounreay and a number of reactor sites. Some of this fuel is planned to be reprocessed. There will also be more spent fuel generated from continued power generation. Under current plans it is estimated that 4,700 tonnes of spent fuel will not be reprocessed.

Contaminated land

Estimates of land contaminated with radioactivity have been made but are very uncertain. The UK's Radioactive Waste Management Advisory Committee (RWMAC)[2] estimated the total amount in the UK to be of the order of 18 million m^3 (36 million tonnes) of unconditioned material. Most of it is at Sellafield, Dounreay and Aldermaston.

Radioactive sources

Approximately 10,000 sources are in use in the UK now, mainly for medical and industrial purposes. Most of these are returned to the manufacturers after use. Record keeping in this area has often been poor, resulting in the loss of sources. Radioactive sources exist in a wide variety of forms, from small metallic objects to gases and liquids.

VLLW

Small quantities of waste (less than 0.1m^3 with low activity - less than 400kBq) can be routinely disposed of to domestic landfills. There are approximately 5 such sites in use in

the UK. VLLW may be lightly contaminated miscellaneous items such as laboratory equipment, gloves and medical wastes.

Miscellaneous

Some organisations have disposed of radioactive waste under other arrangements, either on a nuclear licensed site or local tips (estimated to be 10,000 m^3), or (before it was banned) in the sea (33,000 m^3).

Some radioactive waste can be incinerated either at purpose built incinerators located on nuclear sites or domestic incinerators.

All nuclear facilities may discharge radioactivity to the environment via liquid and aerial effluents under strictly controlled authorisations set by the UK regulators. These materials are not reported in the United Kingdom Radioactive Waste Inventory.

Decommissioning of nuclear facilities

At the end of their lives, nuclear facilities are decommissioned. This involves removal of redundant buildings and clearance of the site. Assumptions regarding the timing of decommissioning vary although most of the waste exists now, and is reported in the 2004 Inventory to be 1.6 million m^3. These wastes have been included in the volumes given against the various categories above.

Decommissioning of old facilities which are now long beyond their design life is very challenging. The early stores for radioactive waste were designed to be filled but emptying was not considered. The structure of these old facilities may be inadequate for decommissioning, and hence there is a requirement to build new facilities to remove and process the waste, as well as to decommission these old buildings. Wastes within old facilities are often poorly characterised. Records of the waste may have been destroyed, or are inadequate.

Recent facilities have been designed with decommissioning in mind and to minimise the radioactive waste arisings.

3 OPTIONS FOR DEALING WITH THE WASTE

The UK Government is currently undertaking a review of long-term radioactive waste management policy (Managing Radioactive Waste Safely - MRWS). As part of this review the Government has established the Committee on Radioactive Waste Management (CoRWM). CoRWM's task is to review the range of possible long-term waste management options and recommend a preferred option to Government in mid-2006. We fully support the work of CoRWM and the necessity for due process in assessing and selecting a preferred option through stakeholder and public engagement.

This section sets out options and presents some of the arguments that have led us to the view that a phased geological repository is our preferred option. This is not intended to cut across or overlap with the work of CoRWM. Rather it is undertaken in support of our mission[2] and has already been made available as an input to CoRWM.

3.1 Long-term waste management options

A range of long-term waste management options has been investigated world-wide for radioactive waste. Nirex has been working on options since its creation in 1982 [3]. Based on a review of the literature and stakeholder discussions Nirex has identified a range of waste management options. A comprehensive description of the long-term waste management options for radioactive wastes is provided in Nirex Report N/050[3] [4]. The Phased Geological Repository Concept is described in Section 4. Descriptions of other options are given below.

Long-term storage

Long-term storage would involve the construction of purpose-built facilities either above ground or underground. The radioactive waste would be contained by ensuring, through a combination of a controlled environment in the store[4] and waste package design, that the waste packages would not degrade significantly during the storage period. Long-term storage would make the monitoring and retrieval of wastes relatively straightforward. The long-term performance of the wastes and the store itself relies upon continued institutional control and means that the stores and packages would have to be refurbished or replaced periodically. Hence, information on the stores would have to be available to future generations, who would need the knowledge, capability and resources to undertake the necessary actions.

By precedent from currently operating interim storage arrangements, this option could be considered for all categories of waste.

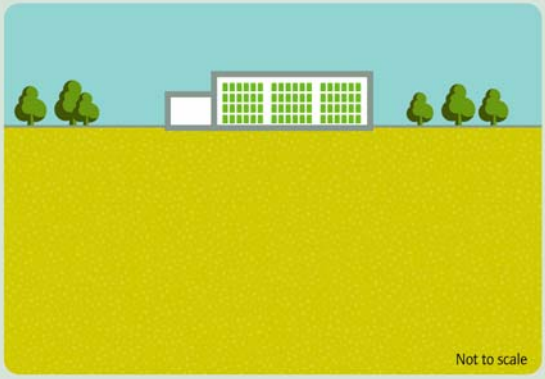
---

[2] "In support of Government policy, develop and advise on safe, environmentally sound and publicly acceptable options for the long-term management of radioactive materials in the UK".

[3] This report and other information gathered in preparing this report has been fed into CoRWM for use in the identification and assessment of options.

[4] Suggestions for long-term surface storage include: conventional stores that are replaced about every 100 years or 'monolith' stores that are intended to remain intact for tens of thousands of years.

Figure 3
Surface storage



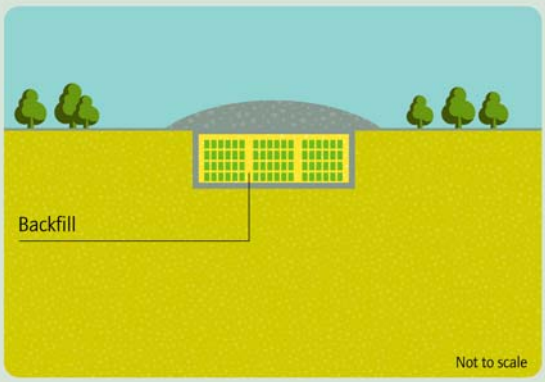
Near-surface disposal

Near-surface disposal at ground level

Near-surface disposal at ground level involves the construction of vaults cut into the ground and lined according to present-day practice (e.g. concrete and/or impermeable membrane). Waste in containers is placed in the vaults; when full the spaces around the waste packages in the vaults are backfilled; and when the disposal capacity of the whole facility has been reached, it will be covered with an impermeable membrane or low-permeability clay and capped with top soil. Many such facilities are in operation and often include controlled drainage systems [4].

Such facilities are considered suitable for the disposal of LLW and short-lived ILW (containing no significant amounts of radionuclides with a radioactive decay half-life greater than 30 years).

Figure 4
Near-surface disposal at ground level

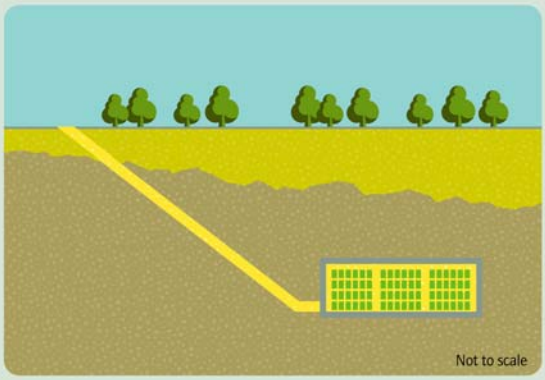


Near-surface disposal below ground level

Near-surface disposal in caverns below ground level involves the excavation of rock cavities at depths up to of order 100 metres below ground. The cavities can be in the form of tunnels, vaults, or silos; they may be lined with concrete and, sometimes, clay. Access to the excavated cavities for emplacement of waste is via an inclined tunnel or a vertical shaft. When the excavated cavities are filled with waste packages, the remaining spaces around the packages may be backfilled, but this is not always required. At an appropriate time after the facility has reached its disposal capacity engineered seals would be placed in the access-ways, and possibly at the access points to the various excavated cavities. The remainder of the access-ways would be backfilled. Several such facilities are already in operation [4].

As in the case of near-surface disposal at ground level, such facilities are typically considered suitable for the disposal of LLW and short-lived ILW.

Figure 5
Near-surface disposal below ground level



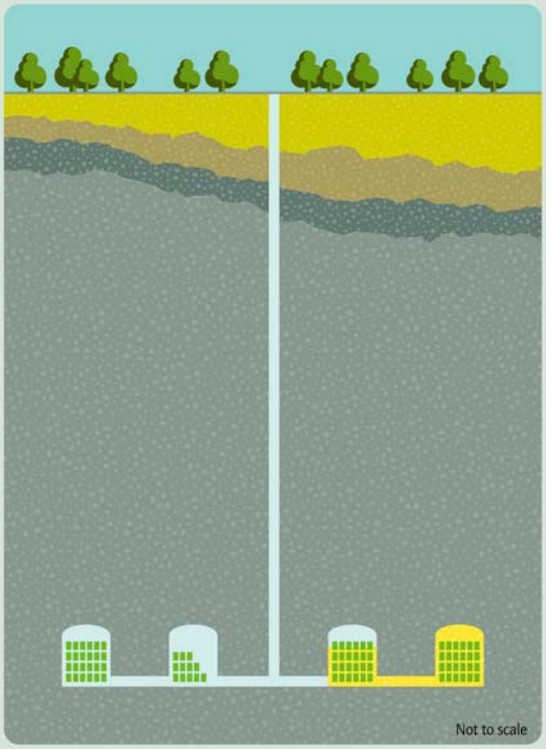
Deep geological disposal

Deep geological disposal would involve the excavation of tunnels or vaults at depths typically between 250 and 1,000 metres below ground in a suitable "host" rock. Access to the mined cavities for emplacement of waste is via an inclined tunnel or a vertical shaft. In most concepts for deep geological disposal, the engineered waste package is surrounded at an appropriate time by a backfill (which can be a cement-based grout or, in the case of disposal in salt, crushed salt) or a "buffer" material (typically a clay which swells on contact with water).

The choice of the design and materials of the waste container and of the backfill or buffer material is dependent upon the type of waste to be disposed of and, in some instances, the choice of host rock. After waste emplacement, sealing and backfilling would be carried out.

Deep geological disposal has been considered internationally for the isolation and containment of long-lived radionuclides in wastes such as vitrified HLW and spent nuclear fuel. In the UK and elsewhere it has also been considered for the disposal of ILW and LLW containing long-lived radionuclides.

Figure 6
Deep geological disposal

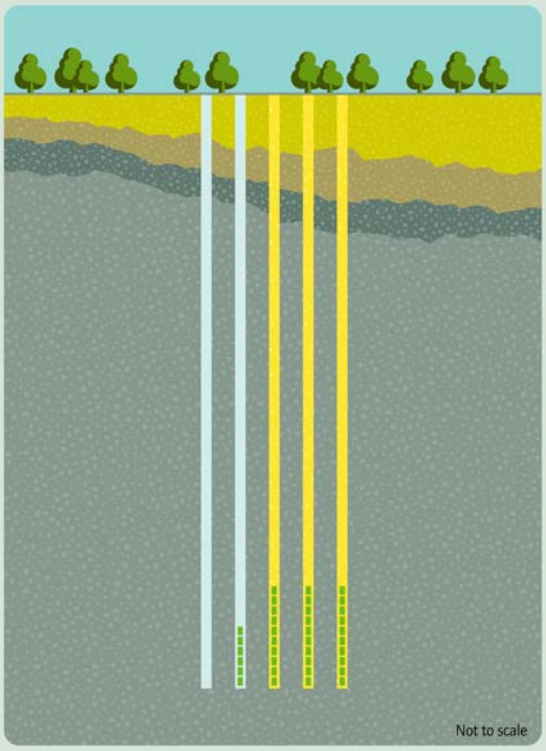


Deep borehole disposal

Deep borehole disposal would involve accessing a suitable "host" rock by drilling a borehole of suitable diameter typically to depths of several kilometres. Subsequently waste packages would be lowered into the borehole with the option to separate waste packages by layers of a suitable backfill or buffer material. Typically waste would not be placed in the top two kilometres of the borehole which would be sealed and backfilled with suitable materials.

Consideration of this option has been undertaken for certain categories of waste, but the technological resources required would make the option unattractive for high volume/low activity waste types. In contrast, the option has received considerable attention as a possible means of disposal of unwanted plutonium [5].

Figure 7
Deep borehole disposal

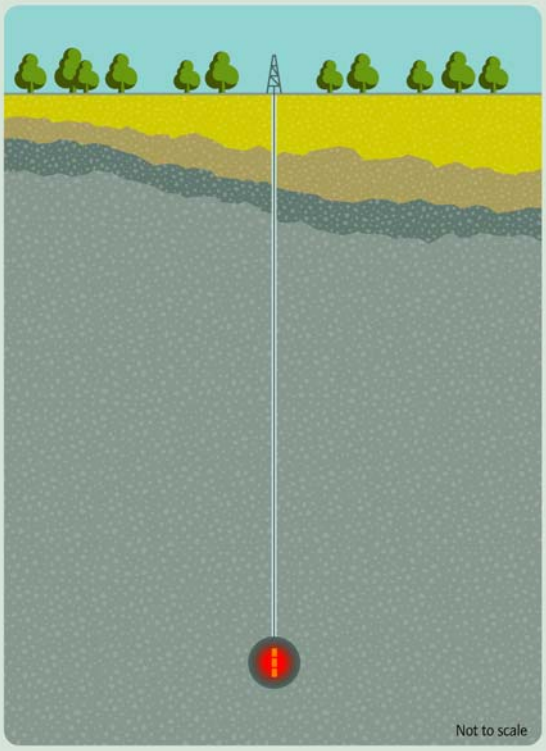


Rock melting

Rock melting would involve the introduction of heat-generating waste into a suitable rock mass (either by means of a borehole or placement, via a shaft or tunnel, in an excavated cavity). The heat generated by the waste needs to be sufficient to melt the surrounding rock after which, either the radionuclides are then dissolved in the molten rock and immobilised when the rock solidifies, or the rock solidifies around a container, in which the wastes were placed, providing a natural seal.

By definition, this option has been considered for highly heat-generating wastes, in particular vitrified HLW or its precursor liquid form.

Figure 8
Rock melting

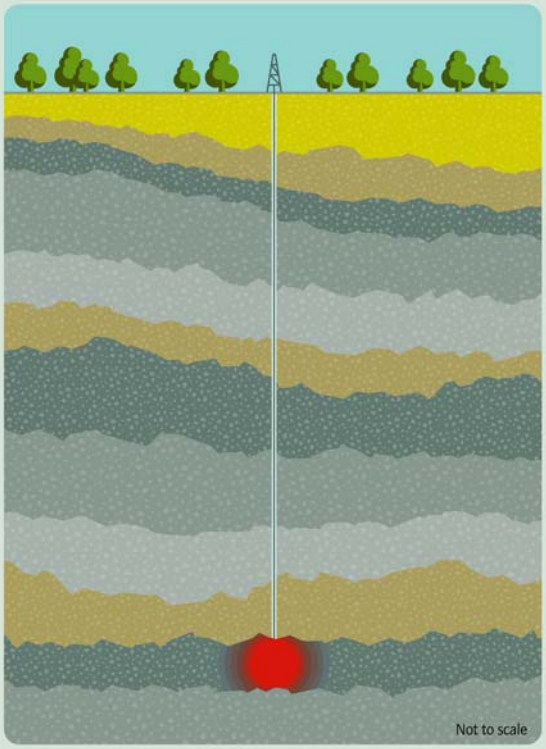


Direct injection

Direct injection would involve the injection of liquid radioactive waste, typically via a borehole, into a layer of rock deep underground.

This option has been used for liquid HLW in Russia. In theory, this option could be considered for all categories of waste provided they were in the form of a solution or slurry.

Figure 9
Direct injection



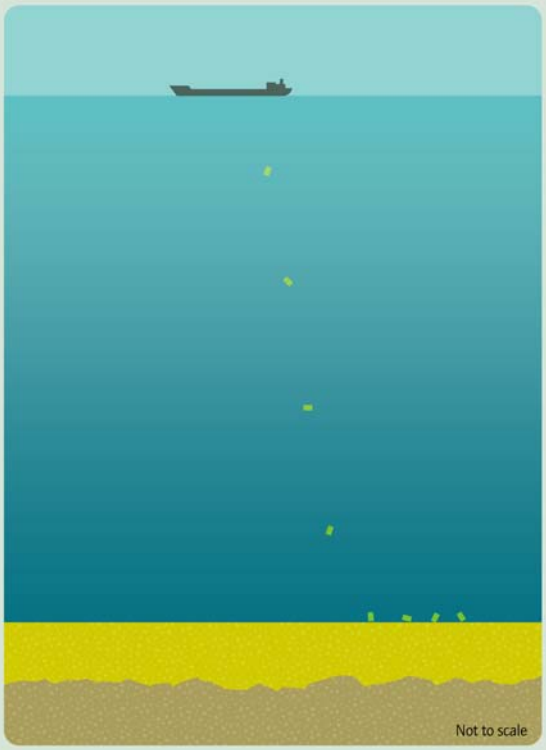
Disposal at sea

Disposal at sea would involve radioactive waste being dropped into the sea in suitably designed packages such that the packages either:

- implode on reaching a certain depth (as a result of the over-pressure) releasing their contents; or
- sink to the seabed intact.

This option has been used in the past for the disposal of ILW and LLW by a number of countries (including the UK). It has not been considered for HLW.

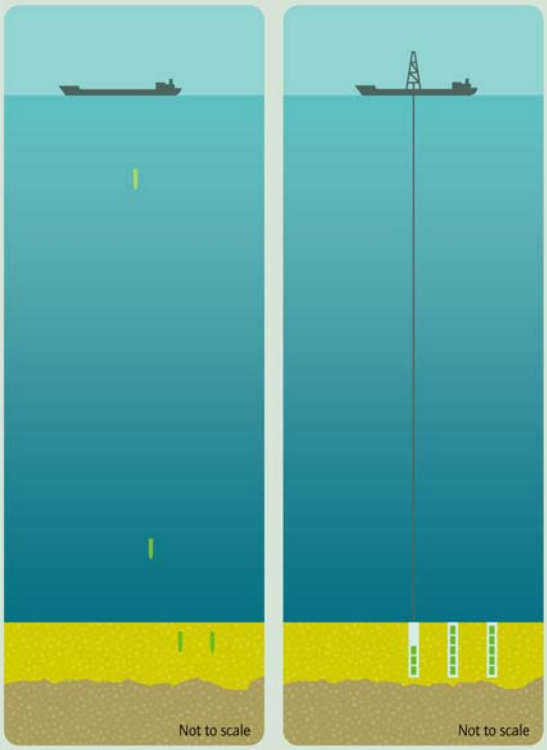
Figure 10
Disposal at sea



Sub-seabed disposal

Sub-seabed disposal would involve the emplacement of wastes in suitable geological formations beneath the deep ocean floor. Two concepts considered correspond to deep geological disposal and deep borehole disposal as described above, and the same analysis can be made as to the wastes considered. A third concept within this broad option involves the placing of waste packages in sediments on the deep ocean floor at depths typically of order a few tens of metres. This can be achieved by dropping the wastes from a ship in the form of a "penetrator" (designed to bury itself in the seabed sediments) or by drilling placement.

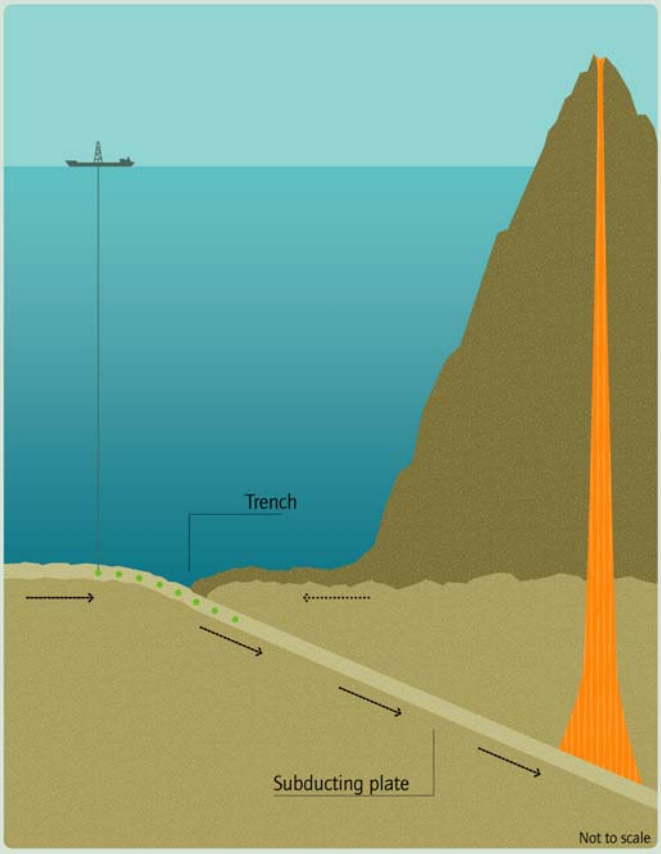
Figure 11
Sub-seabed disposal (two concepts)



Disposal in subduction zones

Disposal in subduction zones would involve the placement of wastes close to a boundary between two tectonic plates in the Earth's crust, such that the wastes are drawn deep into the Earth beneath an overriding lower density plate. Such converging plate boundaries are found below deep ocean trenches and would require disposal from a ship.

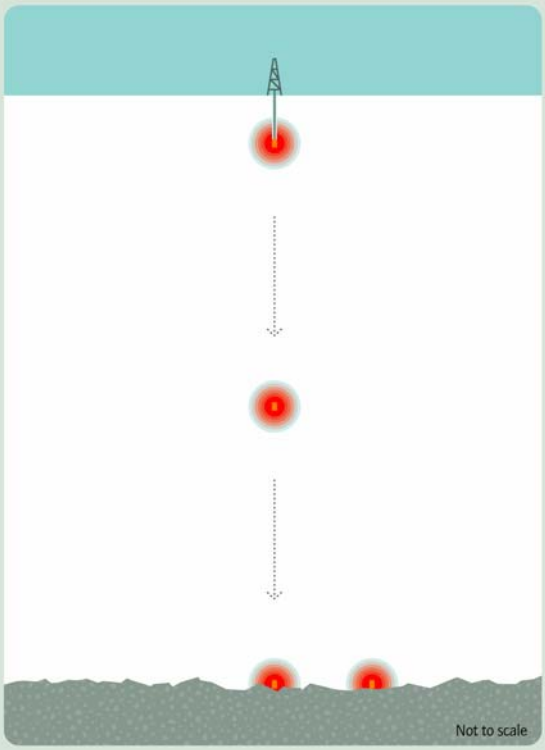
Figure 12
Disposal in subduction zones



Disposal in ice sheets

Disposal in ice sheets would involve placing heat-generating wastes in stable ice sheets (such as those found in Greenland and Antarctica). The properties of the wastes would be such that they melt the surrounding ice and move downwards under gravity with the melt water subsequently freezing above it to create an isolation barrier. Ice melting, by definition[5], has been considered for heat-generating wastes, mainly vitrified HLW or spent fuel.

Figure 13
Disposal in ice sheets



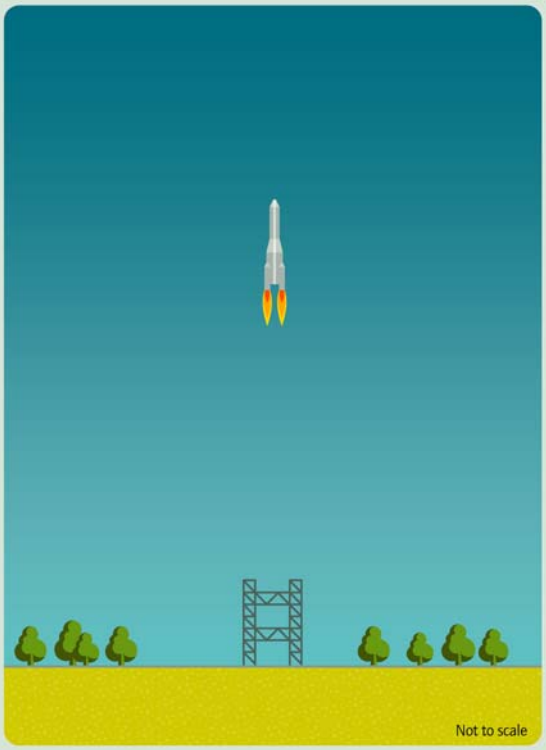
[5] Surface storage has also been proposed in ice-sheets. Wastes would not melt down into the ice but would be incorporated into the ice sheet by snow and ice accumulation.

Disposal in outer space

Disposal in space would involve the launching of radioactive waste into space, beyond the influence of the Earth's gravitational field (a variety of ultimate destinations have been discussed).

Consideration of this option has only been investigated for waste types of small volumes and high activity.

Figure 14
Disposal in outer space



3.2 Credible long-term waste management options

Nirex believes that ethically it is the responsibility of this generation to deal with its radioactive waste and it should not burden future generations or other countries. Credible options allow this generation to deal with it, and it should and can be dealt with now on behalf of the public.

Many of the options above are not viewed by Nirex as credible as they would:

- Contravene international laws and agreements;
- Involve the transfer of UK waste overseas;
- Require the use of speculative or experimental technology.

This therefore screens out the following options:

- Disposal at sea – The London Dumping Convention (LDC) [6], that the UK has signed up to, prohibits indefinitely the dumping of all radioactive wastes at sea.

- Sub-sea bed disposal (not accessed from land). The London Dumping Convention also prohibits sub-sea bed disposal, except for facilities that are accessed from land. Nirex has taken legal advice on this issue. This legal advice suggests that the London Dumping Convention and other relevant international conventions[6] do not preclude the long-term disposal of radioactive waste in sub-sea bed formations which are accessed by tunnel from the UK land-mass [7].

- Subduction zones – Similarly to sub-sea bed disposal, this option would also be ruled out by international agreements and treaties if not accessed from land. Subduction zones are not available in UK coastal waters.

- Disposal in ice sheets – To implement this option would require transfer of UK wastes overseas. This option has been rejected by countries that have signed the Antarctic Treaty [8] (which includes the UK).

- Disposal in outer space – To implement this option would require international agreement. The UK has also signed up to “The Outer Space Treaty” of 1967 [9], an international treaty outlawing “harmful contamination” of celestial bodies. Space disposal is likely to be in breach of this treaty [10]. The other issues that challenge the credibility of this option are the cost of implementation and the risk of space-craft failure.

Some of the other disposal options discussed above are also not suitable due to the characteristics of the waste.

- Direct injection – This option requires wastes to be in liquid or slurry form and is therefore precluded for the majority of UK radioactive wastes and materials as they are solid. In addition, the Nuclear Installation Inspectorate’s passive safety principles require that wastes that are initially liquids be solidified [11].

- Rock-melting – Rock-melting has only been suggested for highly heat generating wastes. This option would also require the use of speculative or experimental technology.

- Near-surface disposal – The near-surface disposal option has been developed and implemented for short-lived wastes. It is not suitable for any HLW and there would only be a very small amount of short-lived ILW for which this option would be suitable.

Therefore although many options have been proposed for long-term management of radioactive waste, we believe that the only credible options are variants on geological disposal or storage.

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[6] UNCLOS and The Convention for Protection of the Marine Environment of the North East Atlantic (OSPAR).

3.3 Pros and cons of credible options

Radioactive wastes are currently stored in surface stores at over thirty sites in the United Kingdom. The storage option allows wastes to be monitored and retrieved relatively straightforwardly. However, if the storage option is to address the need to protect humans and the environment for hundreds of thousands of years whilst long-lived radionuclides decay to safe levels, then this option requires continued active management. Reliance on the stability of society with the necessary skills and funding to maintain a suitable environment for the wastes over such time periods is not credible. Surface stores also leave the waste vulnerable to man-made and natural events [12]. For example, there is an increasing amount of data on climate change, including sea level rise. Global sea levels are currently rising at about 1 to 2mm per year [13]. Long-term interim storage at existing coastal sites may therefore not be feasible. Overall, long-term storage of this type for hundreds of years or indefinitely is not viewed by Nirex as a suitable option because it would not be ethical to leave our waste for future generations to deal with indefinitely. Storage is only credible as a temporary measure until a repository can be made available.

This view is shared in other countries. For example, the Municipality of Oskarshamn, Sweden, where spent fuel is stored in the Central Interim Storage for Spent Fuel (CLAB), has expressed the view that extended supervised storage in a facility requiring daily supervision, active cooling and other institutional measures to stay safe is not an acceptable long-term solution. In arriving at that view [14] knowledge about deterioration of nuclear installations in the former USSR was debated and the vulnerability of the long-term stability in our societies was seen as a threat larger than the stability of the two billion year old crystalline rocks in Sweden.

Geological disposal provides a viable long-term solution that does not rely on continued management. The waste is also much less vulnerable to the effects of terrorism and major changes to the surface environment. In geological disposal the waste is separated from the environment by hundreds of metres of rock and multiple engineered barriers. The skills and experience to implement this option are available now. However, some stakeholders are concerned that disposal is an irreversible step that should not be taken and could foreclose better options that may be available in the future.

Nirex has therefore investigated these issues to develop a waste management option that combines the flexibility of storage with the long-term passive safety of geological disposal. The PGRC has been developed to take advantage of the strong safety benefits of geological disposal whilst addressing public concerns about retrievability. Time is required in the decision-making process for stakeholders to gain confidence in geological disposal as a viable option. In the UK, there has been public demand for retrievability and a staged approach to decision making. Most other countries with radioactive waste are also proposing geological repository concepts that incorporate some degree of retrievability and a phased approach to implementation.

4 THE PHASED GEOLOGICAL REPOSITORY CONCEPT FOR ILW/LLW (PGRC)

4.1 Overall description

Nirex has developed its Phased Geological Repository Concept (PGRC) to provide safe, long-term management for ILW and for LLW that is not suitable for disposal in existing near-surface facilities.

Before 1997 many stakeholders had asked Nirex to incorporate retrievability into its geological repository concept. These requests were resisted and we argued that if necessary the waste could be mined out of the facility. We were missing the point.

One of the lessons learned was that Nirex needed to listen to stakeholders' views and allow them to influence our work. Through dialogue, including a series of workshops, we established what was being asked for in terms of retrievability. Instead of refuting or ignoring these requests Nirex did the research and found that it could deliver the retrievability that was being asked for:

- in terms of technical feasibility; and
- without compromising safety.

It is not only the UK that has seen the demand for and acceptance of retrievability. For example an EC funded project on retrievability [15] was undertaken in 2000 with representatives from ten national waste management organisations. Nine of those organisations are now incorporating retrievability into their disposal concepts. Only Germany has not adopted retrievability.

With retrievability for up to several hundred years built into it the concept is a multi-barrier, phased and reversible approach, based on storing waste deep underground, where it is much less vulnerable to disruption by man-made or natural events. The concept is designed to prevent, or at worst slow down to a safe level, the release of radio-toxic substances to the environment whilst the natural process of radioactive decay occurs. The incorporation of monitoring and retrievability means that choices on how, and if to proceed towards closure of the facility are offered to future generations without placing an undue burden on them. Monitoring and retrievability are discussed further in Section 4.2.

Typically the wastes are immobilised in a cement-based grouting material within a standardised, highly engineered stainless steel or concrete container. The resulting packages are an integral part of the PGRC and have to meet performance standards specified by Nirex that are derived from the concept.

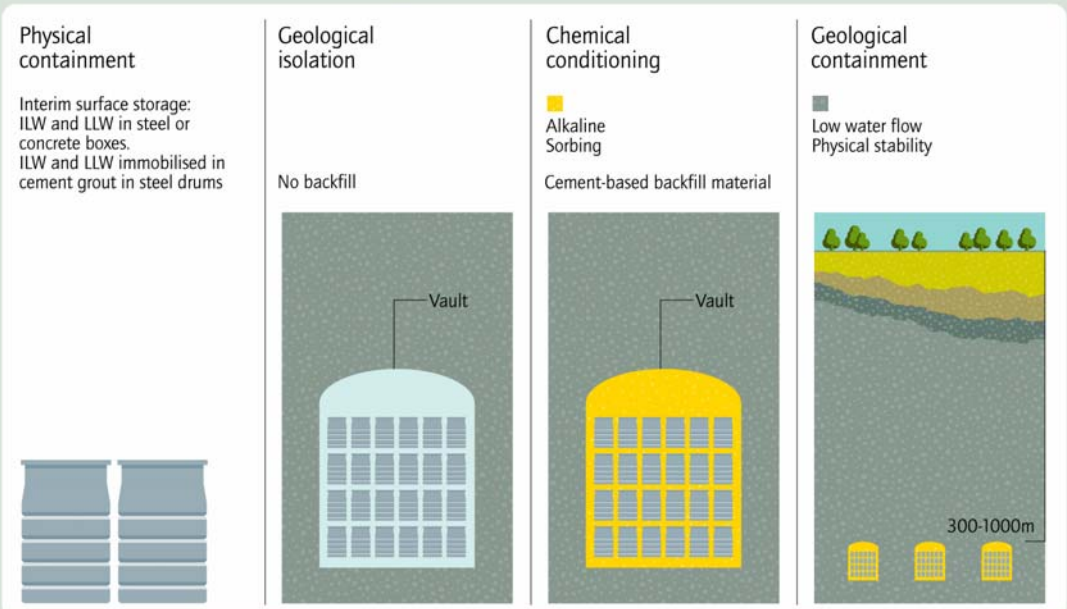
The typical stainless steel thicknesses used for waste containers are expected to resist penetration by corrosion under repository conditions for many thousands of years [16]. In the absence of any other process that might degrade the container, any release of radionuclides to groundwater would be via a gas-release vent (when this is installed), and would be controlled by diffusion of radionuclides in the encapsulating grout within the container. This would only occur once a continuous groundwater phase had been established between the wasteform and the backfill. Calculations have shown [17, 18] that diffusion along this pathway would greatly limit any releases of radionuclides to the backfill

to tiny fractions of the inventory within the waste container. Combining these results with calculations used in the generic long-term safety assessment, the “Generic Post-closure Performance Assessment” (GPA) [19], shows that more than 90% of the initial inventory of radionuclides would decay inside the container during the first thousand years after repository closure.

No credit is taken for this containment in the reference case repository system model used in the GPA. Instead, it is conservatively assumed that there is an instantaneously evenly distributed solution of dissolved radionuclides throughout groundwater that is assumed to saturate the repository immediately after closure, and that this is available for transfer into the rocks around the repository. Even using this cautious approach, it is calculated that no more than 1% of the initial radionuclide inventory would be outside the repository in the geosphere at any time and that containment and retardation in the repository itself ensures that the remaining 99% decay in situ.

The geological barrier would be selected so that the rock surrounding the repository would have a long and slow groundwater pathway back to the surface, and, ideally, favourable geochemical and mineral properties to prevent or delay the movement of the radionuclides along that pathway. In that way the possible release of radionuclides from the repository to the surface would be prevented or, in a few cases, limited, and the majority of radionuclides released from the repository would decay away deep underground.

Figure 15
Phased geological repository concept



In our long-term safety assessment studies, we calculate the effect that these long-term, low-level releases might have on the health and safety of people living on the surface in the vicinity of the repository at the time the releases might occur. The results of these assessment studies show that we could meet the rigorous safety and environmental criteria set by the UK regulators in up to 30% of the UK landmass.

The concept would be implemented in a number of phases, each of which is described below.

4.1.1 Phase 1 – Packaging the waste

Current policy is that Intermediate Level Waste should be packaged to Nirex standards. This means that the waste can be packaged now in a form that is suitable for long-term management. This includes surface storage, transport to a repository and then emplacement and storage underground in a phased geological repository. The packages provide the first of the multiple barriers – the main safety function being physical containment.

Figure 16
Nirex standard ILW package

BNFL

Phase 2 – Surface storage

Packaged wastes are generally stored at the site of origin in surface stores. Those stores generally have a design life in the order of 50 years. Nirex issues guidance on appropriate storage conditions to ensure that the waste packages remain suitable for subsequent underground storage in a phased geological repository [20]. This provides a marked improvement on the conditions for storing raw wastes. However, because some of the waste remains hazardous for hundreds of thousands of years, such stores do not provide a long-term management solution

Figure 17
Surface storage of packaged wastes

BNFL

Phase 3 – Transport

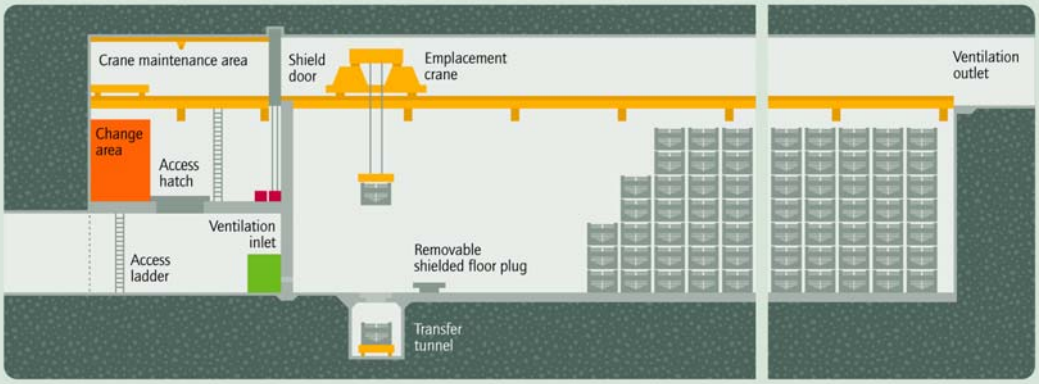
Figure 18
Waste package transport

The concept provides for the transport of waste packages to a repository. A transport system has been developed based upon internationally recognised standards developed by the IAEA [21] and incorporated in EU and UK legislation. There is extensive worldwide experience of the safe transport of radioactive materials to these standards. Transport to a repository need not be restricted to road and rail. Sea transport is being considered to minimise the movement of radioactive materials on land.

Phase 4 – Waste emplacement

To isolate this hazardous waste from the environment, waste is emplaced in deep underground storage vaults. The vaults would be constructed in a stable geological environment that offered conditions necessary to provide geological containment at a later date. The storage vaults would be similar in design to existing surface stores with carefully controlled environmental conditions. This in itself would provide a significant barrier of several hundred metres of rock so the waste is less vulnerable to natural disasters or terrorist attack.

Figure 19
Retrievable underground storage facility



Phase 5 – Monitored retrievable storage

In this phase the waste would continue to be stored underground. The repository and its contents would be monitored and the waste would be retrievable. Our studies indicate that this phase could be maintained (at a cost) for several hundreds of years with the main consideration for closure being societal rather than scientific or engineering [22]. This gives future generations a wide range of options. They could proceed to the next phase, continue with this phase or retrieve the packages if desired.

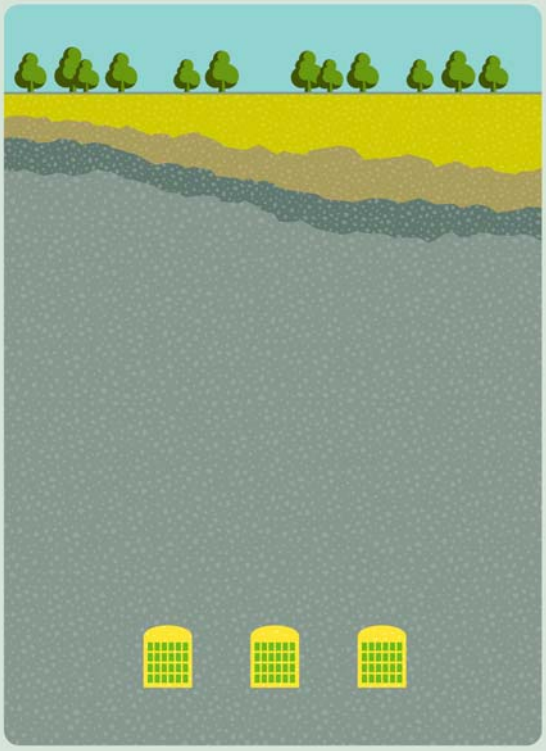
Phase 6 – Vault Backfilling

When and if there is sufficient confidence in the system, the repository vaults could be backfilled with a specially developed cement-based material. This material is designed to provide a very effective barrier against the movement of radioactive materials into the groundwater that is present in rocks deep underground. It achieves this by increasing the alkalinity of the groundwater and because the grains of cement provide a very large surface area onto which many radionuclides attach. Not all of the vaults need to be backfilled at the same time, monitoring of a backfilled vault can continue alongside phase 5. Waste packages could still be retrieved at the end of this phase, albeit with increased difficulty.

Phase 7 – Repository closure

When backfilling has been completed, the repository can be closed and sealed. The vaults, connecting tunnels and repository access ways would be backfilled and closed using high integrity seals. This barrier would retain or slow down the fraction of the radioactivity that we calculate could eventually escape from repository vaults.

Figure 20
Geological containment



Phase 8 – After closure

The multiple barriers introduced in earlier phases provide the long-term containment of radioactivity in the repository without the need for continuing maintenance and would thus protect human health and the environment. This does not mean the repository would be forgotten and Nirex is working with its equivalent organisations overseas to develop plans for very long-term monitoring of the performance of a closed repository.

A fuller summary of the PGRC is given in Nirex Report N/074 [23].

4.2 Monitoring and retrievability

4.2.1 Motivation for monitoring and retrievability

The geological repository concept was conceived as a means of providing robust containment and isolation of radioactive waste in the very long term not relying on actions by future generations. There is, however, a balance to be struck between avoiding placing responsibilities on future generations and respecting their competence and right to make decisions. Discussions around this topic, which we see as an ethical issue, have been taking place in international radioactive waste management circles since the late 1980s, for example, as crystallised in principles proposed by the Swedish National Council for Nuclear Waste (KASAM), which included the point that:

> " *… a repository should not be designed so that it unnecessarily impairs future attempts to retrieve the waste, monitor or repair the repository." [24]*

In the years since, the balance has moved more towards acknowledging future uncertainties and providing flexibility to this and future generations on how to deal with long-lived radioactive waste.

In 1995 the Radioactive Waste Management Committee of the OECD Nuclear Energy Agency published a 'collective opinion' on the environmental and ethical basis for geological disposal [25]. In that document it states that:

> *"Retrievability is an important ethical consideration since deep geological disposal should not necessarily be looked at as a totally irreversible process, completely foreclosing potential changes in policy. In this context , it should be noted that the sealing of a site and its access will always require a specific decision and that such a decision could be delayed until well after the end of the waste emplacement operations to continue to allow reversibility and flexibility in the process if considered necessary.*"

In the UK, it was the view of the House of Lords Select Committee on Science and Technology in their investigation into radioactive waste management in 1999 that:

> *"the preferred approach is phased geological disposal in which wastes are, following surface storage, emplaced in a repository in such a way that they can be monitored and retrieved. The repository would be kept open while data are accumulated, and only closed when there is sufficient confidence to do so". [26]*

Similarly, the UK CEED National Consensus Conference on Radioactive Waste Management in 1999 concluded that:

> *"Radioactive waste must be removed from the surface and stored underground, but must be monitorable and retrievable". [27]*

Nirex, through dialogue on its own programme, has recognised the importance of retrievability and monitoring to many stakeholders and has consequently undertaken work to address this [28, 29, 30].

4.2.2 Nirex work and strategy for retrievability

Nirex has carried out technical studies to investigate the practicalities of delivering retrievability and monitoring within a geological repository concept and the technical, operational and cost implications of doing so [31, 32]. It has also participated in international studies through which it has accessed experience related to retrievability and monitoring in other countries [15, 33]. Based on this experience, Nirex has developed a flexible strategy for achieving retrievability of the waste [22]. Monitoring and retrievability are now central to the PGRC, and Nirex has included requirements related to the delivery of monitoring and retrievability in its Waste Package Specification [34] and Generic Repository Design [35].

The Nirex strategy is that retrievability should be achievable at all stages during the development of the PGRC. Emphasis is placed, however, on the period during and after completion of waste emplacement and before vault backfilling. During this period, the waste is fully accessible and can be easily retrieved by reversal of emplacement operations, using the same installed equipment. The waste is monitorable and the concept demands monitoring to ensure that the condition of the waste, vaults and installed equipment remains satisfactory.

Nirex envisages that the repository may be held at this step in its implementation until such time as society is ready to take the decision to move towards closure, or to define some other course to manage the waste safely. Nirex's technical studies indicate that a repository can be designed to be held in such condition for up to about 100 years by initial design measures and routine maintenance activities similar to those required during the operational period. If a longer period of monitored, retrievable storage is required, then this could be achieved by the construction of additional vaults and a rolling programme of waste transfer between vaults and refurbishment of the emptied vaults. The repository could be kept open for hundreds of years.

The key technical requirements to ensure satisfactory underground storage conditions and the capability to retrieve the waste are:

- the emplacement vaults must retain sufficient structural stability for storage and waste retrieval operations;
- waste packages and stillages must retain sufficient integrity to be lifted and removed from the vaults;
- the emplacement/retrieval equipment and other in-vault systems, must remain operable, or be maintainable and/or renewable;

- the groundwater management system must prevent direct contact of groundwater with waste packages and also minimise degradation of vault rock stabilisation systems; and

- the vault environment must be controlled, e.g. with adequate ventilation, to provide suitable conditions for extended storage and, if necessary, waste retrieval operations.

We believe that these conditions can be readily met in the UK.

To assess and maintain the condition and effectiveness of the above, and also to ensure the underground facilities, services and safety of workers, a comprehensive programme of monitoring and maintenance would be needed, as well as the capability to recover from accidents and fault conditions. This, in turn, requires continued commitment to maintaining the operating organisation and regulatory functions, and corresponding financial commitments. In particular, the technical capability to proceed towards final closure must be maintained to give assurance that a state of passive long-term safety can be reached.

Maintaining the emplacement vaults in an open condition for an extended period has some influence on waste package and local geological conditions that could potentially influence the backfilling operations and post-closure performance. Nirex has made exploratory studies of the relevant issues [36, 37], and concluded that, for its reference conceptual design, potential impacts are manageable and need not have any significant impact on long-term safety. These issues will have to be assessed on a site- and design- specific basis.

After vault backfilling, retrieval of the waste packages would still be possible, and Nirex has carried out tests to confirm this [38], but additional equipment would be required and the retrieval would be more costly. Even after the repository is closed and sealed, the waste could be retrieved by conventional mining techniques. However, this is considered unlikely because the decision finally to close the repository would not be taken unless long-term safety was assured and all reasons for keeping the waste accessible for longer had been assessed and dismissed.

4.2.3 Benefits of monitoring and retrievability

The prime reason for incorporating monitoring and retrievability into the Nirex PGRC has come from stakeholder concerns. For some stakeholders, this is pragmatic concern over taking irreversible, or difficult to reverse, actions in the face of residual uncertainties, i.e. that we are moving too fast and, if faulty, the situation would be difficult to remedy. For other stakeholders, it springs from an ethical argument that future generations who will have to live with the solution should, as far as is practical, be given an opportunity to share in or revoke the decisions we are making now.

Nirex considers that the PGRC, with the incorporation of retrievability and monitoring, allows an ethical balance to be struck between:

- making progress now towards a permanent solution for providing long-term safety; and

- allowing future generations the opportunity to change or modify the implementation so as to better meet their requirements and preferences.

The concept aims to combine the flexibility of storage options with the long-term passive safety of geological disposal.

4.3 Regulation of the packaging of ILW

On 1 January 2004 improved arrangements relating to the conditioning of intermediate level wastes on nuclear licensed sites were introduced by the UK's nuclear regulators [39]. These arrangements require that safety cases covering the operation of plants built for the purposes of retrieval and conditioning of intermediate level waste, also address the disposability of the waste packages thus produced. This change ensures that the long-term management of waste packages is considered before they are manufactured.

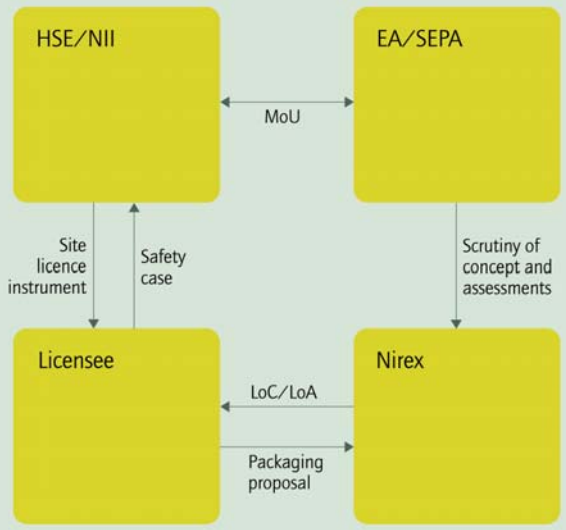
To support this new requirement, the Environment Agency of England and Wales and its counterpart in Scotland, the Scottish Environment Protection Agency, have established Nuclear Waste Assessment Teams (NWATs) that will advise the HSE-Nuclear Installations Inspectorate on waste package disposability, in accordance with relevant statutory provisions and Memoranda of Understanding between the Agencies and HSE. The arrangements recognise the important role of the Nirex Letter of Compliance (LoC) process and Nirex assessment is seen as the primary vehicle for demonstration of disposability. To enable the regulators to gain a full understanding of the LoC and underlying assessments, Nirex's work is now subject to scrutiny by the NWATs. A series of reviews have been initiated and findings are being published.

The regulatory arrangements are recognised within the Government's updated policy on the decommissioning of UK nuclear facilities issued in September 2004 [40] . The policy statement covers all (existing and new) nuclear industry facilities and their sites. This includes power stations, other reactors, research facilities, fuel fabrication and reprocessing plants and laboratories on nuclear licensed sites. It also includes fusion research facilities and, where appropriate, facilities on sites owned by the Ministry of Defence, nuclear submarines and their liabilities. The policy update confirms that operators should continue to process decommissioning wastes in accordance with Letter of Compliance arrangements.

The improved regulatory arrangements are illustrated in Figure 21.

In March 2005 NII, EA and SEPA issued 'Guidance to Industry' on the operation of the revised arrangements [41]. In summary the revised arrangements require that site operators produce an "ILW Conditioning Proposal" for all wastes on their sites. This should set out the strategy for retrieval, conditioning, storage and ultimate disposal of wastes and should form an essential component of the safety case for the plant and proposed waste products.

Figure 21
Regulatory arrangements for ILW packaging

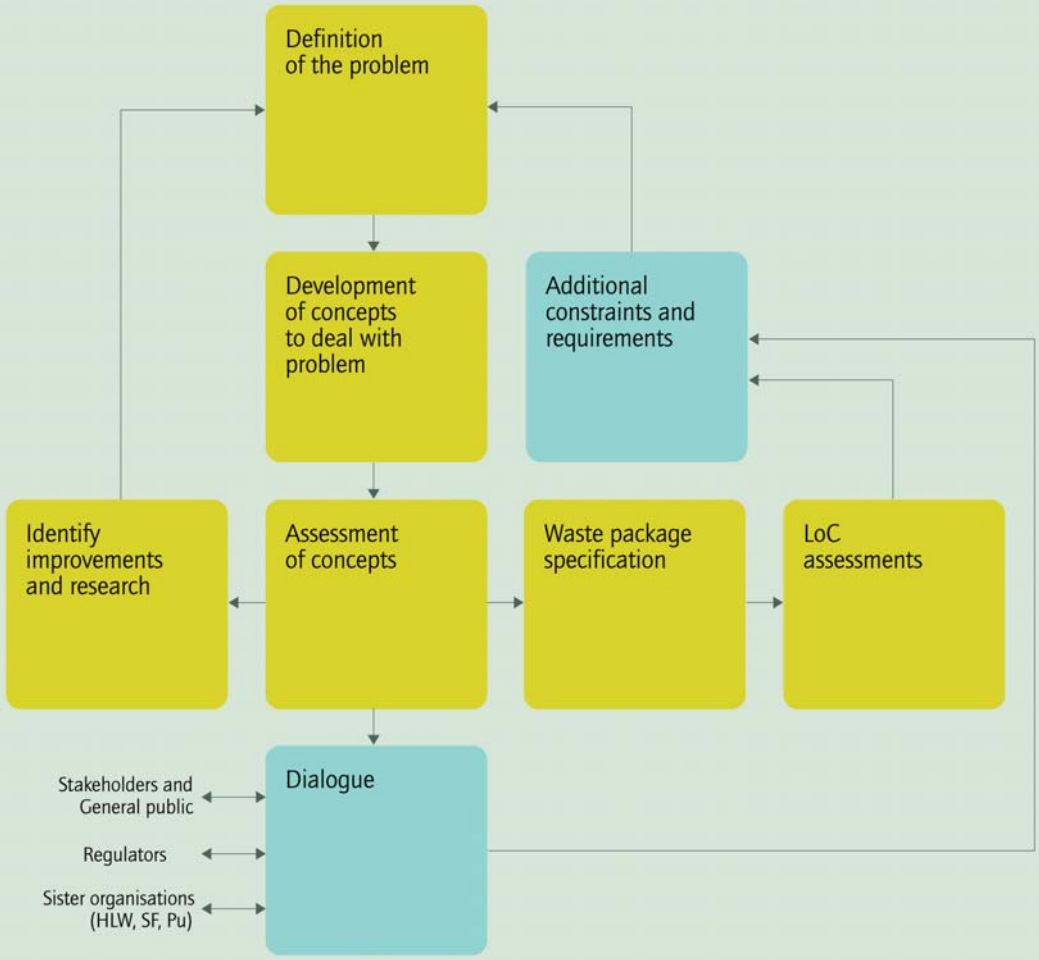


The regulators normally expect licensees to seek an assessment via the Nirex Letter of Compliance (LoC) process (see section 4.6) unless ultimate disposal to an existing disposal facility is planned. The LoC process is therefore an important input to the licensees' ILW conditioning proposals.

4.4 Iterative development of the Phased Geological Repository Concept

Figure 22 shows the iterative process that is applied to the development of the Phased Geological Repository Concept.

Figure 22
Iterative development of the PGRC



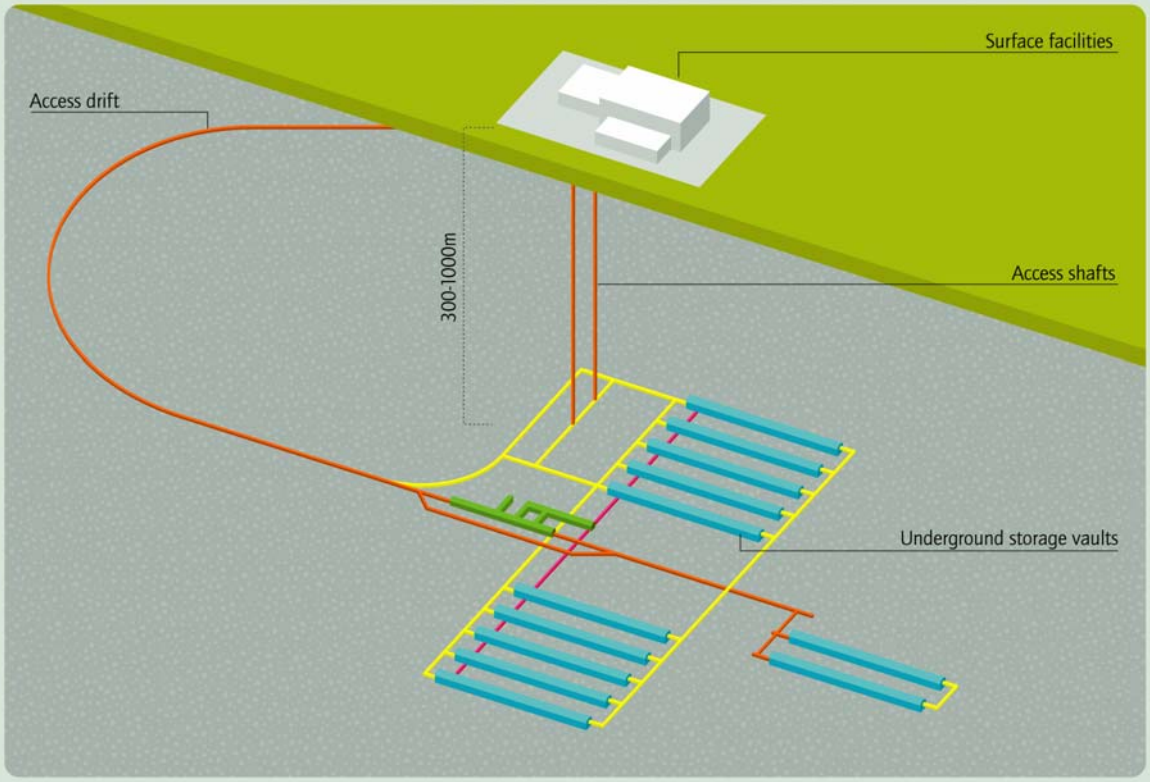
4.4.1 Definition of the problem

The process begins with the definition of the problem. This includes details of the nature and quantities of radioactive waste requiring long-term management, regulations that apply to the various phases of the concept, requirements identified from dialogue with a wide range of stakeholders and constraints derived from assessments of the safety and environmental performance of the concept. The definition of the problem is updated as new information becomes available e.g. the publication of a new UK Radioactive Waste Inventory.

4.4.2 Development of Concepts

Having defined the problem, conceptual designs are then developed to deal with the problem. These include designs of waste packages, transport packages, transport system and the repository itself. A key driver in the design is that proven technology is used for all system components hence the proposals are realistic and achievable using today's technology. A study has been reported that systematically compares all elements of the PGRC with proven technology [42].

Figure 23
Phased Geological Repository Design



The generic repository design (Figure 23) has been based on real data obtained from Nirex's investigation of Sellafield as a potential repository site. However, different rock types offer different qualities and present different challenges in terms of repository construction and repository safety and environmental performance [43, 44]. Hence Nirex has investigated the implications for the generic design concept of constructing a repository in a range of different host geological environments that might be suitable for a repository in the UK [45].

Four main rock mass types were considered:

- igneous and metamorphic rocks (e.g. at Sellafield) – the strongest rocks for construction – such as granite, basalt, quartzite and slate;
- strong sedimentary rocks such as sandstone, limestone and dolomite;
- weak sedimentary rocks such as mudstone, siltstone and stiff clay; and
- evaporites such as rock salt, potash, gypsum and anhydrite.

The generic design would be broadly compatible with igneous and metamorphic rocks and also strong sedimentary rocks in the UK.

Nirex has examined the basis of design for geological repositories in clays and evaporites [46]. In such rocks, the cross-section of stable underground openings would be reduced, and/or more substantial rock support measures might be required, e.g. concrete or metal lining sections. The development of a geological repository in clays and evaporites is feasible; this is confirmed by work from other national repository programmes, e.g. in France, Germany, Belgium and Switzerland.

It should be noted that the repository designs described at this stage of the concept development are generic and would be subject to future changes in configuration and to optimisation. Host rock properties, hydrogeology and specific characteristics of the waste can all affect the repository design configuration.

4.4.3 Assessment of concepts

This part of the iterative process is described in more detail in section 5. Assessments of safety and environmental protection provided by the concept are undertaken covering transport to a repository, repository operations and long-term, post-closure performance. The results of these assessments are compared with regulatory criteria in order to demonstrate compliance. Carrying out these assessments enables Nirex to:

- Derive waste package specifications for compatibility with the concept as described in section 4.5.

- Assess individual waste packaging proposals for compatibility with the concept under the Letter of Compliance (LoC) process described in section 4.6. The LoC assessments can also lead to the identification of additional constraints and requirements to help improve the definition of the problem (for example better information on the waste being packaged).

- Identify future research requirements and priorities as described in Section 6. The results of the research then lead to an improved definition of the problem.

The descriptions and assessments of the concept are subject to dialogue with a wide range of stakeholders. This dialogue is essential to gain an understanding of others' views on the viability of the concept. Such dialogue allows stakeholders access to and influence on our work programme and can lead to additional requirements and constraints and identify research requirements for example:

- The demand for monitoring and retrievability by external stakeholders (see Section 4.2) [26, 27, 28, 29, 30] resulted in a focused programme of work [31, 32, 22] leading to the incorporation of retrievability and monitoring in the concept. Dialogue with other national waste management organisations and international bodies has shown that this is now a common theme in the development of repository concepts [15, 33, 47].

- There is now continuing scrutiny of Nirex's work by the regulators (see section 4.3) which is a key driver in shaping our future research programme.

- Formal links with our 'sister' organisations overseas provide us with access to a vast body of work on geological repository concepts – the results of that work are used in further development of our own concepts.

4.5 Waste Package Specification and standard containers

The design of waste packages and materials used in their construction must be robust enough to ensure the integrity of the packages throughout the further stages of waste management and also meet requirements for efficient and safe handling, including transport through the public domain.

To facilitate this, Nirex has developed:

- a Generic Waste Package Specification (GWPS), which defines the standard waste containers and specifies the characteristics and performance requirements for the complete waste package;
- guidance on practical approaches to meeting the WPS; and
- guidance on a range of issues of relevance to production of conditioned waste packages.

4.5.1 Waste Package Specification

The Nirex Generic Waste Package Specification (GWPS) [34] is derived from the Phased Geological Repository Concept. It has been developed over many years in compliance with national and international standards and regulations for the safe packaging, storage, transport and disposal of radioactive waste, and in consultation with waste-producing organisations [48]. The GWPS sets criteria for identified parameters related to:

- the waste container – handling, radiological protection, durability and identification; and
- the wasteform – radioactivity, and chemical, physical, mechanical, thermal and biological properties.

It also defines the quality assurance controls to be applied to waste package production and the measurements and records required. The GWPS is supported by guidance on practical approaches to meeting its requirements, e.g. container materials, wasteform development, manufacture and data recording and measurement processes.

The GWPS being generically based on the PGRC, incorporates various safety margins so that, as progress is made towards a specific site and design, the GWPS can become more focused and eventually issued as Waste Acceptance Criteria (WAC) for an operating repository. This progressive refinement, from generic WPS to facility-specific WAC, is consistent with recommendations issued by the International Atomic Energy Agency [49].

The Nirex GWPS and the guidance documentation are subject to periodic review to ensure that they remain up-to-date. The review takes into account: the ongoing development of the PGRC; improvements in the scientific understanding and data; experience and technical insights gained from the LoC assessment process (see Section 4.6); and any relevant changes in legislation and regulatory guidance.

4.5.2 Standard containers

When a waste container is filled with conditioned waste, the complete assembly is termed a package. Nirex has defined two generic types of waste package:

- unshielded packages, which owing to radiation levels or containment requirements require remote handling and must be transported in a shielded transport container; and

- shielded packages, which have built-in shielding (if needed) and/or contain low-activity materials so that packages can be handled using conventional techniques and are transport packages in their own right**.**

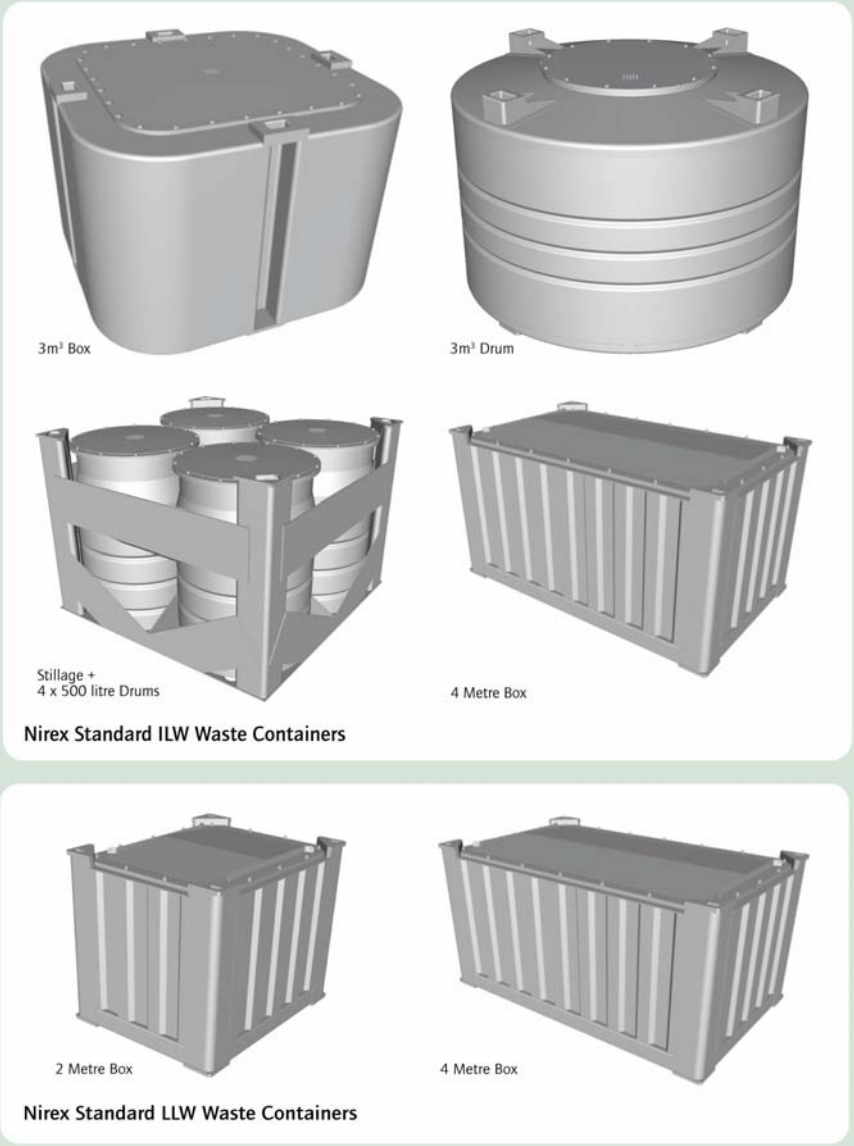
Nirex has developed a range of standard waste containers (Figure 24) that will meet the needs for the intermediate-level and low-level wastes predicted to arise in the UK.

The standard range comprises

- three “unshielded” containers – the 500 litre drum, the 3m^3 box and the 3m^3 drum;

- two “shielded” containers – the 4 metre box and 2 metre box.

Figure 24
Nirex standard waste containers for ILW and LLW



The standardisation of waste container designs is good practice. It simplifies quality control and package handling arrangements, and allows operations to be optimised around a limited number of package variants. The standardised exterior envelopes and handling features facilitate the design of the waste handling and transport equipment as well as general features of storage facilities and the repository vaults. Standardisation also provides efficiency by allowing development costs to be shared.

4.5.3 Wasteform and container materials

Waste packages must be designed to provide safe containment of radioactive material during transport, handling and storage (above and below ground), and in the event of accidents. This requires stable wasteforms and strong, corrosion-resistant container materials.

A combination of desirable characteristics has made cement-based wasteforms the most favoured for waste packaging in the UK. Cement formulations are easily produced, stable and long lived, and can be designed to tolerate the expected range of radiological, chemical and thermal conditions [50]. The UK and world-wide nuclear industry has had extensive experience with cement-based materials for the immobilisation of ILW and LLW.

The container is a key component of the complete waste package. To allow retrievability, the container must retain its strength, containment and capability for safe handling throughout periods of storage both above and below ground. Stainless steel is the material favoured by Nirex for waste containers because of its excellent resistance to corrosion. Nirex has carried out considerable research on the corrosion properties of stainless steels [16], and is managing research to investigate remaining corrosion issues.

4.6 Letter of Compliance assessment process

Nirex assesses waste producers' proposals for waste packaging for compatibility with the PGRC and compliance with the GWPS through the Letter of Compliance (LoC) process. This process, which was formerly known as the “Letter of Comfort” process, has been operated since the mid-1980s. Since January 2004, the process has been brought under regulatory scrutiny (see Section 4.3) and the LoC process is now embedded in the regulatory arrangements for the treatment and packaging of intermediate-level waste in the UK.

The regulatory arrangements require that nuclear site operators produce a safety case for any conditioned waste packages that will be produced. The Nirex assessment of the waste package will be provided to the site operator as a disposability assessment, describing why (or why not, as the case may be) Nirex believes the packaged waste to be compliant with plans for transport, operations (including a monitored storage phase) and final closure of the PGRC. The disposability assessment provided by Nirex will be incorporated into the site operators’ overall safety case for consideration by the regulators. For further description of this process see [51].

The issue of a Letter of Compliance is not a one-off event but is one step in the process of managing radioactive wastes. The LoC signifies that packaging of the waste can be undertaken in compliance with Nirex standards and specifications and will lead to waste packages that would be compliant with the requirements of the PGRC.

The waste packaging process will lead to the generation of information and records which with the LoC will form the “package record” that will follow the waste package through subsequent stages of its life. The package record shows stakeholders that:

- packages have been assessed against the requirements of the PGRC and issued with a LoC;
- packages have been produced against a defined Waste Product Specification (WPrS);
- data on the waste package have been generated and recorded;
- processes have been undertaken in accordance with controlled quality management systems (QA); and
- independent checks have been made to confirm that the operator has actually produced the packages according to Nirex's standards.

These elements of the package record play an essential role as the waste package passes from one phase of management to the next. They are essential to making the safety cases for a repository.

It can be seen that the LoC and assembled package record has to be maintained, added to and updated appropriately throughout subsequent phases of the package lifetime. Nirex has also identified the need for periodic review of issued LoCs so that LoCs and associated package records are kept "live" and never more than say 10 years old. Nirex is currently discussing the scope of periodic reviews with appropriate regulators. Finally it should be noted that all necessary parts of the package record are defined within Nirex documentation and will be strengthened by the improved regulatory arrangements discussed previously.

Progress made in assessing and endorsing waste packaging proposals is described in the Nirex annual report on waste packaging interactions, e.g. [52]. The total conditioned volume of ILW declared in the UK Radioactive Waste Inventory is 241,000 m^3. As of March 2005, some 40% of waste has been assessed through the LoC process and of about 22% has been issued with a final LoC, although only about 8% has been conditioned and packaged.

4.7 Compatibility of packaged waste with future waste management

The packaging or repackaging of radioactive wastes is costly and implies significant radiation dose commitments. Nirex, regulators and the industry therefore need maximum assurance that waste packages being produced now will not require re-packaging in the future. The Nirex GWPS and LoC assessment process, described above, are designed to give that assurance.

4.7.1 Compatibility with alternative management options

It is possible that future Government policy may specify some alternative long-term waste management concept be adopted for some, or all, of the ILW and LLW currently packaged according to the GWPS.

Nirex has reviewed the international literature and identified a range of options, see Section 3, that have been suggested for the long-term management of radioactive waste[7], and

[7] The options identified are broadly the same as those subsequently identified by CoRWM.

carried out a preliminary review of the extent to which wastes, conditioned and packaged in line with the GWPS, could be compatible with these alternative options [53].

The feasibility and safety of managing Nirex-specified waste packages in each of the alternative options were considered qualitatively, and each option classed as:

- Compatible – waste packaged to the GWPS would be fully compatible with the option, (essentially phases of the PGRC or very similar in requirements);

- Not foreclosed – if waste is packaged to the GWPS these options would not be ruled out (a reversal of packaging steps would not be required but in some cases additional packaging steps would be needed);

- Precluded – options that are not readily compatible with the waste and/or package specification.

It was concluded that, of the long-term management options identified in Section 3, only four would be precluded; these included disposal in ice sheets, rock melting, direct injection (of liquid waste) and transmutation. This was mainly on grounds that the basic characteristics of the waste would be incompatible with the option.

The question of continuing to package waste according to the GWPS during the current review of radioactive waste management policy has been discussed at workshops sponsored by the Radioactive Waste Policy Group (RWPG) operated under the auspices of Defra. It was concluded that the waste should continue to be packaged under the LoC arrangements, and it would not be acceptable to defer packaging to await CoRWM's review of options [54].

5 SAFETY AND ENVIRONMENTAL PROTECTION PROVIDED BY THE PGRC

Assurance of the safety and environmental protection afforded by the PGRC is obtained from analysis of scientific and technical information and understanding, and associated quantitative assessments. These analyses and assessments have been documented in respect of:

- transport of waste to the repository;
- operation of the repository;
- the long-term, after the repository has been backfilled, sealed and closed (post-closure);
- nuclear criticality; and
- non-radiological environmental impacts.

Although it is important to provide assurance on all of these aspects, the key test of a repository concept is the evaluation of the level of safety and environmental protection it will provide in the long term. There is ample precedent from operating nuclear transport systems and from the operation of nuclear facilities both in the UK and internationally, that these operations can be carried out in compliance with modern health and safety and environmental protection standards, and that there are established methods for carrying out the necessary analyses to demonstrate that compliance. Therefore, the main focus of this section concerns the long-term safety of the PGRC.

5.1 Long-term safety of the PGRC

The long-term safety of the PGRC is based on the isolation and containment functions of its combination of man-made and natural barriers. It also depends on the scientific and technical information and understanding of the characteristics and behaviour of the geological and engineered systems and materials comprising these barriers. Numerical models have been developed to analyse the isolation and containment of radionuclides as the repository system evolves in the long term and to show the effect of uncertainties in information or understanding on this analysis. The outputs of these models are the calculated releases of radionuclides from the PGRC, eventually to the surface environment. This allows calculation of potential radiological consequences of these releases for comparison with the relevant regulatory standards.

International and UK safety requirements

The United Nations organisation, the International Atomic Energy Agency (IAEA), has a Radioactive Waste Safety Standards (RADWASS) programme that is aimed at establishing a coherent and comprehensive set of principles, requirements and recommendations for the safe management of radioactive waste. These are published as IAEA Safety Standard Series documents, to provide an internationally agreed framework for the setting of national safety standards and for the development of management, technological and analytical systems for the safe management of radioactive wastes. The Safety Standards document of most specific relevance to the PGRC is that dealing with ‘Safety Requirements for the Geological Disposal of Radioactive Waste’ [55]. It proposes a long-term safety standard, that

> *'the estimated average dose or risk to members of the public, who may be exposed as a result of the disposal facilities in the future, shall not exceed a dose constraint of 0.3 mSv in a year or a risk constraint of order of 10^{-5} per year.'*

In the IAEA context this means a risk to a person of 1 in 100,000 per year of a serious health effect. In the UK, a more conservative dose to risk ratio is adopted that gives a radiological risk to a person of 1 in 55,000 per year of developing either a fatal cancer or serious hereditary defect.

The IAEA Safety Requirements document also proposes the basis for establishing that estimate, and the associated confidence in the safety of a geological repository, as follows (paragraph 3.24):

> *"An understanding of the performance of the disposal system and its safety features and processes evolves as more data are accumulated and scientific knowledge is developed. Early in the development of the concept, the data and the level of understanding gained should provide the confidence necessary to commit the resources to further investigation. Before the start of construction, during emplacement and at closure, the level of understanding should be sufficient to support the safety case for fulfilling the applicable regulatory requirements. In establishing these requirements, it is important to recognize that there are multiple components of uncertainty inherent in modelling complex environmental systems and that there are inevitably significant uncertainties associated with projecting the performance of a geological disposal system."*

The OECD-NEA has co-sponsored the "Safety Requirements" document and published a companion report explaining to a technical audience the nature and purpose of the long-term safety case for geological disposal [56].

The UK environment agencies have set requirements for the land-based disposal of radioactive wastes [57], in particular that the assessed radiological risk to an individual should be less than one-in-a-million per year. This means a risk to a person of less than 1 in a million per year of developing either a fatal cancer or a serious hereditary defect. This compares to the 1 in 55,000 per year risk constraint implied by the IAEA Safety Requirements. The environment agencies note that it is also between one hundred and one thousand times below the radiological risk to which members of the population are exposed as a result of natural background radiation levels in the UK. This means that the risk to a person from natural background radiation is between 1 in 10,000 and 1 in 1,000 per year of developing either a fatal cancer or a serious hereditary defect. The UK environment agencies recognise the uncertainties associated with calculating radiological doses and risks in the very long term and require to be satisfied with the quality of the science and engineering used in developing a proposal for a repository. They also require that the calculation of radiological doses and risks is complemented and supported by multiple lines of evidence.

Performance assessment methodology

The understanding of the performance of the repository is documented as a "performance assessment". The structure of a performance assessment and the methods and tools to be used in its development have been the subject of much analysis, exploiting, where relevant, risk analysis in other technological areas such as chemical plants, aircraft design etc. A substantial literature has developed in relation to geological repositories, which has been most recently summarised by the IAEA and NEA reports outlined above. Nirex has

developed its approach to performance assessment to conform with best practice, as laid out in those documents and their underpinning information.

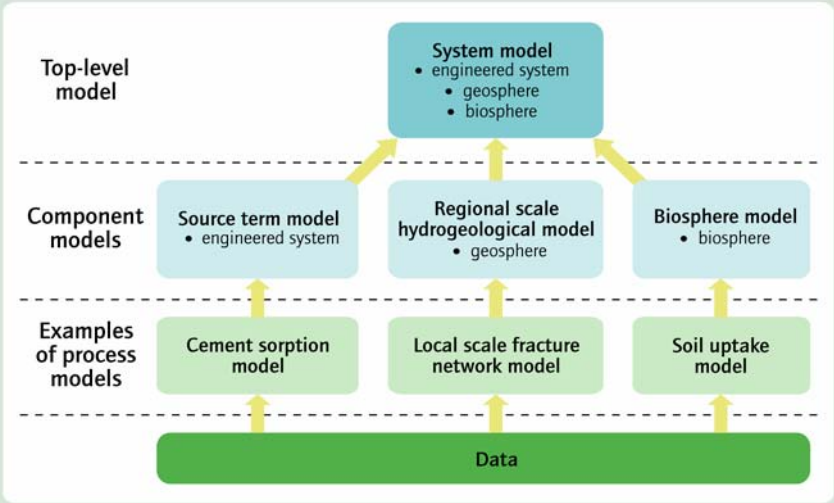
The Nirex approach is based on a series of analytical steps, starting with a wide-ranging consideration of all the features, events and processes (FEPS) that could possibly affect the long-term safety of a repository. This step is a formal, structured process involving independent experts in the relevant fields of science and technology whose inputs in identifying FEPs are recorded in a highly traceable manner. The Nirex FEPs were compared with international FEP lists [58] to ensure they provided a comprehensive description of all the potential issues affecting the long-term safety of the repository.

The FEP analysis leads to an hypothesis of general behaviour of the system, focussing on the different ways in which radionuclides could leave the repository and enter the accessible environment, with consequent potential for radiation exposure of humans. This hypothesis is represented by a series of conceptual models. Conceptual models are qualitative (not numerical) descriptions of the repository system and its evolution over time that reflect the understanding of the chemical, physical and (more-specifically) hydrogeological processes affecting the repository. Conceptual models are developed to represent the main processes occurring within each of the different components of the repository system, namely:

- the engineered system (also known as the near field) – comprising the underground vaults, waste packages, backfill and other materials;
- the geosphere – comprising the rocks in which the repository is constructed and those that surround them, extending to the surface; and
- the biosphere – the near-surface and surface environment, including the atmosphere, water bodies (terrestrial and marine), the soil and the upper part of underlying bedrock.

The process understanding that underpins these models is obtained from the Nirex research programme (see Section 6), from the accumulated international scientific and technical information and understanding, and from scientific evidence as reported in the peer reviewed literature. The Nirex research programme is structured around the current status of knowledge concerning important safety-related processes and the formal identification of outstanding issues in relation to those processes. Data at this 'process level' can be used to construct and populate process models. These are the most detailed models in a safety assessment model hierarchy that is illustrated in Figure 25.

Figure 25
Model hierarchy, examples of different levels of models



The aim of the detailed, process level models is to develop and demonstrate a depth of understanding and provide the relevant parameters for the component and system level models. For example, a process level model may represent the detailed chemistry of the wastes, this may feed into a higher-level model representing the whole of the engineered system, which in turn will supply information to a model of the complete repository system. It is the top-level repository system model that is used to calculate the overall performance of the system.

Because of the uncertainty regarding the future, it is necessary to consider a range of alternative scenarios. An internationally accepted approach, also adopted by Nirex, is to consider a 'base case' or 'reference' scenario that represents the natural, or expected, evolution of the repository system in the absence of any major disturbances and a range of variant scenarios. Variant scenarios can be used to consider, for example, the effects of drilling in the vicinity of the repository or a criticality scenario.

All the above stages are encompassed within the Nirex scenario development methodology; this has been published [59, 60] and received a favourable formal international peer review from an OECD-NEA expert group [61]. A conclusion from that group was that:

> *"The specification, in the Nirex methodology, of the conceptual models in terms of FEPS and their interactions is subsequently used to assess the applicability of already existing models and to identify potential needs for further model development. Even if no further model development is judged necessary this approach enhances confidence in the assessment models."*

The use of performance assessment in development of the PGRC

Performance assessment is being performed iteratively throughout the development of the Phased Geological Repository Concept and its implementation:

- to synthesise and test the current level of scientific understanding and data for the given design concept or possible repository at a site;
- to demonstrate understanding of the projected long-term performance of the repository and its safety, and identify factors that are most important to that performance and safety and related uncertainties;
- to identify those aspects on which greater understanding or data are needed. Research and data requirements can then be specified for future iterations to reduce, or better quantify, uncertainties in order to obtain better substantiated estimates of performance;
- to identify possible repository design or layout modifications to improve performance or to avoid specific uncertainties; and
- to demonstrate that the Concept meets regulatory requirements and will remain safe over all timescales.

The understanding of system performance and safety gained from the performance assessment forms part of the overall case for the safety and environmental protection afforded by the repository. A safety case is the formal compilation of evidence, analyses and arguments that quantify and substantiate a claim that a radioactive waste repository is safe [56].

Basis for generic assessment

At present, there is no site selected for the development of a repository in the UK. Nirex has, therefore, developed a Generic Post-closure Performance Assessment (GPA) [19]. This is based on a range of geological characteristics consistent with conditions that could be found in up to 30% of the UK landmass. The GPA is used to test the generic design, and to test the compatibility and safety of waste producers' packaging proposals in support of the LoC assessment process.

A fundamental feature of the Nirex approach is that the characteristics of the generic site are deliberately pitched to give a repository performance at the 10^{-6} risk target so as to include as wide a range of sites as possible.

Alongside the development of a strong theoretical basis for the PGRC, Nirex also has significant experience gained in developing performance assessments that are site-specific, particularly from the investigation of the Sellafield site between 1991 and 1997, e.g. as described in Nirex 95 [62] and Nirex 97 [63]. The Nirex 97 assessment has been subject to formal peer review [64]. That review concluded:

> *"Nirex 97 is an impressive achievement, both for Nirex and for the field of performance assessments of deep repositories."*

The review went on to note that Nirex 97 could have been made more accessible by improved presentation. Nevertheless, the reviewers believed that the capability and computer programs developed in Nirex 97 would be readily transferable and provide a sound basis for future assessments, whether for Sellafield, or for other sites.

The way that performance assessment might be applied to different stages of a programme is described in a Nirex Report [65], which also sets out the general approach and features of the Nirex performance assessment methodology.

Performance assessment of the PGRC

For the Nirex Geological Repository Concept three main pathways that could lead to radiation exposures have been identified. These are:

- the groundwater pathway – migration of dissolved radionuclides and radionuclides associated with colloids in groundwater;
- the gas pathway – transport of radionuclide-bearing gas generated in the repository; and
- the human intrusion pathway – exposure during drilling or excavation activities or resulting from the deposit of radioactivity at the surface, as a result of such activities.

Groundwater pathway

Figure 26 shows the calculated annual individual radiological risk from the groundwater pathway for the Generic Performance Assessment (GPA) reference case [19], showing contributions from individual radionuclides.

In the absence of site-specific information, a set of three parameters has been used to describe the key features of groundwater flow in the geosphere. These are:

- Q, the volumetric flow of groundwater through the engineered system;
- T, the travel time for water to move from the engineered system to the biosphere; and
- F, the volumetric flow of water in the near-surface geological units that will mix with water that has travelled from repository depth.

Values have been chosen for these parameters so that the peak calculated radiological risk in the reference case assessment will be just less than the one in a million per year that defines the regulatory standard. Thus the peak risk in Figure 26 is 9×10^{-7} (or 1 in 1.1 million) per year which effectively defines the requirements from any potential repository site.

Figure 27 shows the results of a variant calculation conducted in the GPA for the case where the ILW (and LLW unsuitable for near-surface disposal) resulting from the final stage of decommissioning of nuclear power plants would be put into the same repository. The peak risk is unchanged from that in Figure 26, but the risks calculated to arise about 10,000 years after repository closure are slightly higher. This is mainly because of the increased inventory of chlorine-36 in the repository as a result of including these wastes.

The combination of values chosen for the hydrogeological model parameters Q, T and F in the Generic Performance Assessment are consistent with ranges of combinations of these values for various geological systems found in the United Kingdom – that is, sites affording suitable hydrogeological conditions are not uncommon and could be found in a number of areas.

As stated above, previous studies by the British Geological Survey (BGS) have shown that potentially suitable conditions can be found in up to 30% of the UK's deep geology [43]. Nirex has recently commissioned the BGS to use its updated national geoscience database and geoscientific knowledge and experience to review the values ascribed to Q, T and F and the UK geological systems where these would be expected to be satisfied.

Figure 28 shows the equivalent calculated risk, to that in Figure 26, for the Reference Assessment Model for the Nirex 97 assessment of a potential repository at the Sellafield site [63]. The peak calculated risk was 1.2×10^{-7} (or 1 in 8.3 million) per year. However, this occurred at 50 million years after closure when such calculations, based on assumed persistence of the Earth's current surface geology, can have little basis. The peak risk calculated for the Sellafield site up to one million years after closure was 1.3×10^{-8} (or 1 in 77 million) per year. At Sellafield, measured parameter values and their associated uncertainties were available to describe groundwater flow at the site. In effect the calculated radiological risks correspond to measured Q, T and F values for Sellafield and are well below the risk that defines the regulatory standard.

At times around 10,000 years to 100,000 years post-closure, the risk is dominated by chlorine-36 and iodine-129. These radionuclides are soluble and mobile (that is, they are not strongly retarded or retained by processes such as sorption to solid surfaces), which is why they give rise to a risk at relatively early times.

Much later, on timescales of a million years, the risk is dominated by the daughters of the naturally-occurring uranium-238 that is present in significant quantities in the wastes, most notably radium-226 and thorium-230. Uranium, thorium and radium have low solubilities under the chemical conditions expected in the repository, and are likely to sorb or adhere

strongly to the rocks in the geosphere (the rock around the repository) and to the repository backfill.

The uncertainties in the behaviour of uranium, thorium and radium are all included in the quantitative assessment by the construction of probability density functions (PDFs) for their solubilities in water and their sorption onto repository backfill and minerals on the surfaces of rock pores and fractures in the geosphere. A systematic description of the treatment of the identified uncertainties relating to all the processes involved in the assessment of the PGRC is beyond the scope of this report. However, an example is given below of how this is done for uranium-238 which dominates the risk calculations at very long times in the future.

The peak radiological risk calculated to arise from the release of the daughter products of uranium -238 is strongly affected by the values assigned to uranium solubility in the repository. Uranium has a low solubility in the alkaline water that is in equilibrium with cement, as used in the backfill material, but the presence of organic materials in some ILW has the potential to produce organic complexants as degradation products. These complexants can increase the solubility and decrease the sorption of uranium with a consequent higher calculated radiological risk than if the organic materials were not present. The peak risk is dominated by a small number of 'realisations' in the probabilistic assessment in which a combination of unfavourable values has been sampled from the relevant solubility and sorption PDFs. It is likely that a combination of further research and model refinement would result in lower calculated risk.

If the uranium-238 inventory were to increase significantly, for example, as a result of separated uranium, depleted uranium or spent fuel being re-classified as wastes, it would not necessarily tend to a proportional increase in the calculated risk. It should be possible to put these materials in repository vaults separate from ILW containing organic materials and from contact with complexants. The lower solubility and higher sorption values that would then apply would mean that adding these materials to an overall repository inventory would not have a significant effect on the radiological risk from uranium -238 and its daughters.

Figure 26
Annual individual risk vs time for GPA reference case

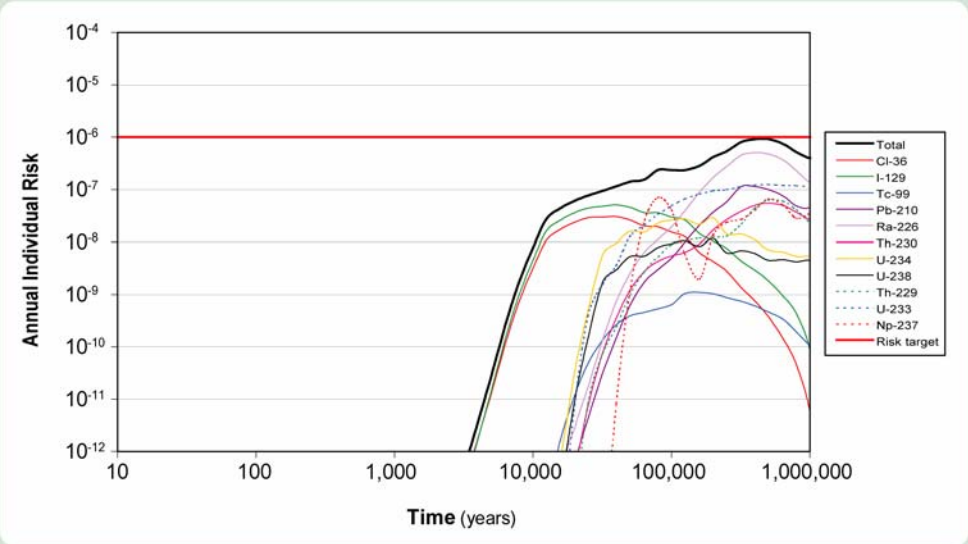


Figure 27
Annual individual risk vs time for final stage decommissioning wastes added to GPA reference case

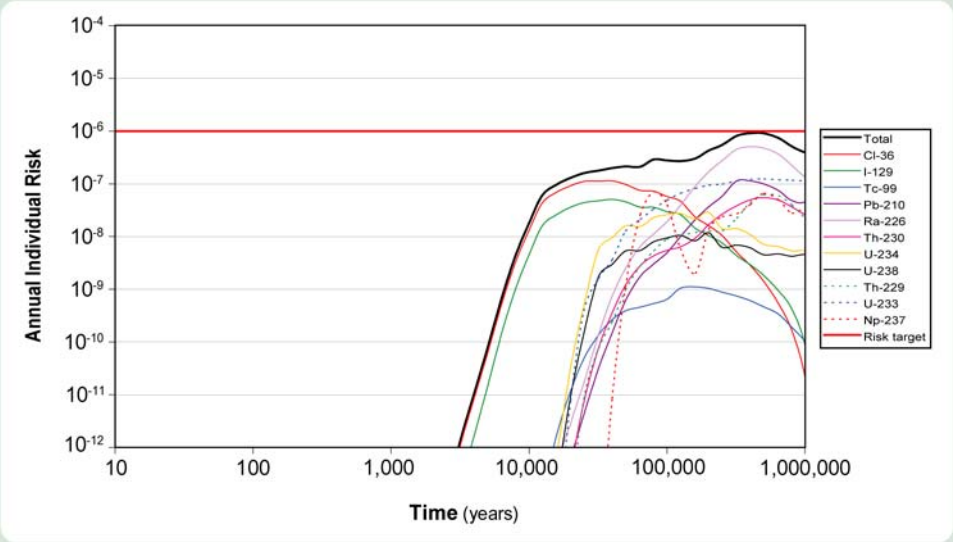
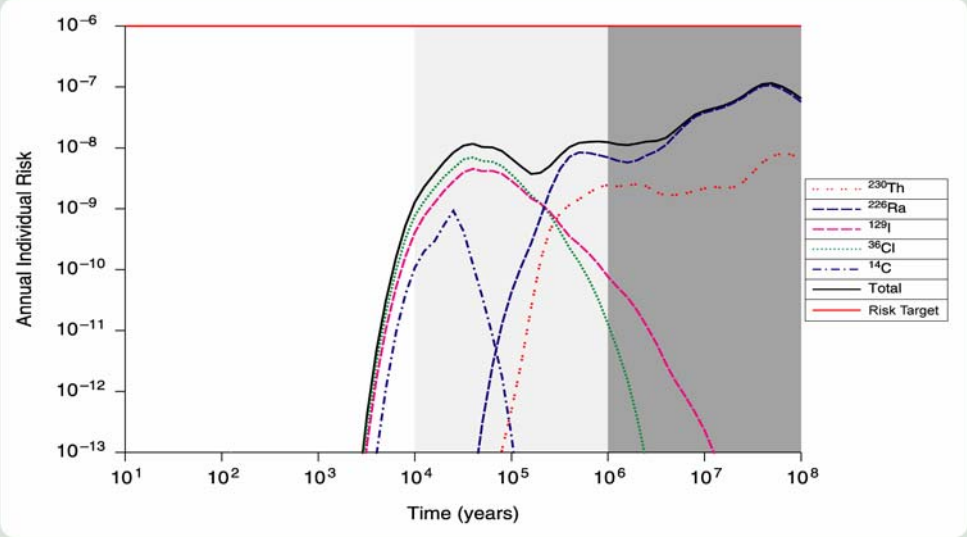


Figure 28
Annual Individual Risk vs Time for the Nirex 97 Reference Assessment Model



Gas pathway

As discussed in section 6.2, the wastes for disposal in the PGRC contain materials that could form gas when they degrade. It is therefore important to assess the level of potential gas generation and the ways it could affect the overall safety of the repository.

Post-closure performance assessments have consistently shown that there would be no significant risk from overpressurisation due to gas generation for a repository in a hard fractured host rock and no flammability hazard at the surface is expected to arise from gas generation. Risks from the gas pathway are dominated by the radiological impact of carbon-14 in the form of methane.

Carbon-14 has been identified as a key issue in the PGRC and further work is planned, which may include the identification of siting requirements. However, on balance, Nirex believes that carbon-14 is not a threat to the viability of the Phased Geological Repository Concept.

Calculations have been carried out to scope the potential impact of carbon-14 and the results are shown in Figure 29. Two curves are shown, reflecting alternative scenarios. The lower (blue) curve shows the calculated risk from carbon-14 if it all dissolves in groundwater and is released to the biosphere in solution.

Some of the gas generated in a repository could dissolve in groundwater and the migration of gas in the geosphere would depend on the site geology. In many geological settings, some form of gas retardation may be expected. Other waste management organisations such as Nagra (Switzerland) and Andra (France) have taken account of gas retardation in the geosphere in their performance assessment calculations. For example in the Nagra model, gas is retarded in the upper geosphere and then dissolves in an aquifer [66].

Nevertheless a situation can be envisaged where gas forms and is not dissolved in the groundwater, as was assumed for example by SKB in its 1995 Template for Safety Reports [67]. In Figure 29, the upper (yellow) curve scopes the impact of a scenario where carbon-14 is released as gas and all methane generated is released directly to the biosphere as gas, taking no account of delay in the geosphere. This scenario has not been researched to the same extent as the groundwater scenario. Therefore, in order to undertake a scoping calculation, a number of assumptions have been made.

Where possible, the calculations are based on the best understanding of gas generation rates. Where there is uncertainty, assumptions have been chosen to maximise the generation of methane in the period after repository closure, as any gas generated before this time does not lead to a post-closure risk. The calculation includes sources of carbon-14 which were qualitatively recognised in the GPA, but for which understanding and model development has only recently allowed their inclusion in scoping calculations. The calculation has been carried out on the following basis:

- The calculation is based on the 2001 National Inventory including final stage decommissioning wastes [68].

- An analysis of the Inventory has been undertaken to estimate the proportion of carbon-14 present within different materials (e.g. steel, graphite) within each waste stream.

- All carbon-14 is conservatively assumed to remain in the wastes until it arrives at the repository, i.e. none is released during the initial packaging and storage of the

wastes. However, gas generation during the operational period and during repository backfilling is assumed to occur and to be managed through the ventilation system.

- The repository is assumed to resaturate with water over a 5 year period following repository closure, and this water is available to react with the waste, causing corrosion. After this 5 year period, unlimited groundwater is assumed to be available.

- The carbon-14 in metals was assumed to be evenly distributed throughout the metal and to be released as the metal corrodes. The initial surface area of the metal waste is uncertain and would vary between waste streams; for the calculation metal wastes are represented as spheres, of a size determined by expert judgement.

- The metal corrosion rates are dependent on temperature. For this calculation we have applied a temperature of 35°C throughout the operational and post-closure periods. Metals would experience a higher temperature (and higher corrosion) than this during the backfilling period and the gas generated would not contribute to the post-closure risk.

- All of the carbon-14 in the metallic wastes is assumed to be released as methane. (Some metal carbides could produce acetylene, but this is thought to give rise to a similar or slightly lower radiological risk than if it is assumed to be methane).

- Organic materials that contain carbon-14 were assumed to be degraded by microbes and by radiolysis. The rates of these reactions are uncertain and the rates used in the calculation were derived by expert judgement.

- Organic waste degrades to form a mixture of carbon dioxide and methane; it is assumed that the carbon dioxide reacts with cement in the repository and does not contribute to the calculated risk from gas.

- It is conservatively assumed that all of the carbon-14 in the graphite is released, with 1% released as methane and the remainder as carbon dioxide[8]. In these calculations, we have assumed that methane is generated at a rate one order of magnitude lower than the detection limit achieved in recent experiments, up to a total of 1% of the graphite inventory of carbon-14. (If the detection limit itself were used the gas would only be released for a very short time after repository closure).

- The generated gas is assumed instantaneously to break through the overlying rocks to reach the biosphere.

- It is assumed that people will be growing and consuming crops on the land above the repository immediately after it has been closed, whereas in reality buildings would have to be demolished and the site cleared, and the regulators envisage a period of institutional control over the site.

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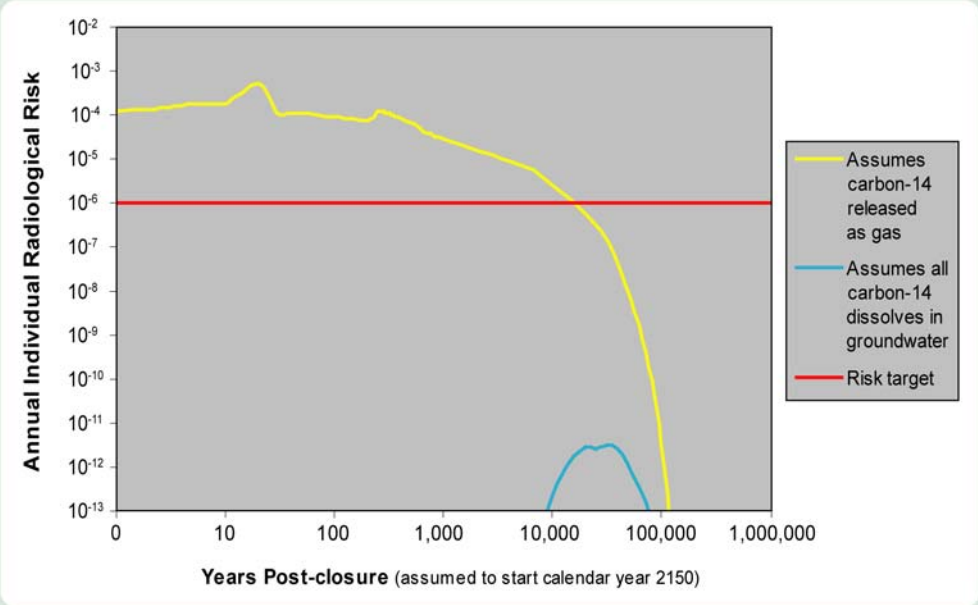
[8] Experiments show that 0.001% to 1% of the carbon-14 in graphite could be released as methane and that this is likely to be a short-term release; however, a lower but longer-term release rate has not been ruled out and has been assumed in these calculations.

- The radiological risk from the gas that is released to the biosphere is calculated using the biosphere factors used in the GPA. The biosphere factor for carbon-14 in the form of hydrocarbon gases has recently been reviewed and revised. The new biosphere factor has a dependence on the rate of release of non-active methane, which means that at longer times when the rate of non-active methane degradation has decreased, risks could be higher than that shown here. The peak risk would not be affected, however.

Figure 29
Annual individual risk vs time for carbon-14 dissolved in groundwater and for the scoping calculation for carbon-14 released as gas



The yellow curve contains contributions from methane produced from the corrosion of the more chemically reactive metals; the degradation of organic materials; irradiated graphite; and the corrosion of irradiated steels and Zircaloy. These contributions to the calculated risk are discussed further below.

The peak risk in the first 100 years (as calculated above) arises from the corrosion of uranium, with Magnox corrosion as another key contributor. In practice these metals will have undergone some corrosion prior to repository closure and their post-closure corrosion rate could be limited by water availability as the repository resaturates. Improving our understanding of these issues could reduce the peak post-closure risk modelled in the calculations.

Organic wastes containing carbon-14 contribute to the peak radiological risk calculated at around 250 years post closure. Although these wastes are declared in the Inventory, they may not come to a repository in this form as they could be re-used or treated in some other way, which could reduce their capability to generate methane gas. Organic wastes are calculated to completely degrade over a timescale of about 10,000 years, after this time the only sources of radioactive methane that remain are irradiated steels and Zircaloy.

The calculated risk from irradiated graphite makes a relatively lower contribution to the yellow curve (with a calculated risk of ~10^{-5} per year for about the first five hundred years).

Nirex has an ongoing programme of experiments on irradiated graphite and it is possible that improving the experimental detection limits could lead to a lower post-closure gas generation rate from graphite than that assumed for the scoping calculation. However, the accuracy of the inventory of carbon-14 in graphite has been questioned and this issue is also being reviewed and discussed with waste producers as part of the future work programme.

Corrosion of irradiated steels contributes significantly to the risk calculated above, especially after the other sources are degraded. Further research is required to determine the distribution of carbon-14 in irradiated steels and the form in which it is released during corrosion, which is uncertain. If the carbon-14 was heavily concentrated at the metal surface and it was released as methane, there might be an increase in the risks calculated (but only for a short time).

The calculation of the yellow curve assumes that methane generated in the repository would be directly released to the biosphere, taking no account of delay in the geosphere. In practice, some or all of the methane could dissolve in groundwater, depending on site conditions. If all the carbon-14 were to dissolve into groundwater and be released to the biosphere in solution, then the calculated risk is shown by the blue curve in Figure 29. Gas could also be retarded in the overlying rocks; for example many geological environments would include overlying sediments, which offer the potential to disperse gas migration from the repository, reducing the hazard from repository-derived gas. Also sedimentary rocks can often contain impermeable layers, such as mudrocks, which would be expected to retain gas.

As described in section 6.2, Nirex has an ongoing programme of research on carbon-14, which is improving our understanding of these issues. Further work is still required, which includes: work to assess the extent to which gas would dissolve in groundwater; work to assess the extent to which different geological environments (as measured by the presence of highly impermeable layers in the overlying strata) have the potential to retard gas migration; and work to reduce uncertainties in the rates and quantities of gaseous carbon-14 generated.

If, through further work, the calculated rates and quantities of carbon-14 containing methane generated were not to be significantly reduced, compared with those used in the scoping calculation presented here, it could be necessary to establish siting criteria that would ensure that significant gaseous release to the biosphere would be unlikely. Additional work is required to assess the extent to which different geological environments in the UK have the potential to retard gas migration and to determine how this could be assessed as part of a site characterisation programme. The implications of these criteria would need to be assessed and included within the requirements for the generic geology in the PGRC.

Although further work is planned which may include the identification of specific siting requirements, on balance Nirex believes that carbon-14 is not a threat to the viability of the phased geological repository concept.

Human intrusion pathway

International guidance has been provided on the siting of geological repositories to reduce the likelihood of inadvertent human intrusion, for example in [55]:

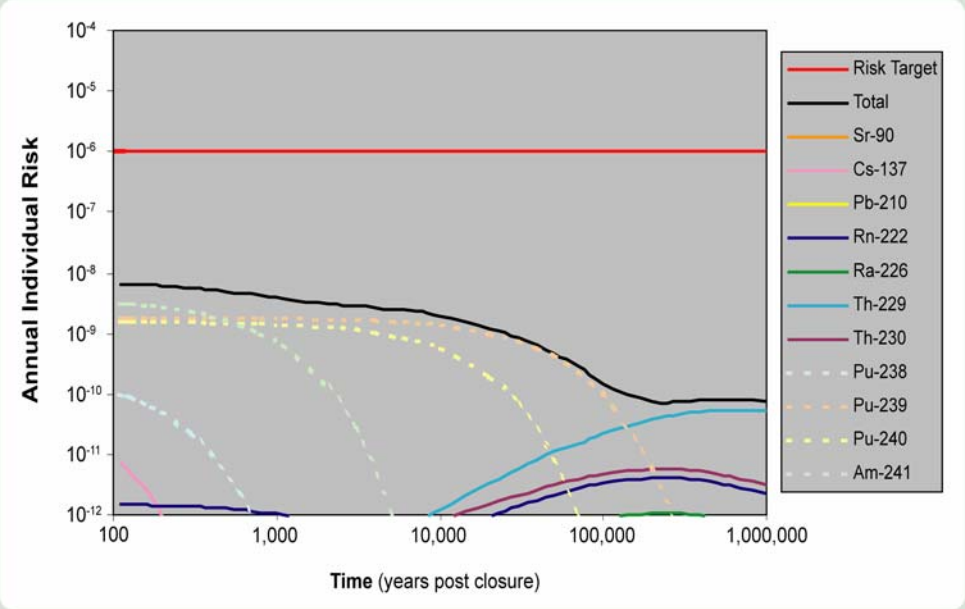
> *"Location away from known areas of underground mineral resources is desirable to reduce the likelihood of inadvertent disturbance of the geological*

disposal facility and to avoid resources being made unavailable for exploitation".

In practice this means selecting a geological host environment that holds little potential interest for exploration for minerals or other resources. Therefore the GPA considers the human intrusion pathway as a variant scenario, i.e. it is not expected to occur and hence not part of the base scenario.

In the human intrusion scenario, two potential exposure routes arising from drilling in the vicinity of the repository have been considered: 1) the geotechnical worker, who examines contaminated drill core; and 2) the site inhabitants who are exposed to radiation from discarded contaminated drill core. The peak radiological risk to the geotechnical worker, for an intrusion 100 years after repository closure, is 6.6×10^{-9} (or 1 in 152 million) per year and the peak calculated for a site occupier, after 200,000 years, is 9.3×10^{-7} (or 1 in 1.1 million) per year. Figure 30 gives the risk profile for the geotechnical worker.

Figure 30
Calculated annual risk in the geotechnical worker scenario, for intrusion into unshielded ILW vaults of a repository, reference case inventory



Implications for siting

The Generic Performance Assessment for the PGRC demonstrates that it is possible to locate such a repository concept in a range of geological environments and meet the regulatory risk target over all timescales.

Treatment of uncertainty

As described above the long-term safety and environmental assessment of the concept is based on an understanding of the general behaviour of the system focusing on the different ways in which radionuclides could leave the repository and enter the biosphere. This is represented in mathematical models that are used to calculate the safety and environmental impacts.

Some of the assessment models and associated parameters relate to processes on which there is little information or where information is difficult to obtain. This is a common problem in scientific and engineering analyses. Based on that experience, internationally accepted strategies for handling such data uncertainties in safety assessments have been developed, for example, NEA study groups have reached international consensus and published reports on establishing and communicating the long-term safety of deep disposal [69].

However, it is also important to recognise that there is substantial uncertainty associated with certain processes operating in a radioactive waste repository system on a timescale of a million years or more, and this uncertainty requires appropriate treatment in performance assessments in support of such a facility. In a repository system there are a number of different areas in which uncertainty may influence a performance assessment, including data uncertainty, model uncertainty, uncertainty about future states of the system and uncertainty about human behaviour.

There are various ways of handling uncertainty in data. These include using the most conservative possible values for uncertain data; and probabilistic approaches in which the range of uncertainty in parameter values is represented within probability density functions. A performance assessment may be relatively insensitive to some parameters, therefore poor data will be less important in some areas than others – sensitivity studies are very helpful in determining the significance of a particular parameter value to the overall repository performance.

Uncertainty in the formulation of conceptual models may be best handled by identifying and testing a range of different conceptual models. For example, in the Nirex 97 assessment [63] two conceptual models of the host rock structure were developed and carried through to the calculation stage where the different models could be calibrated and assessed for validity against independent data. The accuracy and correct functioning of the software itself can be verified by comparisons of results against those produced by other computer programs. It may also be possible to conduct test cases to reproduce answers from known analytical solutions.

For a post-closure performance assessment, there may be substantial uncertainty associated with the future of the repository system, and substantial variability. Nirex has developed a methodology for addressing this uncertainty in a systematic way, based on the analysis of FEPs and development of scenarios which can then be addressed in detail in a performance assessment.

For a given scenario, strategies for handling uncertainty tend to fall into the following broad categories:

- Demonstrating that the uncertainty is not important to safety because, for example, safety is dominated by other processes.

- Addressing the uncertainty explicitly, usually using probabilistic techniques, and showing that the expected situation is acceptable.

- Bounding the uncertainty and showing that even the bounding case gives acceptable safety.

- Ruling out the uncertainty, usually on the grounds of very low probability of occurrence, or because other consequences, if the uncertain event were to happen, would far outweigh concerns over the repository performance.

When assessing the performance of a radioactive waste repository over extremely long timescales, there are acknowledged to be uncertainties in many areas and some of these uncertainties will be large. However, not all of the uncertainties will be significant and there is international consensus [69] that, by using a combination of these strategies for treating such uncertainties, it is possible to develop a safety case for a repository.

A key driver for a deep geological repository as an option for the long-term management of radioactive waste, is to remove the large uncertainty associated with leaving the waste accessible to humans over very long timescales. This is because there is very much more uncertainty over the future of society than there is over whether the geosphere will perform its desired role of isolating the waste from such future societies. This is reflected in the relative timescales of geological change versus social change. A well-chosen geological site will be relatively stable for a long time into the future and provide effective containment of the radioactive material (see “Confidence in geological processes” below).

Status of Nirex performance assessment studies

A large amount of work has already been undertaken by Nirex and by similar organisations around the world to develop robust methodologies for the assessment of the long-term performance of geological repositories (see for example, [65]).

Nirex has a deliberate policy of seeking both preview (prior to implementation) and review of its scientific and technical work. The Nirex scenario development methodology and general assessment approach [59] and Nirex’s most comprehensive performance assessment, the Nirex 97 assessment of a repository at the Sellafield site [63], have both been subjected to thorough formal peer review [61,64].

The current Nirex performance assessment studies are generic [19]. However, the assessment approach followed provides a link to earlier site-specific studies [70] and Nirex has published a report that describes the overall context for performance assessments and the ways in which they are expected to develop at the different stages of a repository development programme [65].

Nirex seeks continual improvement in its safety assessment work and is currently previewing proposals for its next safety assessment update. These proposals, which include more detailed modelling of the early post-closure timescales, will be scrutinised by the Nuclear Waste Assessment Team (NWAT) as part of the regulatory arrangements described in Section 4.3.

Confidence in geological processes

The safety of a geological repository is linked inevitably to time periods of at least tens or hundreds of thousands of years. It is hardly surprising that most people, non-scientists and scientists alike, find it difficult to come to terms with intervals such as these and to accept that they can be measured accurately. Yet it is vital that we understand the processes that will affect the repository and its surroundings over these immense time periods.

Central to the earth sciences are studies of the history of our planet. Underpinning this has been the development, over many years, of very precise methods for dating events and processes in geological history and, based on these, the establishment of an accurate record of geological time. The Earth is now believed to be slightly more than 4.5 thousand million years old – appreciably older than the periods we are concerned with here.

The discovery and systematic analysis of radioactivity provided the technical basis for a precise time scale against which to calibrate the geological record. A few natural chemical elements have unstable nuclei which decay, at characteristic and fixed rates, to produce different ("daughter") nuclei. Perhaps the most widely known and utilised is potassium 40 which decays to an isotope of Argon (argon-40). Potassium is a metal and very commonly found in rock-forming minerals such as feldspar and micas. Argon is a gas which is not incorporated into the minerals when they form. Once they are formed, however, the products of radioactive decay are trapped in the crystal lattice and, as time passes, argon builds up as potassium decays. Measuring the ratio of these two gives a direct estimate of age. On the basis of these and similar measurements, literally hundreds of thousands of "ages" have been measured in laboratories around the World with much research devoted to establishing uncertainties and precisions.

Other, independent, scientific techniques have been developed which allow the precision of the scale to be greatly refined and applied to many different rock types – not just those for which radiometric dating is possible. The Earth's magnetic field reverses relatively regularly and periods of "normal" and "reverse" magnetism have been calibrated and measured in different rocks. Equally, higher resolution biological dating has emerged from studies of fossil pollen and plankton – and utilised very successfully in the search for oil and gas. Finally, climate oscillations have been recorded in deep sea sediments (which give a continuous record going back many millions of years) by water temperature estimates from oxygen isotope ratios preserved in marine plankton. The painstaking research which led to this remarkably comprehensive understanding, including detailed descriptions of the methodologies employed, is described fully in [71].

On this foundation, earth scientists have built up a sound and quantitative understanding of the different kinds of process that cause the geosphere to be modified, including surface processes, and the time scales upon which they operate.

The long-term safety of the Nirex PGRC, in common with repository concepts adopted elsewhere, capitalises on the inherent stability of the geosphere compared with processes that occur at the Earth's surface. For its generic performance assessments Nirex has simplified the various rock mass characteristics that influence the transport of radionuclides in groundwaters into three parameters, Q, T and F (see above). These three parameters can be used to indicate how the return of many radionuclides to the surface environment would be prevented, and to what extent the concentrations of any radionuclides that might return would be affected by the processes of radioactive decay, retention on rock surfaces, or dilution in the groundwater system.

Any repository site that might be selected would have to demonstrate appropriate values for these parameters, that would be set in accord with regulatory safety requirements. However, the key issue to be addressed in any assessment of the suitability of a prospective site is how to provide credible evidence that the processes of groundwater movement and radionuclide transport are unlikely to be accelerated at repository depths at any time in the future.

Rocks are made up of a solid mineral framework and a network of groundwater-filled pores and fractures. The connectivity and dimensions of these pores and fractures determine the ease with which groundwater can flow through rock under an imposed driving force (the "permeability"). Driving forces and gradients in groundwater pressures are caused by spatial variations of water infiltration and land topography and by variations of water density due to salinity and/or thermal effects.

Potential changes that might alter Q, T and F in the long term are mainly those that might affect the volume and connectivity of pores and fractures in the rock mass and in the forces

that drive groundwater movement. Examples of the changes that could affect the volume and connectivity of pores and fractures include the precipitation or dissolution of minerals due to chemical reactions and the closing or opening of fractures due to changes in imposed stress. Driving forces can similarly change with time, for example due to additional water pressure being exerted through the development of overlying ice sheets, groundwater infiltration decreasing in response to climate change, or density changes as groundwater compositions evolve or the thermal characteristics of a region change.

When considering more dramatic events that might change the rates of processes, we know, on the basis of radiometric dating of geological events, that some regions of the Earth's surface, located close to plate boundaries, are tectonically active. Frequent and massive earthquakes cause rock fracturing and may enhance permeability. Such regions remain susceptible to tectonic disruptions for many millions of years since the pattern of plate geometries only changes exceedingly slowly. Equally, there are large regions of the Earth's surface far away from plate boundaries where "quiet" conditions prevail – again for many millions of years. This is the case in the UK. Because these periods are very long, even compared with the longevity of artificially induced radioactivity, we can be confident that the characteristics of the deep subsurface will not change "suddenly" and site characteristics obtained by site investigation will be good indicators of future behaviour – even on a million year time frame.

Nirex is currently developing proposals for integrating the quantitative assessments and the other lines of reasoning, such as presented here, in an Environmental Safety Case (see Section 5.6).

Analysis of breakdown of PGRC multiple barrier system

The information presented above is intended to provide assurance of the long-term safety and environmental protection that will be provided as the repository system evolves with time. Further assurance of the intrinsic robustness of placing wastes in deep geological formations may be obtained from a separate type of analysis.

The post-closure performance assessments for the PGRC conducted by Nirex have attempted to take account of all identified uncertainties concerning the processes that may impact upon the calculated radiological risk. Safety of the concept is provided by multiple barriers avoiding undue reliance on any single safety function of one of the barriers. However the hypothetical extreme situation has been assessed, where no physical or chemical containment is assumed from the repository near field and all beneficial retardation processes in the geosphere are removed. Even under this scenario the results would not be catastrophic. Calculated annual doses are the same as those routinely received by members of the public in some locations of the UK from natural radiation [72]

5.2 Safety of transport to the repository

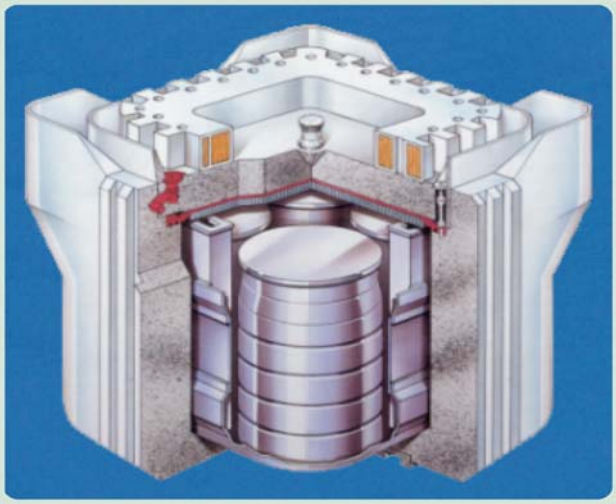
ILW exists at 34 nuclear sites distributed around the UK. The PGRC assumes that all this ILW will require transport to a single destination. Any national waste management strategy based on one or more centralised sites would have a similar transport requirement.

Focus group exercises show that transport will be the aspect of radioactive waste management that is likely to affect the public most directly. Hence, the safety of transport is a key issue for public acceptability of the PGRC and it is extremely important that the transport system is developed in a way that addresses stakeholders' concerns. Nirex is developing a strategy for stakeholder engagement in relation to its transport safety

programme to help achieve this [73]. For example, we are looking at sea transport as a possible means to reduce road and rail transport.

International standards and guidance for the safe transport of radioactive materials have been developed based on world-wide experience and best practice. This experience is distilled into the IAEA Transport Regulations [21], which apply to road, rail, sea and air transport of radioactive materials. These international regulations are enacted as EU Directives and by individual states, including the UK, and govern all transport of radioactive materials, including waste, through the public domain. A report has been produced annually by the National Radiological Protection Agency (NRPB) [74] which reviews the safety of radioactive materials transport within the UK. The reviews shows that radioactive materials have been transported safely to these standards for decades.

Figure 31
Standard transport package



Nirex has developed a concept for a national transport system to transport safely and efficiently all the UK's packaged ILW, and relevant LLW, from their sites of arising to a repository site [75]. This includes the specification of a range of transport packages (see Figure 31) and vehicle types, as well as the transport operation logistics. Key aspects are:

- development of designs and specifications for standard waste containers and specifications for their allowable contents (see Section 4.5);
- conceptual design of a range of reusable shielded transport containers for the transport of unshielded waste packages requiring shielding;
- development of realistic transport routes and logistics for a national transport system including all 34 nuclear sites and any one notional destination; and
- development of designs for rail wagons, road vehicles and associated transport hardware.

All individual elements are consistent with IAEA regulations, where applicable, and Nirex is working towards a formal demonstration of compliance with all the applicable safety standards. In addition to meeting international standards, Nirex has undertaken a detailed

assessment of the safety of the transport operation which provides a basis for dialogue with stakeholders.

The assessments of transport safety are documented in the Generic Transport Safety Assessment (GTSA) [76]. The assessment uses probabilistic risk-based methodologies for safety assessment similar to those applied to repository operations (see Section 5.3). These are consistent with the Health and Safety Executive (HSE) requirements for operational safety assessments at nuclear sites [77]. The GTSA currently assumes a transport operation based on a combination of road and rail transport, with scenarios looking at different mixes of the two. The generic nature of the assessment is achieved by dividing the Great Britain mainland into 10 geographic zones and considering transport to a notional repository in each zone. The GTSA also includes an initial consideration of sea transport issues and this is to be expanded in the future. Initial stakeholder feedback indicates that this will be important.

Doses and risks are estimated for routine transport operations and also from transport accidents, taking account of significant features of the transport routes. The GTSA shows that the radiological risks from transport accidents will generally be small compared with the conventional accident risks. The estimated radiological risks are dominated by external radiation from the transport packages during routine operations.

The GTSA methodology is also applied to the assessment of individual waste packaging proposals, as part of the Letter of Compliance assessment process (see Section 4.6). Experience gained from this work provides feedback into the GTSA development programme.

Overall, the GTSA shows that a national programme for the transport of ILW and relevant LLW can be achieved within risk levels that are acceptable under Nirex safety policies and guidance from HSE. However, we are very conscious of stakeholder and public concerns in this area. Current work is focusing on:

- optimising areas of the transport system design where the GTSA has shown that, under some circumstances, risks could approach the Nirex design targets;

- enhancing the GTSA methodologies to deal better with the issues identified, to treat some additional scenarios, and to bring the methods used in assessments for transport operations more closely into line with those for repository operations; and

- identification of infrastructure, logistics and safety issues associated with a sea transport operation.

5.3 Safety of repository operations

The operation of any industrial facility carries risks that must be controlled so as to protect workers, members of the public and the environment. The key design feature of the repository system is the use of tried and tested technology, e.g. the lifting and handling systems are similar to those used routinely in existing nuclear facilities. For the PGRC, Nirex has developed safety standards and criteria consistent with international standards [78] and UK regulations and guidance [79]. Adherence to these standards and criteria is designed to ensure that all radiological risks are as low as reasonably practicable and within applicable regulatory limits. Conventional risks are also considered and judged against safety standards and best practice in conventional mining and construction operations.

The operational safety of the PGRC will be assured by good design and operational procedures, which are being developed through iterative design and safety assessment studies, as described in Section 4.4. The Generic Operational Safety Assessment (GOSA) [80] addresses the radiological and conventional safety of all phases of repository operation, i.e. waste package emplacement, monitored retrievable storage, vault backfilling, and repository sealing and closure.

The approach to assessing the design at each stage is to:

- identify faults and hazards that could be associated with repository operation;
- identify good engineering practice that can eliminate, reduce or mitigate hazards; and
- assess impacts of faults and hazards and routine operations in the generic safety assessment.

A HAZOP process is used to identify faults or hazards. This is a structured, critical examination of plant or processes that is undertaken by experienced designers, assessors and operators, aimed at identifying all potential hazards along with the consequent effects concerning safety, operability and the environment.

Faults and hazards are then addressed as follows:

- where practicable the potential hazards are eliminated by changes to the design, system, or process, which gives rise to the hazard;
- where the hazard cannot be removed or reduced to acceptable levels, protection or isolation from the hazard is provided to the workers and/or the public;
- where the hazard cannot be eliminated, its effects are mitigated by design, process changes and/or management control; and
- where faults and hazards cannot be eliminated the consequences are evaluated.

The consequences are evaluated by the following methods:

- Design Basis Accident (DBA) Analysis – is an assessment of the consequences from what are judged to be worst case accidents. The results of these calculations are used to judge whether there are sufficient safety features within the design and what safety status should be assigned to these features.
- Probabilistic Safety Assessment (PSA) – is an assessment of the annual radiological risk to workers and members of the public from operations (including accidents).
- Operational Dose Assessment – is an assessment of radiological doses to members of the public and workers both from direct radiation and discharges during normal operations.
- Conventional Safety Assessment – is an assessment of the consequences from conventional (non-radiological) faults and hazards.

Nirex has undertaken these evaluations based on its own experience of many years of research and development on geological repositories, and information from the operation of surface facilities for radioactive waste management in the UK. The evaluations take account of factors such as repository design features, the timing of the different operational phases, radionuclide and chemical inventories, package types, performance of different package types in accident scenarios, and the effect of external conditions.

The results of the assessments, which are presented in the GOSA show that the current design can meet the applicable regulatory and Nirex criteria, and operations would not present an undue risk to workers, members of the public or the environment.

The examination of operational safety issues will continue as the repository design becomes more specific and also will investigate safety implications of alternative designs and changes to the inventory of waste. Issues may also be raised through the ongoing assessments of operational safety in support of the LoC assessment process (see Section 4.6) and through Nirex's programmes of stakeholder dialogue. Nirex is also working to improve progressively the safety assessment methods and information base as the repository design and variants are developed.

5.4 Criticality safety

Criticality refers to a self-sustaining fission chain reaction, usually involving the fissile radionuclides U-235 or Pu-239. Such an event releases energy and, in a highly engineered special case, forms the basis for nuclear weapons. We find that this link between criticality and a nuclear explosion is a concern to many stakeholders.

The conditions required for a nuclear explosion would not be possible in a repository. In a weapon designed to produce a nuclear explosion, the fissile material must be brought together ("assembled") very quickly, usually by a conventional explosion, and neutron moderators, such as water, must not be present. In the repository environment, fissile radionuclides would migrate slowly through materials that would be saturated with water and they would be more likely to be dispersed than to be accumulated.

However, there is a theoretical possibility of a criticality event leading to a release of energy, although accumulating sufficient fissile material for a criticality event would be difficult. Nirex's specifications are designed to avoid the accumulation of sufficient material, but work is undertaken to understand the potential consequences of such an event if it were to occur.

During storage, transport and operational phases of the PGRC (up to vault backfilling), criticality could lead to damage to the waste packages, spread of contamination, exposure to workers during the event and during remediation of the damaged and contaminated areas. In these phases, the potential for criticality must be avoided. This is achieved by controlling the package design, including the level of fissile material, to avoid the potential for criticality in individual packages and assemblies of packages during storage, transport and repository operations. In addition, package designs are robust to accidents (impact and fire), which eliminates the possibility of criticality occurring as a result of an accident.

After repository closure, groundwater will cause gradual degradation of the waste packages and wasteform so that radionuclides may migrate within the vaults and surrounding rock. It could take several thousand years for this to occur. There is a possibility that migration could lead to the accumulation of fissile radionuclides from more than one package, with an associated, but low, probability of criticality. The consequences of such an event are less

than in the transport or operational phases, as they would be contained by the geological barrier. Still, the potential for criticality after repository closure must be assessed.

In detail, calculations with very pessimistic assumptions, e.g. of geometry and neutron moderation indicate an amount as low as ~500g of Pu-239 could constitute a critical mass. Nirex modelling has shown that by setting a screening level of 50g Pu-239 equivalent per package the accumulation of a critical mass would be avoided. If a package contains less than the screening level, it can confidently be assumed that the possibility for criticality has been eliminated.

Analysis of inventory information indicates that 15-20% of ILW packages will contain more than the equivalent of 50g Pu-239. Packages containing levels of fissile material above this screening level can still be considered, and are currently assessed on a case-by-case basis, through the LoC assessment process, to determine the Safe Fissile Mass for these packages. A safe fissile mass above 50g could be accommodated in the presence of materials that inhibit the criticality chain reaction such as uranium-238 that may be present in the waste.

Recently the Nirex approach to setting waste package fissile levels has been reviewed by the Environment Agency [81]. The review recommended that Nirex should continue to develop the methodology underpinning the generic screening level, the objective being to:

- derive post-closure screening levels based upon an approach that considers both conservative and less pessimistic assumptions with regard to the likely evolution of the system after repository closure;

- align the approach for the criticality safety assessment of the operational phase with principles being developed by regulators and the industry; and

- develop waste transport safety criticality safety assessments through interactions with the Department for Transport.

The new approach is designed to enable a balance of risk arguments to be made, with the aim of ensuring that any agreed limits are proportionate and not unduly restrictive whilst being safe. The approach will identify general screening levels for waste packages containing four common categories of fissile material: low enriched uranium; highly enriched uranium; plutonium contaminated material; irradiated natural uranium.

After repository closure, the probability of criticality is minimised by limitation of individual package contents and operational constraints. The uniform chemical conditions created in the vault backfill (see Section 6.3) would severely restrict the migration and accumulation of fissile radionuclides. In addition to assessing and taking such steps to reduce the likelihood of a criticality occurring Nirex carries out research to assess the potential consequences of a criticality [82].

If a criticality did occur, some local mechanical damage and some heat-induced chemical changes might take place. Also there would be a change in the inventory (reduction of fissile radionuclide and production of fission products). The effects, however, would be confined within a small part of the repository and surrounding rock so that no immediate impacts would be experienced and any long-term impacts would be very minor. The study concluded that:

- the potential for a criticality is low, because a number of unlikely conditions and mechanisms would have to be met or act together for a criticality to occur; and

- even if a criticality did occur, its impact on repository performance would not be significant, because the criticality could only affect a small volume of a repository and a very small fraction of the inventory.

5.5 Non-radiological environmental assessment

In addition to the radiological assessments Nirex is planning to undertake a non-radiological environmental assessment of the PGRC. This has been in response to stakeholder feedback and a scope of work and methodology [83] have now been developed as a result of dialogue.

This envisages the following components:

- a non-radiological environmental assessment of the PGRC;
- a preliminary assessment of the impact of the repository on species other than humans;
- a report setting out issues that have emerged from ongoing stakeholder dialogue and describing how those issues are being addressed; and
- consideration of whether any of the criteria suggested or used by others for assessing waste management options should be used in the assessment of the PGRC.

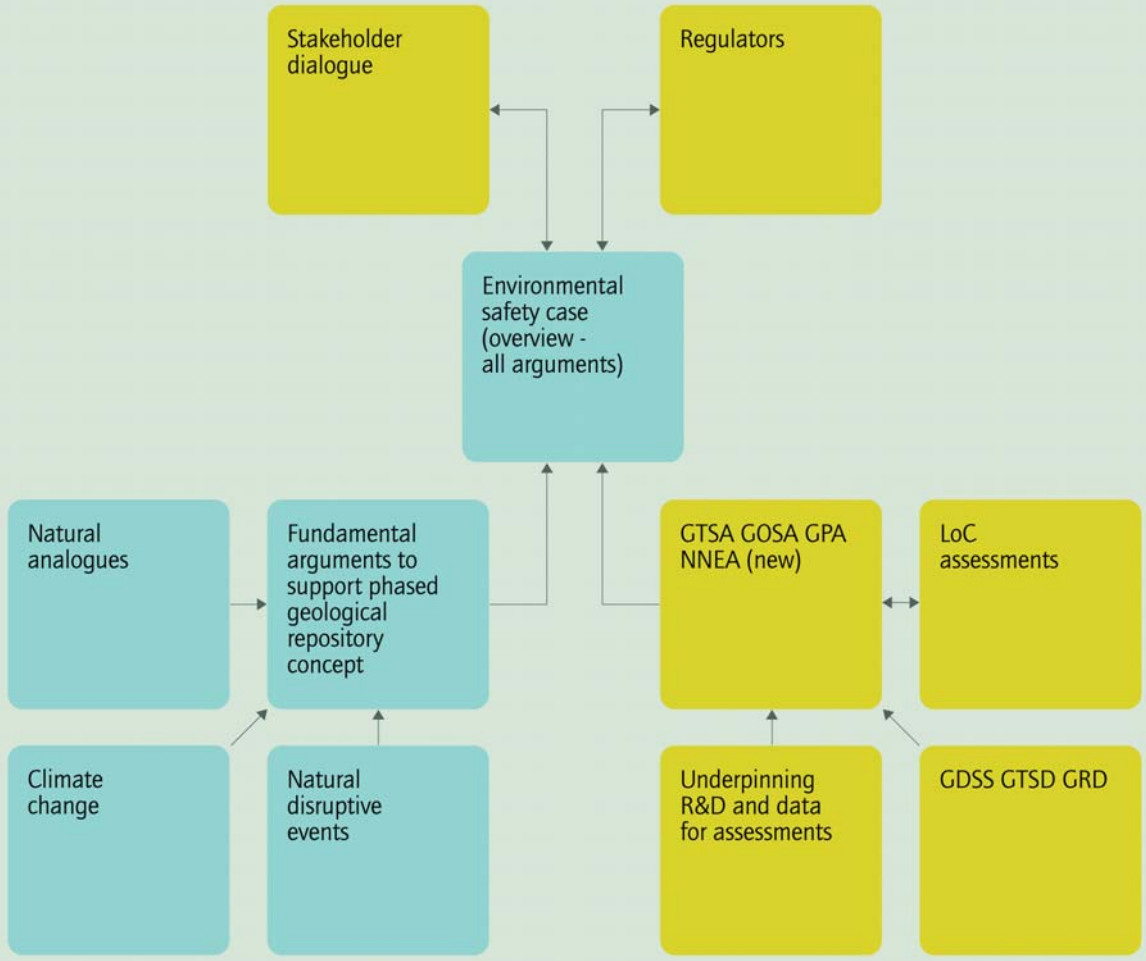
The strategy has been discussed at two workshops (in 2002 and 2005) to which Nirex invited a range of stakeholders including national and local Government representatives, regulators, NGOs, academics, members of the public, contractors and members of the nuclear industry. Feedback received is being used to guide the development of the non-radiological assessment. Progress to date has led to :

- a non-radiological environmental assessment scoping report;
- an assessment of the impacts of chemically toxic species; and
- a preliminary assessment of the impacts on species other than humans.

5.6 Environmental Safety Case

Nirex is currently developing proposals for an overall Environmental Safety Case that will present the case for the safety and environmental performance of the Phased Geological Repository Concept. It is envisaged that the Environmental Safety Case will use direct evidence from natural analogues (defined very widely) and other fundamental arguments. These arguments will be supported by the existing transport and operational safety assessments, the GPA and non-nuclear environmental assessment (see Figure 32).

Figure 32
Environmental safety case



6 RESEARCH PROGRAMME

A key component in demonstrating the viability of the concept is that it is underpinned by a credible research programme. Nirex has been carrying out research for over twenty years, covering a vast range of subjects and involving scientists from many organisations, both in the UK and abroad.

Key drivers for carrying out research are:

- Safety and environmental assessments of the Phased Geological Repository Concept. The assessments of the concept are underpinned by research, to ensure that the processes that are likely to affect the future safety and environmental performance of a repository are appropriately captured in the models.

- The Letter of Compliance process. In the process of giving packaging advice, we develop our understanding of specific wastes and their long-term behaviour and this can raise issues which need to be addressed by further research.

- Interaction with regulators. The Environment Agency has a programme for scrutinising our work, and this process may raise issues where further research is required.

- Stakeholder dialogue particularly within the scientific community. It is important to be able to show that we understand the key processes that would occur following closure of a repository. Research is required to establish whether these processes need to be represented explicitly in the concept safety and environmental assessments.

- Preview - a particular type of stakeholder interaction that involves dialogue about the future direction of research. This is a way of involving others, including external specialists, in defining our programme and setting the direction of particular research projects.

The research programme is extensive, covering a broad range of topics and it is not appropriate to give a full status report here. The current status of the key issues are described below by the main themes which are: wasteform research; gas generation; near-field research; geosphere research; biosphere research and criticality safety research. A comprehensive listing of reports from the research programme and other Nirex work can be obtained on the Nirex website www.nirex.co.uk.

6.1 Wasteform research

The packaging of radioactive wastes involves the immobilisation of wastes using a suitable encapsulant material to create a wasteform. The conversion of raw waste to an acceptable wasteform provides passive safety during storage and also contributes to the physical and chemical barriers after repository closure. Developing an understanding of the long-term behaviour of encapsulated waste is the focus of the wasteform research programme.

Many of the issues considered in this research programme arise through dialogue with waste producers, particularly as wastes are assessed under the Letter of Compliance process and details about the packaging of specific waste streams and their proposed

wasteforms is provided. Waste producers conduct research aimed at developing appropriate wasteforms for specific waste streams and liaise with Nirex about this research. The Nirex wasteform research programme studies:

- The physical and chemical evolution of wasteforms [84].
- The integrity of the wasteform [e.g. 85].
- Generation of gas.
- The compatibility of wasteforms with the Phased Geological Repository Concept [86].

Most ILW is immobilised within a cement-based matrix, which is compatible with the repository concept by design. However for some wastes there can be advantages in considering other immobilisation systems, which also need to be compatible with the overall concept. There are two key aspects in achieving this; the immobilisation matrix should not generate significant amounts of acid, which could adversely affect the high pH environment within the repository and should not degrade to produce species that could complex with radionuclides, making them more mobile.

Both of these aspects have been the subject of extensive research programmes involving waste producers and external experts from contracting organisations. A methodology has been developed to take account of acid-generating material within wasteforms when calculating the amount of backfill needed in a repository [87] and this work can be used as a basis for considering the impact of non-cement based immobilisation matrices. The impact of complexants is discussed further under near-field research in Section 6.3.

To date, in performance assessment risk calculations, no credit has been taken for containment of radionuclides by the wasteform once the repository has been closed. However, we calculate [17, 18] that more than 90% of the initial radioactivity would decay inside the container in the thousand years following repository closure. This issue will be addressed in future modelling work, which will require further research to build on the current understanding of wasteform evolution.

A key aspect of the wasteform research programme relates to the potential for the wasteform to generate gas. This is discussed further in section 6.2 below.

The current status of wasteform research is sufficient to conclude that there are no issues that fundamentally threaten the viability of the concept. Through the Letter of Compliance process, Nirex will continue to address wasteform issues that may arise as each waste stream is packaged. Wasteform research will continue to be an important part of the Nirex research programme, particularly as post-closure performance assessment models are refined to model more explicitly the wasteform evolution.

6.2 Gas generation

A feature of intermediate and low level wastes is that they can contain materials that produce gas when they corrode or degrade. The metal containers, in which wastes typically are packaged, will also eventually corrode over thousands of years, producing gas. Gas is generated by corrosion of metals, by degradation of organic wastes (particularly cellulose) and by radiolysis. Minor quantities of gas would also be generated by radioactive decay. A small proportion of the generated gas could be radioactive, containing the isotopes tritium and carbon-14.

Wastes that are expected to generate gas are packaged in vented containers in order to prevent pressurisation of the waste container. The Nirex Phased Geological Repository Concept (PGRC) has been designed with features that mitigate the potential consequences of gas generation. During the operational phase, the disposal vaults and other parts of the underground repository will be ventilated, which will prevent the build-up of gas. Gas concentrations and discharges would be monitored, filtered and controlled to ensure compliance with authorised discharge levels as is the case in surface stores. Such levels are set to ensure that any discharges do not pose an unacceptable risk to man or the environment.

The discharge of radioactive gases during repository operations can be reduced, for example by chemically scrubbing the gases before discharge. In the post-closure phase, the vault backfill has a relatively high porosity which will allow gas to disperse in the vault volume. The vault backfill and the grout within waste packages are cement-based and will react with carbon dioxide to form low solubility carbonates, limiting the release of gaseous carbon dioxide from the repository. Further work is required to demonstrate that the carbon dioxide would have sufficient access to backfill and that there would be sufficient time for the carbonation reaction to occur. However, scoping calculations presented in Volume 4 of Nirex 97 indicate that sufficient equilibration would be achieved and that therefore negligible gaseous carbon dioxide would be present in the repository.

Issues related to gas generation have been the subject of research over many years, both in the UK and internationally. Nirex has established an understanding of these issues sufficient to guide the design of the concept and to develop a model of gas generation within the repository, although some uncertainties remain about the amount of gaseous carbon-14 that would be generated from the waste. The possible impacts of gas generation have been reviewed in a recent EC-funded project [88]. An assessment of many of these impacts is included in the generic documents, although a more detailed assessment would be undertaken in support of a site-specific repository performance assessment.

A key issue for the Nirex Phased Geological Repository Concept is the potential radiological consequences of gases containing carbon-14. There are three potential sources of carbon-14 containing gases that are typically identified [19, 89]. These are irradiated graphite, irradiated metals and organic wastes.

The possibility of the release of gaseous carbon-14 from irradiated graphite and irradiated metals has not so far been included in gas pathway calculations in the generic documents, but simple models have now been developed to allow these possible sources to be subject to scoping calculations.

These scoping calculations show that, if it is assumed that the carbon in these materials reacts to form carbon-14 bearing methane and that this migrates as a free gas to the biosphere, there could be a significant impact on the calculated risk from this gas pathway. However, groundwater has the capacity to dissolve methane and work is underway to see if this capacity can be scoped in the absence of site-specific information. In some national programmes, dealing with broadly similar quantities of wastes with a potential for gas generation, it is calculated that all the methane generated will be dissolved in the groundwater systems overlying the repository. Once gas has dissolved, long groundwater travel times to the surface and release at the surface in solution both reduce the calculated impact of carbon-14 in methane to insignificant levels.

A key issue is the extent of the mixing between gas bubbles and groundwater, which depends on site-specific features, including the nature of the host rock. If there is considerable mixing, all of the gas can dissolve. Also, real, low-permeability rock-water

systems, such as would be suitable for an ILW repository site, typically contain highly impermeable layers that could prevent the movement of free gas to the surface. Conversely, extended fracture systems could act as conduits for upward migration of free gas.

Such site-specific processes and features are not included in the geosphere description given in the generic documents and further work will be carried out to define better the range of conditions under which significant free gas release to the biosphere is unlikely to occur. In parallel, further research is required to determine the rates and quantities of gaseous carbon-14 generation.

6.3 Near-field research

The near field of the PGRC consists of the repository vaults and the immobilised waste within them, as well as the cement-based vault backfill. The near field provides two types of barrier functions to prevent the migration of radionuclides into the surrounding rock: physical barriers provided by the waste package, backfill and repository seals; and a chemical barrier provided by the cement-based materials in the repository.

The engineered barrier system is designed to provide the following benefits:

- Wastes are immobilised in cement within a stainless steel container. This package provides passive safety during the operational period [90] and also contributes to the physical and chemical barriers after repository closure. Although no credit is taken in performance assessment risk calculations for package integrity after repository closure, calculations [17, 18] have shown that more than 90% of the initial radioactivity would decay inside the container in the first thousand years after repository closure.

- Once the vaults are backfilled and sealed, oxygen will be consumed (mainly by metal corrosion), so that anaerobic or reducing conditions are established [91]. Reducing conditions limit localised corrosion of stainless steel waste containers and maintain some radionuclides in low oxidation states, which have low solubility.

- Incoming groundwater will dissolve small quantities of the cement-based backfill, becoming alkaline (high pH) as it fills the vault [92]. The high pH environment ensures that the rate of corrosion of the stainless steel containers is very slow [16].

- The high pH of the cement porewater ensures that the chemistry of the near field is dominated by the hydroxyl ion (OH^-), which favours the formation of metal hydroxides. Hydroxides of many radionuclides have low solubility at high pH [50]. This effectively reduces the amount of radioactivity that can be dissolved in the groundwater.

- The backfill provides a high surface area for the sorption[9] of radionuclides from solution [92]. Radionuclides in solution in the backfill porewater can be removed from solution by “sorbing” to the backfill, reducing their ability to migrate out of the repository in groundwater.

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[9] The generic term “sorption” covers the processes of absorption, physical adsorption and chemical adsorption. It is used here to include all processes that involve partitioning of a substance between solid and liquid phases, reducing the concentration in solution or retarding its migration.

- The backfill provides physical stability surrounding each container.

- At closure, the repository access routes would be backfilled and sealed to prevent these acting as preferential pathways for contaminated water [42].

The behaviour of a cementitious repository near field has been the subject of research programmes for more than twenty years. Nirex has established an extensive research base, which supports and underpins assessments of the long-term safety of the PGRC. The research programme has involved experts in universities and in contracting organisations, both in the UK and abroad, and draws on wide experience of the use of stainless steel and cement in a range of applications. The Nirex research base is supported by further research by other waste management organisations overseas and by co-operative international projects.

The near-field research programme can be described by the following key themes:

- Physical containment of radioactivity within the near field and the role that this plays in the PGRC.

- Chemical containment of radioactivity, particularly by the cement backfill over the long timescale for which the chemical barrier would have to operate.

- Chemicals or processes in the repository near field that could challenge the chemical containment of radionuclides by making certain radionuclides more mobile and whether these need to be explicitly represented in the long-term safety case.

The first of these themes relates to the role of physical containment and how this is modelled in the safety assessment. Corrosion of the waste container would be extremely slow and the waste immobilisation matrix would also provide physical containment for the radioactivity. To date, in performance assessment models, no credit has been taken for containment of radionuclides in waste packages once the repository has been closed, but in future modelling work, these features will be better represented.

The second theme relates to the requirements placed on the cement backfill, particularly given the long timescale over which the chemical barrier would have to operate. Chemical containment is an important safety function of the Nirex Phased Geological Repository Concept, providing a number of additional benefits over and above those provided by the waste package alone. Nirex has carried out a large programme of research in this area, including experimental and modelling work. However, demonstrating to stakeholders that the chemical barrier would indeed provide conditions in which the solubility of radionuclides would be low and that the high pH environment would last over the timescales required can be challenging. This is, therefore, considered to be a key issue and is the subject of ongoing research.

The third theme relates to chemicals and processes that could challenge the chemical containment of radionuclides. Under this theme the following topics have been considered:

- The effect of complexants

- The significance of backfill cracking

- Temperature and heating effects

- The effect of non-aqueous phase liquids (NAPLs), such as oils and greases

- The role of microbes
- The establishment of reducing conditions (see above) and the effect on radionuclide solubility
- Groundwater chemistry
- Colloids
- Radiolysis

Of these, two issues are particularly challenging, the effect of complexants and the effect of non-aqueous phase liquids (NAPLs), or more specifically light NAPLs, being substances that are less dense than water.

Complexants make radionuclides more mobile by increasing their solubility and reducing sorption. One of the most significant sources of complexants within the repository results when cellulose (present in the waste) degrades. The increases in solubility and decreases in sorption caused by the presence of cellulose degradation products have been measured in experiments and a methodology has been developed to include the effects in performance assessments. Other experimental and modelling work demonstrates that there are unlikely to be significant quantities of other materials within a repository that could have a similar magnitude effect on near-field solubility and sorption.

Light NAPLs are challenging because they have a known potential for uptake of some radionuclides and may migrate more rapidly through the geosphere than groundwater. The light NAPLs would only leave each repository vault if there was sufficient pooled in a reservoir in the roof space to overcome the forces that prevent such materials entering narrow fractures in the host rock. Once in the rock, further losses would be expected . Therefore the repository has a capacity for NAPLs at least up to the amount required to form the critical size of reservoir. Research has shown that the encapsulated wasteforms envisaged for wastes in which NAPLs such as oils and greases would be present at the time of emplacement would limit their rate of release into the repository, making the formation of a reservoir unlikely. Furthermore, materials such as oils are known to break down under radiolysis to give water-soluble or immobile products over timescales as short as 100 years, the timescales being subject to the precise conditions under which radiolysis occurs.

Given that the amounts of NAPLs such as oil and grease in wastes are controlled by the LoC process, this source does not represent a significant uncertainty. However, the possibility exists that further NAPLs could be created in the repository as breakdown products of the radiolysis of organic polymers in wastes. Work is underway to define the realistic potential yield of NAPLs from this source and the nature and rates of production of such NAPLs. Specific polymers in wastes are evaluated on a case-by-case basis through the LoC process.

Results from initial experimentation on the migration of NAPLs indicates that they would not have a significant secondary detrimental effect on beneficial processes such as sorption and confirm that they would access pores and fractures in rocks to become trapped.

The current status of near-field research is that:

- There is sufficient confidence in the behaviour of the repository near field to allow Nirex to give packaging advice to waste producers. In the process of giving

packaging advice we develop our understanding of specific wastes and their behaviour in the repository near field and this helps to guide the research programme.

- Enough is known about the repository near field to begin a programme of site selection. When one or more potential sites have been selected, site specific research will be required.

- An ongoing programme of research will be required to ensure that the key issues continue to be addressed.

6.4 Geosphere research

The geosphere comprises the rocks in which the repository is constructed and those that surround them, extending to the surface. Managing radioactive waste within a geological environment which is several hundred metres underground provides advantages compared with leaving it on the surface, because a well chosen site can provide:

- A physical barrier that protects the repository from natural disruptive events such as weathering, glaciations, erosion, asteroid impacts and earthquakes.

- A mechanically stable environment for the repository.

- Long and slow groundwater return pathways from the repository to the surface environment, along which retardation processes, dilution and dispersion act to reduce the concentration of radionuclides in groundwater.

- A stable geochemical environment, which protects the engineered barriers.

- An environment which reduces the likelihood of inadvertent human intrusion.

- Protection from deliberate human interference.

Nirex has had a geosphere research programme since the 1980's. The programme has included research on the following themes, which relate to the safety features described above:

- Geosphere stability – includes consideration of natural processes such as volcanic activity, tectonic uplift, asteroid impacts and seismic events as well as the impact of the repository itself (the excavation disturbed zone and the alkaline disturbed zone).

- Spatial variability – includes developing methods for representing the natural variability of the geosphere in groundwater flow models. The nature of the rocks at Sellafield meant that Nirex was at the forefront in developing "state of the art" computer models capable of representing groundwater flow and radionuclide transport both in fractured and porous rocks [93]. Models of fracture flow were based respectively on knowledge gained from experiments of flow in individual fractures and at experimental sites at Reskajeage in Cornwall and Äspö in Sweden, while models of flow in porous rocks used experience from the water and oil industry. Since then, increases in computer power have meant that even more sophisticated and realistic models are routinely undertaken by the radioactive waste and oil industries.

- Retardation processes – naturally occurring processes that retard the transport of radionuclides in the geosphere. Of these the most important process is sorption of radionuclides to rock surfaces. A large number of laboratory measurements has been collected by Nirex and others, demonstrating that sorption is an effective way of retarding many radionuclides across a wide range of rock and groundwater types.

- Perturbing factors – the retardation described above could be affected by other factors, including complexants (either from the repository or present in the environment), colloids (present in groundwater) and microbial activity.

- Gas migration – processes involving two phase (gas-water) interactions that may impact on the migration of radionuclides in the gas and groundwater phases.

- Modelling – approaches to the development of and confirmation of mathematical models of the various processes noted above.

The research has been carried out using contractors at a number of UK universities as well as organisations such as the British Geological Survey and other specialist contracting organisations, for example, Serco Assurance. Much of the generic work has been carried out through EC part-funded or other international co-operative programmes, e.g. [94, 95], involving other waste management organisations abroad and their contractors.

During the 1990's, Nirex was investigating the geology of the Sellafield area, for its suitability to host a radioactive waste repository (see section 8.4). At that time, the geosphere research programme was closely integrated with the programme of site characterisation work, but since then research has been generic in nature and not linked to any specific site. Site-specific research will be required again if a site or sites are chosen for more detailed characterisation.

A key part of the work involves dialogue with stakeholders and this dialogue has identified a number of key issues, which either alone or in combination could influence the selection of a suitable site for implementation of the concept. For example demonstrating to stakeholders that the spatial variability of a site is appropriately understood and represented in models would be easier if the site were simple and easily characterised. Similarly it would be advantageous to choose a site with a low groundwater colloid population and a low concentration of naturally-occurring complexants. The choice of host rock would also strongly influence the research required on the migration of gas [88].

These issues have been recognised by all organisations investigating the disposal of radioactive wastes [96] and are not considered to be insurmountable. There is considerable experience of carrying out site-specific research, both within Nirex and internationally, where a range of host rock types have been studied.

The current status of work is sufficient to support packaging advice and to proceed with a site selection process in the UK. As part of any such site selection process, the geosphere will need to be characterised and a programme of site-specific research will be required. The choice of host rock and the geological setting would influence the nature of the research required. The geosphere represents a key aspect of the PGRC and geosphere research will continue to be a key component of the Nirex research programme.

6.5 Biosphere research

The biosphere is the near-surface and surface environment. It includes the atmosphere, rivers and lakes, the soil and the upper part of the bedrock. The biosphere is not considered as a barrier to radionuclide releases, rather it is a receptor for such releases. On the long timescales of relevance to performance assessment calculations, typically up to one million years, small quantities of long-lived radionuclides may be released from the repository system, migrate through the geosphere and reach the surface environment. Performance assessment calculations aim to assess the risk to humans and other biota from the subsequent radiological exposure. Biosphere research provides data and understanding about how radionuclides are dispersed or accumulated in the environment and how they enter the food chain.

The Nirex biosphere research programme has been at the forefront of biosphere research for radioactive waste management since the late 1980's and a large volume of information now exists to support assessments. The biosphere research programme has been divided into a number of project areas:

- Climatology (evolution of climate);
- Geomorphology (landform evolution);
- Ice sheet modelling;
- Near-surface hydrology and radionuclide transport;
- Soil-plant radionuclide transfer and uptake into the food chain;
- Description of potentially exposed groups (PEGs)[10].

The scope of the research work that Nirex has carried out to date includes literature reviews, laboratory and field experimentation, and numerical modelling studies of sub-system components.

Because of the long timescales involved, it is not possible to be certain about what a future biosphere might be like and how it might evolve over time. For example, human influence on climate is a topic of current scientific debate. In long-term safety assessments, the biosphere is represented by stylised scenarios, based on our understanding of current and past environments. The future biosphere conditions that are assumed are hypothetical and much of the ongoing work is to ensure that models encompass the range of conditions that could reasonably be expected to occur.

The use of stylised scenarios in long-term safety assessments is also the subject of work by the OECD Nuclear Energy Agency and advice on the formulation of biosphere scenarios has been developed through international co-operation during the IAEA BIOMASS programme [97] in which Nirex participated. Engaging stakeholders in dialogue about these scenarios will be a key part of the future programme.

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[10] In the glossary to the GRA [57], Exposed Group is defined in the following statement "For a given source, any group of members of the public within which the exposure to radiation is reasonably homogeneous; where the exposure is not certain to occur, the term potentially exposed group is used."

The biosphere research programme is guided by the need to conform to regulatory requirements and take due account of international best practice. In the UK, the most relevant regulatory guidance is that issued in 1997 by the Environment Agency, in conjunction with SEPA and the Department of the Environment for Northern Ireland [57].

The standards and data that Nirex uses to support its biosphere assessments take account of emerging national and international guidance, recognising that such guidance may ultimately influence the UK regulatory position and views on good assessment practice. Such guidance has been published by the National Radiological Protection Board –NRPB (now part of the Health Protection Agency) in the UK [98, 99] and overseas by the IAEA [97] and the ICRP [100]. Nirex has a watching brief to ensure that updated advice and guidance is incorporated into the planning of any future research work.

Dialogue with regulators is an important part of Nirex's work and recently the scrutiny of our work by the NWAT team has included review of our approach to the treatment of potentially exposed groups.

The Nirex biosphere research programme has close links with work carried out in overseas radioactive waste management organisations through jointly funded projects and EC supported programmes. Many of the biosphere-related issues are of general interest and several are being addressed in international fora, such as BIOCLIM (Modelling Sequential Biosphere Systems under Climate Change for Radioactive Waste Disposal) [101] and BIOPROTA (Biosphere Data Protocol Development for Assessments) [102]. Such international co-operation is cost effective and makes good use of scarce but internationally available resources. The degree of consensus that is achieved through such joint programmes lends support to the credibility of any conclusions reached. In the UK programme, much of the research is carried out in co-operation with universities, in particular Imperial College, the University of Newcastle and the University of East Anglia.

It is considered that there are no biosphere issues that represent threats to viability of the PGRC. However, it will be important to ensure that the research keeps up with developments in thinking for example about future climate change and to gain support for the modelling approach, which uses stylised scenarios to represent the biosphere. Research will also be required to address outstanding areas of uncertainty concerning the migration of radionuclides in the near-surface and to collate further data.

6.6 Criticality safety research

Section 5.4 summarises the topic of criticality safety with respect to the PGRC and describes Nirex's approach to the assessment of criticality safety. An important part of the Nirex criticality research programme is aimed at demonstrating an understanding of the repository system and the possibility and consequences of a criticality.

The criticality research programme is investigating the effects of possible criticalities arising from a wide range of hypothetical configurations of fissile materials. The consequences of these effects and their impact on subsequent repository performance are then being identified for configurations that could arise. Initial work [82] has concluded that even if a criticality did occur, it would only affect a small volume of the repository and the impact on the overall performance of the repository would not be significant. However, not all types of post-closure criticality event were considered in this initial work. Further work has been commissioned to improve our understanding of criticality in post-closure environments, to enable testing of the robustness of the initial conclusions, involving development of two different types of model to allow independent testing. This research involves criticality experts in universities and in contracting organisations and has been managed by a

committee involving other experts in criticality research. The work is ongoing and will be subject to peer review.

The work to date and the resulting understanding of the likelihood and consequences of criticality are sufficient to conclude that these issues do not pose a significant threat to the viability of the concept. However, criticality is an important topic from a regulatory perspective and because of public concern criticality will continue to be a key component of the Nirex research programme.

6.7 Status of the research programme

- Nirex has established an extensive research base, which supports and underpins assessments of the long-term safety of the PGRC in the UK.

- Nirex commissions its research from experts in a wide range of fields, in universities and contracting organisations.

- The Nirex research base is complemented by further research by equivalent waste management organisations overseas, by co-operative international projects and by guidance material developed by regulators and international bodies such as the IAEA and the NEA. There is a general view that sufficient fundamental research has been done to show that geological disposal of radioactive waste is viable. The focus, for example of EC part-funded research into radioactive waste management, is now shifting towards demonstration that concepts can be implemented.

- There is sufficient confidence in the PGRC to use it as the basis for assessing waste packaging proposals under the LoC process. This process is embedded in UK regulatory arrangements for the packaging of ILW and is subject to scrutiny by regulators. Assessment of packaging proposals develops our understanding of specific wastes and their long term behaviour and this helps to guide the research programme. Recent submissions have highlighted carbon-14 containing wastes and NAPLs as requiring further research. Given sufficient resources, such issues typically take 1 to 5 years to address.

- Enough is known about the PGRC to begin a programme of site selection in the UK. Once a programme of site-selection begins, site-specific research will be required. The extent of the site-specific research programme will depend on the nature of the site, but is likely to require a programme of investigations which would continue through the early phases of construction.

- Ongoing dialogue with stakeholders, including the public and regulators, will be required to understand what further evidence is necessary to demonstrate the viability of the concept. This iterative process will identify requirements for further research.

7 HIGH-LEVEL WASTE / SPENT FUEL (HLW/SF) REPOSITORY CONCEPT

Historically, Nirex's remit has been focused on the long-term management of solid intermediate-level waste (ILW) and that low-level waste (LLW) that is unsuitable for disposal in near-surface facilities. The majority of Nirex's work has therefore been devoted to the long-term management of these wastes. Geological disposal is the preferred option for a range of long-lived radioactive wastes in most developed countries. Over the last three decades, the fundamental safety of this option has been illustrated in many national feasibility studies for geological disposal of a wide range of intermediate and high-level wastes (including spent nuclear fuel).

Nirex's remit is now to look at very long-term management options for all types of radioactive materials and not to simply focus on ILW as it did in the past. Nirex is therefore developing a comprehensive and coherent strategy for the management of all UK radioactive wastes and materials. Lessons learned from past experience have demonstrated the importance of a comprehensive and coherent approach which is flexible to the needs of stakeholders and enables them to be engaged in the debate.

With encouragement from Government, we are working with sister organisations (SKB (Sweden), Nagra (Switzerland) and NUMO (Japan)) to examine the extent to which the vast amount of work undertaken internationally on the long-term management of high-level waste (HLW) and spent nuclear fuel (SF) can be applied in the UK. Through a series of workshops we have developed a strategy, a reference concept for a geological repository for UK HLW/SF and a programme for developing the concept through an iterative process of design, assessment and research.

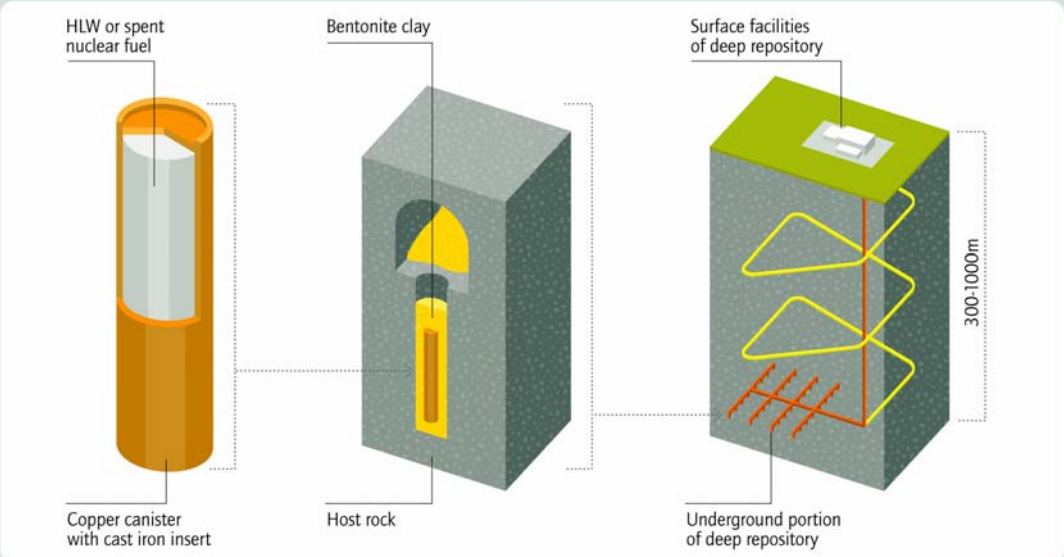
Internationally, a range of geological disposal concepts have been discussed and investigated for HLW and SF over a number of years. The concepts vary according to the nature and quantity of the waste and the different geological and social settings. Nirex has reviewed this range of concepts and has selected a concept to demonstrate the viability of HLW and SF disposal in the UK. Concepts were screened to select a concept that was at an advanced stage of development, based on well-established properties of the engineered and natural containment barrier systems, allowed for ease of retrieval and was supported by extensive R&D.

The UK Reference HLW/SF Repository Concept selected by Nirex for this 'viability demonstration' is based on the KBS-3 concept developed by SKB for spent fuel in Sweden. This concept has been extensively studied by the Swedish and Finnish national programmes for more than 20 years [103]. This selection also reflects the maturity of the Swedish and Finnish programmes, their involvement of stakeholders and their level of regulatory scrutiny and, in the case of Sweden, international peer review.

The KBS-3 repository concept is based on encapsulating spent fuel elements in a copper canister, that costs some £100k, with a cast iron insert. (Under suitable geochemical conditions, the corrosion of copper is extremely slow, and the copper canister is expected to maintain its integrity for an extremely long time). Each copper canister is placed in a vertical hole approximately 8 m deep, drilled along a series of access tunnels excavated at a depth of approximately 500m in water-saturated granitic rock. Within its deposition hole, the canister is surrounded by a bentonite clay that swells when contacted by water. The tunnels and rock caverns would be backfilled with a mixture of bentonite and crushed rock.

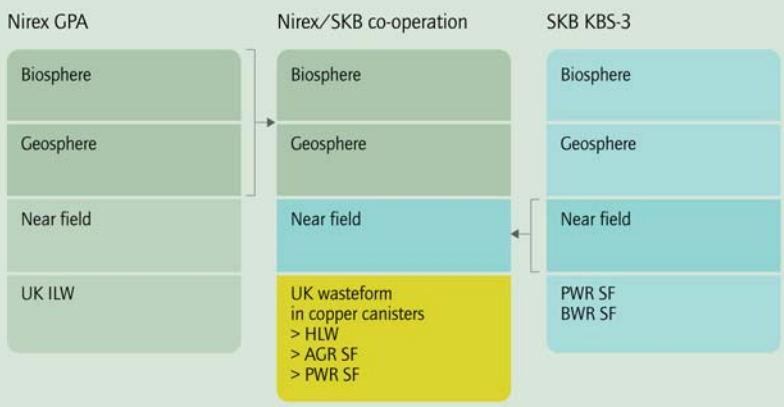
The UK Reference HLW/SF Geological Repository Concept (Figure 33) was developed [104] by adapting the KBS-3 concept in terms of canister length, diameter and structure of the insert to handle HLW and spent fuel from the UK's Advanced Gas Cooled Reactors (AGRs) and Pressurised Water Reactor (PWR).

Figure 33
Geological repository concept for HLW and spent fuel



A preliminary assessment of long-term safety of the UK Reference HLW/SF Repository Concept in a UK setting was performed recently with the help of SKB. In assessing the long-term safety, advantage has been taken of the large amount of assessment work on the safety of the KBS-3 concept already undertaken by SKB, as well as relevant Nirex work on the UK geosphere and biosphere conditions. To do this, SKB and Nirex have developed a model for the assessment of the UK's Reference HLW/SF Repository Concept (Figure 34). The model is underpinned by both Nirex and SKB R&D programmes.

Figure 34
Development of UK reference repository concept for HLW/SF



By carrying out a quantitative assessment of a concept based on SKB's KBS-3 design for spent fuel, it was confirmed that the long-term safety shown by SKB would also be assured for UK inventories and geological conditions that are identified as suitable for a geological repository. In addition to the groundwater flow characteristics, identified as the parameters Q,T and F, it is understood that the required geochemical conditions to ensure the long-term integrity of the copper canister are also available in a high proportion of the UK deep geology.

A probabilistic calculation of risk has been carried out using the model developed with SKB[11] [105]. The peak value of the mean annual individual radiological risk was found to be 10^{-11}, which is substantially below the radiological risk that defines the target applicable to ILW and LLW of 10^{-6} per year [57]. This means a risk to a person of 1 in 100,000 million per year of developing either a fatal cancer or a serious hereditary defect. The very low calculated risk is due to the combination of a long groundwater travel time for the UK geological characteristics used in the GPA and a robust engineered physical containment barrier (the copper canister). As part of the development of a safety assessment for the Reference HLW/SF Repository Concept, Nirex is performing further calculations to address the sensitivity of the system to key processes or components.

SKB's studies also illustrate the fundamental feasibility of reversal of key emplacement stages. Most countries with higher activity radioactive waste are also proposing a geological repository that incorporates retrievability and a phased approach to implementation and there are a range of methods that have been investigated and adopted to provide this. Nirex is taking a flexible approach to concept development that provides options for retrievability and phasing. The concept will continue to be developed through dialogue with stakeholders, including the public, to address their issues and concerns.

A basic cost study indicates a total project cost of around £5 billion for a repository to take the UK's HLW and spent fuel. This is comparable with estimates for repositories prepared in other countries.

In summary, the evidence for the viability of geological disposal for HLW and spent fuel in the UK comes from international experience, which covers a wide range of waste types in diverse geological environments. It is supported by a preliminary assessment by Nirex and SKB of the UK Reference HLW/SF Repository Concept - a provisional concept of what a UK repository for these wastes could look like.

Apart from this demonstration of fundamental concept viability, a further objective of developing a reference concept for a repository for UK HLW and SF was to provide guidance to waste producers on waste characterisation and packaging. Nirex is now developing packaging standards and specifications (WPS) for HLW and spent fuel. The need for such standards and specifications has been recognised by the Radioactive Waste Policy Group (RWPG). The work on the Reference HLW/SF Repository Concept has been used to inform the RWPG on "Initial Consideration of Waste Acceptance Criteria for the Long-term Management of Certain UK Radioactive Wastes and Potential Wastes" [106].

The HLW/SF repository concept is at an earlier stage of development than the Phased Geological Repository Concept for ILW. Our work on this concept is not currently subject

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[11] On the basis of research and development performed by SKB on the evolution of copper canisters it was assumed that one canister each of UK HLW and PWR and AGR spent fuel has a defect that ultimately fails.

to the regulatory scrutiny applied to the ILW concept. However, the HLW/SF concept has been developed by combining the Swedish KBS-3 concept with UK waste data and the UK geosphere and biosphere characteristics used for the PGRC. The KBS-3 concept is underpinned by around twenty years of research, development and demonstration work. Its development has also been subject to continuous scrutiny by the Swedish regulator. Our work on the UK geosphere and biosphere is subject to regulatory scrutiny under our existing agreements for the ILW concept. In short, the HLW/SF repository concept is a well developed option underpinned by an extensive body of research and development all elements of which have been subject to scrutiny. Nirex is also discussing with UK regulators how the process of regulatory scrutiny for ILW can be extended to cover the HLW/SF concept.

Key challenges relating to the HLW/SF repository concept are retrievability and optimising the configuration of the underground openings.

The extent to which a HLW or spent fuel canister can be easily retrieved from an underground opening lined with swelling bentonite clay is an issue raised by some stakeholders. Further work is needed by Nirex to establish views on the degree of retrievability required for these types of waste. Retrievability is increasingly being addressed and incorporated by most countries in concept development. Nirex is seeking opportunities to participate in joint projects to examine technical approaches to HLW/SF retrievability.

Different countries have developed underground configurations based upon drivers such as the properties of the host rock and of the waste canisters. Nirex is working with other waste management organisations on research and demonstration projects that examine the options for configuring the underground openings such as vertical or horizontal emplacement openings. This work will be used together with site specific data to optimise the underground openings and layout for a HLW/SF repository concept for the UK.

Another area of work is the development of a combined repository concept whereby HLW/SF and ILW are located at the same site.

The technical implications of co-locating a HLW/SF facility at the same site as the Phased Geological Repository Concept for ILW is being investigated by Nirex as part of our ongoing work programme. This has potential cost savings compared to providing separate facilities and is also in effect the strategy that is being developed for the long-term management of high-activity and long-lived wastes in other countries such as France, Switzerland and Belgium.

To support discussion of the siting process, the generic work carried out to date is being extended to identify any specific requirements from a site due to the nature of the UK's HLW and spent fuel or the concept for their long-term management.

Other materials

Nirex is using the PGRC and Reference HLW/SF Repository Concept, and associated developments of waste packaging standards and specifications, as a basis for investigating the waste management options and assessing the disposability of the other UK radioactive wastes and materials (if declared as wastes). This includes waste and materials such as separated stocks of plutonium and uranium, spent fuel from submarines and research reactors (as described in Nirex Report N/085 [1]).

8 PROJECT VIABILITY / IMPLEMENTATION

So far this report has set out why we are confident in the viability of the Nirex Phased Geological Repository Concept for the UK's ILW. It has also described why we are confident that a repository concept would be viable for the UK's HLW and Spent Fuel.

However viable concepts do not in themselves provide a long-term waste management solution. To move from a concept to a waste management solution it is necessary to address what would be required to allow the implementation of concepts.

Following the failure in 1997 to obtain planning permission for underground investigation of a potential repository site at Longlands Farm, near Sellafield, Nirex set out to learn lessons from that experience through extensive dialogue, both internally and externally. The aim was to gain an understanding of why previous attempts to solve this problem have failed. Those lessons could then be applied in the development of a new approach which could then lead to the successful implementation of a long-term radioactive waste management solution in the UK. Analysis revealed that Nirex had made many mistakes and that lessons could be grouped under the headings of structure, process and behaviour.

Structure

In terms of structure, one of the main lessons learned was the need for the organisation responsible for long-term waste management to be independent of the nuclear industry and for clear separation of long-term and short-term issues.

- Under nuclear industry ownership Nirex was seen by many as a front for the industry.

- The independence of its overall objectives, including decisions on packaging standards and specifications, was questioned because of its ownership.

- The need for separate organisations to address short-term and long-term issues is necessary to avoid the long-term issues being neglected due to short-term pressures. Separate organisations are also required so that tensions between the short-term and long-term issues are resolved in an open and accountable manner.

Process

We believe that Nirex itself was secretive and adversarial and was part of a secretive environment.

A key lesson was that the process for selection and implementation of a long-term waste management solution must be open, transparent and accountable at all stages. Specific issues included:

- The adversarial nature of the planning process in particular where a planning application is rejected and referred to a public inquiry.

- Recognition of the need to address local issues such as community benefits and veto rights for communities to allow a national policy to be implemented at a given site.

- The need to develop and gain broad acceptance for each step in the implementation process ahead of its application e.g. the approach and criteria to select suitable sites.

- Legitimacy of process. It must be seen to be fair and equitable.

Behaviour

We believe that Nirex's behaviour was unacceptable. It was marked by arrogance and a lack of weight attached to local concerns.

Lessons learned relating to behaviour include the need to:

- Work at stakeholders' speed, be responsive and allow for involvement of a wide range of stakeholder groups, i.e. allow access to and influence on our work programme.

- Have a wide-ranging transparency policy – Nirex's accountability in this regard is now overseen by an independent transparency review panel.

- Reflect stakeholder views in our work programme, e.g. retrievability.

Trying to apply these lessons has fundamentally changed our approach. The following sections describe how, by applying the lessons to the development and implementation of a viable concept, we think that a solution for the long-term management of the UK's radioactive waste can be provided.

8.1 Selection of a long-term waste management option

Past experience and legal advice have made it clear that all credible options need to be properly considered. The process for selecting the most suitable option(s) needs to be open, transparent and accountable. It needs to involve consultation with a wide range of stakeholders to encourage ownership and ensure a robust choice of option(s). The selected option(s) will then need to be reviewed and justified against other options at any stage in the future implementation.

To do this, the Government has established its Managing Radioactive Waste Safely (MRWS) process. As part of this process the Committee on Radioactive Waste Management (CoRWM) has been set up to recommend to Government a long-term management solution for the UK's radioactive waste.

The MRWS process and the work of CoRWM is based around public and stakeholder engagement. As such it addresses the issues of openness, transparency and involvement in the process for selection of a waste management option. The MRWS process effectively mirrors the requirements of Strategic Environmental Assessment (SEA) in aiming to provide a robust and auditable record of the basis for selection of the preferred waste management option.

To date CoRWM has short-listed four options, two of which are geological disposal and phased geological disposal (which Nirex proposes – the PGRC). The other two options on the current short-list are interim storage and near-surface disposal. However, neither of these are solutions in their own right that could be used for the long-term management of all the UK's higher activity radioactive waste. Rather they are options to be used in conjunction with deep geological disposal.

Interim storage by definition will require further actions to be taken after the storage period has expired. Given that some of the waste will remain hazardous for hundreds of thousands of years this on its own will not provide the long-term solution that is required. It could however form part of an overall strategy.

Near-surface disposal would only be appropriate for short-lived radioactive wastes as there is the very real potential for long-term environmental change at the surface disrupting the safety of a near-surface disposal facility (e.g. erosion due to glacial events). This option is therefore only suitable for a small proportion of the higher activity wastes being considered under MRWS.

The current timetable is for CoRWM to recommend an option to Government in July 2006. Following a Government decision to implement an option, work would need to proceed on setting the criteria on which selection of a suitable site would be based. This in turn would lead to the actual selection of a site (or sites) and investigations to evaluate suitability for a repository.

8.2 Selection of a suitable site for a geological repository

This section addresses why Nirex and others believe that a suitable site could be found in the UK for implementation of a repository. The rationale for this can be summarised in the following terms: there are areas of the UK where the geological conditions are potentially suitable for a repository and the technology exists with which to undertake the necessary safety and environmental assessments

The secrecy of the site selection process that identified Sellafield as a preferred site for an ILW/LLW repository was a significant reason for the RCF Local Planning Inquiry Inspector's recommendation, in 1997, that Nirex's appeal against the refusal of planning permission should be rejected.

A lack of public acceptance was also an important factor in the Government’s decision to halt investigations related to geological disposal of HLW in 1981, the withdrawal of the proposal to use the Billingham anhydrite mine for disposal of long-lived ILW in 1985, and the cessation of investigations at four sites for near-surface disposal of short-lived ILW and LLW in 1987.

Experience overseas is that progress is being made where public involvement is actively encouraged and made a key feature of an open and transparent process. In Finland and Sweden site investigations are proceeding and repository concepts are being implemented. In Finland it has been suggested that for a site to be viewed as a legitimate choice there should be general support from at least 70% of the local population, around 40% support from the national population and 70% political support. The 40% can be characterised as a strong national feeling that the issue needs to be dealt with and that the option chosen is probably the way to do it.

In the UK, the siting criteria and the decision-making process will need to be established in an open and transparent manner through consultation. This should be done before the actual site selection process is started and should address issues such as whether it would allow local communities to volunteer or be granted a veto in respect of a site in their locality. This would need to be conducted in line with the European Commission Directive on Strategic Environmental Assessment [107]. An Environmental Impact Assessment would also need to be submitted and scrutinised through planning legislation.

By drawing upon the lessons from overseas and actively engaging in dialogue at both a national and local level, Nirex believes that it would be possible to demonstrate legitimacy of process. This could provide the necessary support for a new site selection process such that a phased geological repository could be implemented.

8.3 Site investigation and characterisation

The purpose of geological investigation and characterisation is to evaluate a site's suitability to host a radioactive waste repository that would conform with regulatory safety and environmental requirements. However, geological investigations integrate a variety of information from a diverse range of scientific and technical disciplines, including hydrogeology, chemistry, physics, rock mechanics etc.

To evaluate the potential suitability of a site, it is first necessary to understand what information is required to allow judgements to be made for hosting a repository. We believe that we have developed a viable concept through over twenty years of research that provides a good understanding of those requirements.

In general terms there are three purposes for the information that would need to be collected:

- to provide an understanding of the specific geological setting and the processes that would be involved in the evolution of the repository;
- to provide data that can be used in assessment models to investigate the long-term safety and environmental performance of the repository; and
- to provide data on rock properties to inform design and construction of the repository.

Nirex and its scientific and engineering colleagues have gained extensive experience of site characterisation from its programmes of investigations at Dounreay (1989-1991) and at Sellafield (1989-1997) and its involvement in overseas site investigation programmes before 1997. This experience coupled with a viable concept has enabled Nirex to establish a generic site characterisation programme. The starting point for the development of that programme is a comprehensive specification of all the information that will be needed from site investigations. From this it is possible to identify the properties that must be measured to derive that information and the techniques to undertake the measurements. This work is being currently refined in co-operation with RWMC of Japan and other European radioactive waste management agencies.

Site characterisation generally involves a programme of surface-based activities followed by underground measurements to test the suitability of a site. At Sellafield the surface based investigations included measurements taken from 29 deep boreholes drilled by Nirex (these have since been closed). To drill the boreholes, large oilfield-type drilling platforms were utilised. Feedback from the local community since then has led us to explore the use of different technologies in order to reduce the environmental impact of such operations.

Sweden and Finland have, in the past decade, developed their site investigation programmes based upon technology that uses mobile drilling rigs mounted on lorries. These mobile rigs are much smaller than those used previously by Nirex and have a much reduced impact on the local environment. Nirex is currently evaluating the feasibility of using similar rigs in the UK or whether environmental impacts could be reduced in other ways.

The proposal at Sellafield was that underground investigations would be undertaken within a rock characterisation facility (RCF). Planning permission for the RCF was sought on the basis that it would be an underground experimental laboratory that for planning purposes was to be developed separately from the eventual repository. This view was never generally accepted and was considered by many to be simply the first stage in the development of a repository for radioactive waste.

Nirex's view now is that any future underground investigations should clearly be undertaken as part of repository construction. Any underground experiments or scientific monitoring activities that might be necessary to test the site suitability in detail would be co-ordinated with the repository construction activities.

In summary, Nirex believes that a potential repository site can be characterised to evaluate its suitability. This is a view shared by our 'sister' waste management organisations overseas and by the geoscience community. An open meeting arranged by the Geological Society of London and the British Geological Survey concluded:

> *"the geoscience community believes that it has the methodology and interpretive capability to characterise successfully a potential repository site"*

The full statement is available on the Geological Society's website [108].

8.4 Suitability of Sellafield as a potential repository site

It has been argued that the rejection of the RCF planning application indicates that Sellafield was unsuitable as a repository site. However, we believe that this was never a conclusion from the RCF Local Planning Inquiry Inspector's report.

Based on the reasons for rejection that were given in the Inspector's report Nirex now recognises that:

- The process that led to the selection of Sellafield for investigation as a potential repository site was flawed. The secrecy was a key issue. The lessons and requirements for any future site selection exercise are discussed above.

- Much more attention needs to be given to conventional planning and environmental issues such as visual intrusion and proximity of access ways to specially designated areas, such as the National Park in the case of Sellafield. Since then Nirex has developed a new Environmental Policy based upon stakeholder feedback and is now incorporating non-radiological environmental assessment into its PGRC.

- Nirex acknowledges that the planning application for an RCF was premature. The scientific information presented to support the application was based on data obtained from the first few years of surface investigations only. Much more data from the surface-based investigations was obtained up to and including 1996. This information was not presented to the Inquiry. It formed the basis for an overall assessment that was carried out in 1997 ("Nirex 97") and completed after the Inquiry result was known.

That post-closure safety assessment Nirex 97, [63] has been published and the evaluation of Sellafield 'Baseline Conditions' has been completed [109]. Both of these reports have been peer reviewed and the results of those reviews are also available [64, 110]. Based on the results of this work, we believe that Sellafield is a potentially suitable site for a

repository. This view is shared by the British Geological Survey (BGS) and many other specialist consultants.

Based on data obtained from Sellafield investigations there would be scope to examine alternative repository locations within the rocks underlying the Sellafield area.

8.5 Repository development

Section 4.4 on the iterative development of the Phased Geological Repository Concept set out how the concept was based upon proven technology. To summarise:

Transport

Transport is one of the key issues to be addressed to ensure the acceptability of implementing a concept. Transport issues are particularly significant because they potentially affect all the communities on transport routes. Consequently appropriate consideration needs to be given to the transport of the radioactive waste and also to the movement of large construction plant and materials.

The PGRC provides for the transport of radioactive waste packages to a repository in its safety assessments, based upon internationally recognised IAEA standards. There is extensive worldwide experience of the safe transport of radioactive materials to such standards.

The movement of large construction plant and materials will be a key consideration in the non-nuclear environmental assessment of the concept. Any planning application for implementation of the facility would need to be supported by a full environmental impact assessment (EIA). Planning permission would be heavily dependent upon an acceptable EIA.

Sea transport – because of stakeholder and public concerns, we are examining the possibility of sea transport to minimise road/rail use.

Repository construction

The construction of the repository would be based entirely upon proven technology. Facilities at the surface for receipt and handling of transport packages would be similar to those used on existing nuclear sites and at conventional freight container ports around the world.

The excavations used for transferring and storing the waste deep underground would use conventional mining and construction technology.

Repository operation

The emplacement of radioactive waste packages into underground storage vaults is a relatively straightforward handling operation. Operations would be similar to those carried out routinely in existing surface waste stores.

Following the emplacement of all wastes in the repository over a period of about 50 years the option would be to:

- retrieve the waste;

- continue with monitored retrievable storage; or
- close and seal the repository.

Retrieval of the waste would involve a reversal of the emplacement operation to return waste packages to licensed storage facilities at the surface. This would be a similar operation to that envisaged for export of packages from existing stores.

Continuing with monitored retrievable storage would be relatively straightforward for a period of up to 100 years. Beyond then it would be necessary to gain access to the underground vaults for inspection and maintenance. This could be achieved through a rolling programme whereby vaults were emptied to enable refurbishment on a 50 – 100 year cycle. The inspection and maintenance activities would be similar to those that would be needed for continuing operation of surface stores.

Repository sealing and closure

Backfilling the ILW vaults with cement-based material would ensure the development of alkaline conditions as the repository resaturated. Such chemical conditioning would limit the solubility of the most radioactive radionuclides in the wastes and provide a medium to retard, through sorption mechanisms, the migration of any radionuclides that might be released from waste packages. Long-lasting repository seals would be constructed in boreholes and in the access ways to provide hydraulic isolation of the repository over the long term and provide further containment.

On-going work in the UK and abroad is examining materials and the engineering practices required to construct plugs, dams and other structures currently used in deep mine construction. Results from this work will be fed into the PGRC and into models used to assess the performance of repository seals.

Large-scale experiments in underground research laboratories have demonstrated that seals can be placed in tunnels or shafts and that they can provide the necessary barrier to the movement of groundwater. Typically the sealing systems that have been devised and tested employ a combination of concrete and swelling clay (usually bentonite) plugs, for example the Shaft Sealing Experiment conducted in the Stripa Mine laboratory in Sweden [111]. The concretes and clays selected are well-known materials which have been used in similar applications in other industries, and bentonite clay has the added advantage that it is a naturally-occurring material and as such shows stability over geological timescales.

Since the materials proposed for use in repository sealing systems have been studied extensively, the conditions under which their desirable properties might deteriorate are well understood. Therefore sealing materials and designs can be tailored to match the characteristics of a repository at a given site, within the overall repository design.

Evidence for the long-term structural integrity of concrete materials includes examinations of Roman concrete and comparisons with concrete structures made over the last century or so from Portland Cement [112]. More indirect evidence of greater longevity of the chemical make up of concretes comes from the study of cement-like rocks, which shows that this material can remain intact for many tens of thousands of years [113]. The longevity of the sealing properties of bentonite clay has been studied extensively for more than twenty years, yielding a detailed understanding of the mechanisms and rates of possibly deleterious chemical reactions. Even where an unfavourable groundwater composition is simulated, the deleterious reactions are limited in their extent and the results of experiments and modelling indicate that the sealing performance would not be impaired

over the long timescales of interest [114]. The one known condition where it may be necessary to avoid the use of bentonite is in groundwaters that are very highly saline [115].

Post-closure monitoring

There are no regulatory requirements to monitor the repository after institutional control over the site has ended, although some monitoring is recognised as being required in a period of institutional control immediately following repository closure [57]. In fact there is a regulatory requirement that the long-term safety of the repository is not dependent upon monitoring or intervention.

However, feedback from dialogue on our proposed work programme suggests that some form of monitoring of repository post-closure performance would be highly desirable. Acting on that feedback we are examining options and techniques for post-closure monitoring [116].

Work on non-intrusive monitoring is now being taken forward in co-operation with a number of our equivalent organisations from overseas under the EC part-funded ESDRED (Engineering Studies and Demonstration of Repository Design) Project.

Programme and cost

Like any major project there are many interrelated activities which must be undertaken in an appropriate sequence in order to ensure successful implementation. The key to success is rigorous project management whereby the many different strands of work are integrated into a coherent programme. For implementation of the PGRC this requires a full understanding of:

- the nature and quantity of the radioactive waste;
- the scientific and technical basis of the concept;
- how the concept can be adapted to address stakeholders' views;
- the safety and environmental regulatory requirements;
- the planning framework including environmental assessments;
- the characteristics required from a site to achieve long-term safety;
- what is needed for public acceptance at a national and local level; and
- the resources needed.

Nirex has some twenty years' experience in the development of plans and programmes for approaching such a project in the UK. Based on previous attempts to implement such a project, both in the UK and overseas, lessons have been learned that must now be incorporated into future plans for implementation.

Nirex has developed a programme and cost estimate for this project which have been used by the producers of radioactive waste to make provisions for its long-term management. That programme has evolved in line with our increased understanding of all of the requirements for implementation of such a project.

The programme is based on repository availability in 2040. We are aware that the Nuclear Decommissioning Authority (NDA) has stated a preference for earlier (2025) availability of a repository.

Nirex is in favour of making progress with long-term radioactive waste management and implementing a deep geological repository in a timely manner. However, although we support the intention, successful implementation will only be possible with public acceptance.

One of the lessons learned from previous attempts to site a long-term waste management facility is that it is important to work at stakeholders' speed. The programme for implementing a facility needs to be flexible and able to incorporate ongoing interactions between the project and the local community. This may mean being able to accommodate longer discussion periods and more research to address stakeholders' concerns.

Figures 35, 36 and 37 illustrate the key activities, durations and costs for implementation of a repository for:

- ILW/LLW
- HLW/Spent Fuel
- Co-location of ILW/LLW and HLW/spent fuel disposal in the same facility

Figure 35
ILW/LLW repository programme and costs

	Costs £m	Estimated Dates
Sunk Costs	700	
MRWS	50	2007
Site Characterisation	910	2020
Construction and Underground Research	1940	2040
Operation of Facility (includes further construction)	1830	2090
Care and Maintenance	510	2140
Closure	250	2150
Total	£6.2 billion	Approximate total project duration 150 years

Figure 36
HLW/Spent fuel programme and cost estimate

	Costs £m	Estimated Dates
Site Characterisation	920	2007 2020
Construction and Underground Research	1600	2040
Operation of Facility (includes further construction)	2100	2090
Closure	315	2100
Total	£4.9 billion	Approximate total project duration 100 years

Includes HLW/SF canisters (£670m)

Figure 37
Co-location programme and cost estimate

	Costs £m	Estimated Dates
Sunk Costs	700	
MRWS	50	2007
Site Characterisation	1050	2020
Construction and Underground Research	2470	2040
Operation of Facility (includes further construction)	3040	2090
Care and Maintenance	530	2140
Closure	330	2150
Total	£8.2 billion	Approximate total project duration 150 years

Includes HLW/SF canisters (£670m)

It can be seen from Figure 37 that there is a significant cost benefit to be gained from co-location of HLW/spent fuel disposal in the same facility as ILW/LLW. Co-location of different types of high-activity and long-lived radioactive wastes in a modular repository design is a strategy for implementation that is being developed by radioactive waste management organisations in other countries such as Andra (France), Nagra (Switzerland), and ONDRAF/ NIRAS (Belgium).

Management arrangements (dependent on outcome of CoRWM)

To put together a consistent, coherent implementation strategy, we believe that it is essential to have a single organisation responsible for planning, directing and co-ordinating all of the necessary activities that will be involved in implementing the very long-term management solution. The credibility of that organisation is of paramount importance to

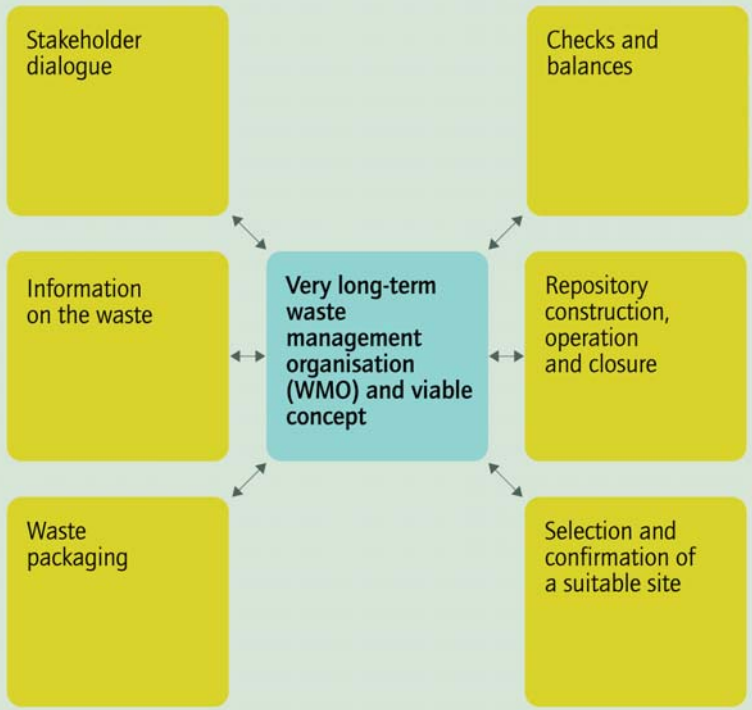
ensure the viability of the project. The Government has already taken such a view with decommissioning and clean-up, with the formulation of the NDA (April 2005). We believe that a similar but separate organisation needs to look after the very long-term.

There are important lessons that have been learned from previous experience in the UK and overseas relating to the requirements for such a long-term waste management organisation (WMO). We believe that the organisation:

- needs to be based on the Nirex role as the concept holder.
- must be separate from the nuclear industry creating the waste:
  - to provide independent standards and specifications to waste producers;
  - to act on behalf of society and not the nuclear industry; and
  - to divorce the issues of new build from the need to deal with existing waste.
- has to be separate from the NDA to avoid short-term prioritisation and to maintain the independence of packaging standards and specifications.
- needs a secure source of funding for the entire project, e.g. segregated account.

Since April 2005, Nirex has been made separate and independent from the nuclear industry and the NDA and is now wholly owned by Government. Funding is currently provided primarily through a contract with the NDA. This funding arrangement would need to be reviewed following the outcome of MRWS. The aim of the review would be to ensure that a secure source of funding was in place for the entire project.

Figure 38
Requirements for implementation



The WMO needs to engage in dialogue with a wide range of stakeholders allowing access to and influence on its work programme. The concept will require further development as exemplified by the introduction of retrievability, described in Section 4. The work of the WMO needs to continue to be subject to scrutiny by the regulators. That scrutiny will continue to provide independent checks and balances on the development of the concept and other work undertaken by the WMO.

Many organisations hold information on their own wastes. However, in our view, the WMO is the organisation that should continue to be responsible for providing a national radioactive waste inventory. As such, it needs to continue to have a thorough understanding of the nature, quantity and location of all radioactive waste in the UK. This knowledge, coupled with the concept, will enable it to continue to set standards and specifications for the packaging of the UK's radioactive waste. Assessment of specific packaging proposals in turn will improve its knowledge base on the wastes requiring long-term management.

Similarly, knowledge of the waste, its packaging and the concept for its long-term management will enable the WMO to establish what is required from a potential repository site. Evaluation and confirmation of a potential site's suitability would need to continue through repository construction, operation, up to and beyond the point of closure. The implementation of a repository would involve a number of organisations such as drilling companies, major construction companies etc. However, as noted above the activities of these various companies are inter-related and must be properly managed. This whole process will need to be overseen by a single organisation with a complete understanding of the concept and its requirements.

Nirex is currently developing its views on an implementation strategy for a PGRC. This is required as an input to the Government’s Managing Radioactive Waste Safely review to show that the PGRC is a viable concept that could be implemented in the UK. If a phased geological repository is selected by Government as the long-term management option for the UK’s radioactive waste then the implementation strategy will allow it to be progressed promptly.

Security arrangements

Nirex considers that integrated and well planned security measures are essential to counter a number of perceived threats which range from the malicious, through theft to irresponsible interference of radioactive waste at a planned radioactive waste repository. Security considerations are built into the design process and the operational planning, although specific details are not revealed since this would defeat their object. At each stage of security planning the Office for Civil Nuclear Security (OCNS) is consulted, for their approval and guidance, in their role as nuclear industry security regulator.

We believe that the PGRC provides robust protection against sabotage terrorism and mis-appropriation as well as being more secure in the event of societal breakdown. Nirex has a Security Plan for a Generic PGRC which has received interim approval from OCNS. However, any change to the PGRC concept will result in the requirement to revise the existing Security Plan or, if necessary, the writing of a new one.

9 SUMMARY AND CONCLUSIONS

In this report we have set out the reasons why we believe that the Phased Geological Repository Concept for ILW and certain LLW, coupled with the Reference HLW/ SF Repository Concept, provide viable technical options for the long-term management of the UK's higher activity radioactive waste. This section presents a summary of why we believe these options can and should be implemented in the UK without further delay.

9.1 Viability of the Concept

The evidence supporting concept viability is set out below against each of the following statements:

The long-term performance of the concept can be evaluated using well established assessment tools.

- The Nirex methodology for performance assessment has been developed in line with international best practice as established by the IAEA and the NEA;
- The Nirex methodology has been subject to international peer review from an OECD-NEA expert group [61];
- Similar assessment tools have been used by other countries to demonstrate the viability of their own geological repository concepts, many of which are at an advanced stage of development with plans for implementation.

The results of those assessments show that all relevant UK regulatory criteria can be met.

- Safety and environmental assessments have been carried out to show that regulatory principles and requirements can be met [19]. Those assessments cover the transport of waste to a repository, operations at a repository site and the long-term performance after the facility has been closed and sealed.
- Research is undertaken with one of its aims being to confirm values of key parameters that can affect the assessment results, for example [117, 118, 119].
- Where there is uncertainty in parameter values, internationally accepted strategies for handling such uncertainties have been adopted [120].

There is a high degree of confidence in the long-term performance of the concept.

- Safety of the concept is provided by multiple barriers avoiding undue reliance on any single safety function of one of the barriers.
- Although no credit is taken in performance assessment risk calculations for package integrity after repository closure, calculations [17, 18] show that more than 90% of the initial radioactivity would decay inside the container in the thousand years following repository closure. Containment and retardation in the engineered system ensures that no more than 1% of the initial radioactivity would be present in the rock around the repository, as a result of releases from the repository, at any

time [19]. We calculate [19] that the geological barrier then prevents any more than 0.005% of the initial radioactivity from ever reaching the surface. This would meet the UK regulatory requirements.

- The predictable nature of the geological barrier provides stability for the very long timescales over which the waste remains hazardous. The earth sciences are the one area of science where such timescales are routinely considered. This emanates from an understanding of many common geological processes based on the ability to date geological materials and events precisely [71].

- Natural analogues have been identified and observed for important processes that contribute to repository performance. For example, at the Maqarin site in Jordan [113] a naturally occurring cement has undergone extensive interaction with groundwaters for many tens of thousands of years. Other evidence exists from analogues for the sorption and retardation of radioisotopes onto mineral phases, as observed for example at the 2 billion year old natural fission reactor at Oklo (Republic of Gabon) [121].

9.2 Remaining challenges to concept viability

The above section summarises the arguments that support our view that the Phased Geological Repository Concept for ILW and certain LLW, coupled with the HLW/spent fuel concept provide viable technical options for the long-term management of the UK's higher activity radioactive waste. This section presents a summary of the remaining challenges that need to be resolved to confirm viability and how these are being addressed.

Whilst the issues are significant, they are not considered to present a fundamental threat to concept viability. Such significant issues are given priority in our work programme and, with appropriate funds and resources, could be addressed within the next five years. Beyond then there will still be work required to provide detailed analysis of the concept and to evaluate the suitability of any potential site, including testing the compatibility of site conditions with the engineered system.

Key challenges to the PGRC

Carbon-14

C-14 has been identified as a key issue in the PGRC. Calculations have been carried out to scope the potential impact of C-14 for two alternative scenarios. In the first of these it is assumed that C-14 all dissolves in groundwater and is released to the biosphere in solution; in this case the calculated risk is well below the regulatory target. The second scenario assumes that carbon-14 is released as gas and all methane generated is released directly to the biosphere as gas, taking no account of any delay in the geosphere. In this case, the calculated risk is significantly over the regulatory target. In practice, some of the gas could dissolve in groundwater and the migration of gas in the geosphere would depend on the site geology. In many geological settings, some form of gas retardation may be expected.

Nirex has an ongoing programme of research on C-14, which is improving our understanding of these issues. Further work is still required, which includes: work to assess the extent to which gas would dissolve in groundwater; work to assess the extent to which different geological environments have the potential to retard gas migration; and work to reduce uncertainties in the rates and quantities of gaseous C-14 generated.

If, through further work, the calculated rates and quantities of gaseous C-14 generated were not to be significantly reduced, it could be necessary to establish siting criteria that would ensure that significant gaseous release to the biosphere would be unlikely. The implications of these criteria would need to be assessed and included within the requirements for the generic geology in the PGRC.

Although further work is planned which may include the identification of specific siting requirements, on balance Nirex believes that C-14 is not a threat to the viability of the phased geological repository concept.

Non Aqueous Phase Liquids (NAPLs) – such as oils and greases

NAPLs are challenging because they can have a greater capacity for uptake of some radionuclides and may migrate more rapidly through the geosphere than groundwater.

NAPLs would only leave a repository vault if there was sufficient pooled in the vault to overcome the forces that prevent such materials entering narrow fractures in the host rock. Therefore the repository safety case can accommodate NAPLs in each vault at least up to the amount required to form a large enough reservoir. This is estimated to be in the order of 10 tonnes [122]. Furthermore, NAPLs are known to break down under radiolysis to give water-soluble or immobile products over timescales as short as 100 years.

Given that the amounts of NAPLs such as oil and grease in wastes are controlled by the LoC process, this source does not represent a significant uncertainty. However, the possibility exists that further NAPLs could be created in the repository as breakdown products of the radiolysis of organic polymers in wastes. Work is underway to define the realistic potential yield of NAPLs from this source and the nature and rates of production of such NAPLs.

Key challenges to the High Level Waste and Spent Fuel (HLW/SF) concept

The HLW/SF concept is at an earlier stage of development than the Phased Geological Repository Concept for ILW. Our work on this concept is not currently subject to the regulatory scrutiny applied to the ILW concept. However, the HLW/SF concept has been developed by combining the Swedish KBS-3 concept with UK HLW/SF data and the UK geosphere and biosphere characteristics as used for the PGRC. The KBS-3 concept is underpinned by around twenty years of research, development and demonstration work. Its development has also been subject to continuous scrutiny by the Swedish regulator. Our work on the UK geosphere and biosphere is subject to regulatory scrutiny under our existing agreements for the ILW concept. In short, the HLW/SF concept is a well developed option underpinned by an extensive body of research and development all elements of which have been subject to scrutiny.

Key challenges relating to the HLW/SF concept are retrievability and optimising the configuration of the underground openings. Another area of work is the development of a combined repository concept whereby HLW/SF and ILW are located at the same site.

Retrievability

The extent to which a HLW or spent fuel canister can be easily retrieved from an underground opening lined with swelling bentonite clay is an issue raised by some stakeholders. Further work is needed by Nirex to establish views on the degree of retrievability required for these types of waste. Retrievability is increasingly being addressed and incorporated by most countries in concept development. Nirex is seeking

opportunities to participate in co-operative projects to examine technical approaches to retrievability.

Optimisation

Different countries have developed underground configurations based upon drivers such as the properties of the host rock and of the waste canisters. Nirex is working with other waste management organisations on research and demonstration projects that examine options for configuring underground openings such as vertical or horizontal emplacement openings. This work will be used together with site specific data to optimise the canister designs, underground openings and layout for a HLW/SF repository concept for the UK.

Co-location

The technical implications of co-locating a HLW/SF facility at the same site as the Phased Geological Repository Concept for ILW is being investigated by Nirex as part of our ongoing work programme. This has potential cost savings compared to providing separate facilities and is also an approach being considered in other countries.

9.3 Implementation

Whilst technical solutions have been available for many years there has never been successful implementation of those solutions in the UK. This section summarises why Nirex believes that the concept can and should be implemented in the UK without further delay.

The geological characteristics required from a site are well understood and are afforded by a significant proportion of the deep geology in the UK.

- The British Geological Survey (BGS) working with Nirex has established geological criteria for deep repositories. Application of those criteria has shown that around 30% of the UK land mass is potentially suitable for a repository. Work is currently underway with the BGS to review the criteria based on current understanding. The geological criteria will be applied to the national geoscience database to update the estimate of the proportion of the UK potentially suitable for a repository.

- Nirex is confident that a potential repository site can be characterised to evaluate its suitability. This is a view shared by our equivalent organisations overseas and by the geoscience community. An open meeting arranged by the Geological Society of London and the British Geological Survey concluded: *"the geoscience community believes that it has the methodology and interpretive capability to characterise successfully a potential repository site"* The full statement is available on the Geological Society's website [108].

- It must be recognised that the selection of a suitable site would require consideration of a wide range of factors not just geological criteria. The establishment of any new siting process and criteria will be addressed as part of the current MRWS programme.

The concept is based on well developed science and technology in the UK and overseas.

- Similar concepts are being developed for the management of higher activity wastes in many other countries. [123]

- Repository concepts are supported by over twenty years of research and development both in the UK and overseas. There is a shared view amongst EU member states that enough fundamental research has been done and that the emphasis should now be on technology demonstration. [124]

- Technology demonstration is now the main focus of work being undertaken in underground research laboratories (URLs) such as Grimsel (Switzerland) and Äspö (Sweden). A major co-operation project currently making use of several URLs is the EC part-funded ESDRED (Engineering Studies and Demonstration of Repository Designs). The overall objective of ESDRED is to demonstrate the technical feasibility at an industrial scale of activities needed to construct, operate and close a deep geological repository in compliance with requirements on operational safety, retrievability and monitoring [125].

- The repository designs are based on the use of existing technology. Nirex has undertaken a review of all elements of the Phased Geological Repository Concept and identified examples to show that all elements utilise tried and tested technology. The HLW/SF concept is based on the Swedish KBS3 - V concept. In Europe this concept is the most advanced in terms of full scale demonstration. The Prototype Repository at the Äspö Hard Rock Laboratory in Sweden is a full scale demonstration of container, buffer and backfill emplacement, and of in-situ testing of its evolution.

- The geological isolation provided by 300 – 1000m of rock means that the concept is highly resilient to disruption by man-made [126] or natural events [127].

Provided that lessons from dialogue and past experience in the UK and overseas are taken into account we believe the UK can implement a long-term solution.

- Past experience shows it has not been possible to reach a consensus in support of implementation in the UK. Other countries are proceeding with implementation, such as Finland. Those countries have found that legitimacy is the key. A basic analysis of the elements of legitimacy would include equity (fairness), competence (the right science and technology) and efficiency (proper use of resources). All of this must be underpinned by transparency and accountability.

- Decisions relating to radioactive waste management must be viewed as ’fair’. This is particularly important when considering implementation because at that stage national decisions start to have an impact on local communities. A particular lesson from the past was that the siting process was carried out in secret and this, what we believe was poor behaviour by Nirex, led to conflict between the local community and Nirex as the body responsible for implementing national policy.

- Recent work (CARL, COWAM) has begun to look at community involvement in national decision making. Issues being considered include volunteerism, the right to veto, planning gain and the need for a ‘contract’ between the local community and national decision makers.

- For implementation to be possible it is essential that the underlying science and technology is seen as correct, robust and safe. Recent agreements between Nirex and regulators ensure that Nirex’s work on ILW is now subject to independent scrutiny. The results of this are made publicly available. Future submissions in support of any planning application would also need to be subject to rigorous peer

review. The scope of such reviews should be developed with the involvement of local affected communities.

- There needs to be a recognition that a solution is being provided by scientists and technologists on behalf of society This is different to the previous approach whereby specialists would develop a solution and then try to persuade society to accept it. An illustration of this change in approach is the incorporation of retrievability within the Nirex repository concept. Stakeholders had consistently demanded retrievability as a feature of the repository concept, but before 1997 Nirex challenged the need for this. This was a fundamental reason for opposition to Nirex's proposals. The difference in the approach is that Nirex now takes such demands as requirements to be met. The role of the technical specialists is to provide a means of meeting the requirements without compromising safety.

- For radioactive waste management, safety is paramount but it is necessary, at all stages of development and implementation, to ensure that value for money is obtained through efficient use of resources. To do this requires a sound knowledge of the nature and characteristics of the UK's radioactive waste, a thorough understanding of the concept and its performance over very long timescales and from this identification of the requirements from a specific site. Together this information allows the concept holder to focus resources on those elements that really matter thereby avoiding unnecessary cost.

It is the duty of this generation to implement a long-term solution.

- The UK has been generating radioactive waste in significant quantities since the 1940s. In 1976 a report by the Royal Commission on Environmental Pollution (the Flowers Report) highlighted the urgent need for a solution to deal with such waste. Yet here in 2005 the UK has still not implemented a long term solution for the management of its higher activity wastes. It cannot be right to continue passing this hazardous burden onto future generations.

- The ethical issues surrounding geological disposal have been debated on a national and international level. A workshop organised by NEA in 1994 on Environmental and Ethical Aspects of Radioactive Waste Disposal [25] agreed a number of points of relevance to this topic and summarised below.

- From an ethical standpoint including long term safety considerations our responsibilities to future generations are better discharged by a strategy of final disposal than by reliance on stores which require surveillance, long term responsibilities of care, and may in due course be neglected by future societies whose future should not be presumed.
    - *Those who generate the waste should take responsibility and provide resources for the management of those materials in a way which will not impose undue burdens on future generations.*
    - *If the present generation delays the construction of a repository to await advances in technology, or because storage is cheaper, it should not expect future generations to make a different decision. Such an approach in effect would always pass responsibility for real action to future generations and for this reason could be judged unethical.*

- Of particular importance in the above discussions was the participation of the OECD Environment Directorate, and of independent experts from academic and environmental policy centres.

9.4 Conclusions

Radioactive waste exists now and something needs to be done about its long-term management in the UK. Without such management the hazard and associated risks to people and the environment would be significant and unacceptable. Most other countries are planning to place long-lived radioactive wastes in a geological repository. Increasingly the concepts are being developed to incorporate retrievability and implementation in a phased, reversible manner.

After many years of research both in the UK and internationally we believe that the Phased Geological Repository Concept for ILW and certain LLW, coupled with the HLW/spent fuel concept developed with SKB of Sweden provide viable technical options. In this report we have also set out why we believe that the concept can and should be implemented in the UK without further delay.

We strongly support the need for an open and transparent process to select and implement a long-term waste management option for the UK. To that end we are making this report and supporting information available as an input to the Governments' MRWS consultation process.

Appendix 1 Concept review process

Objectives for the evaluation of issues

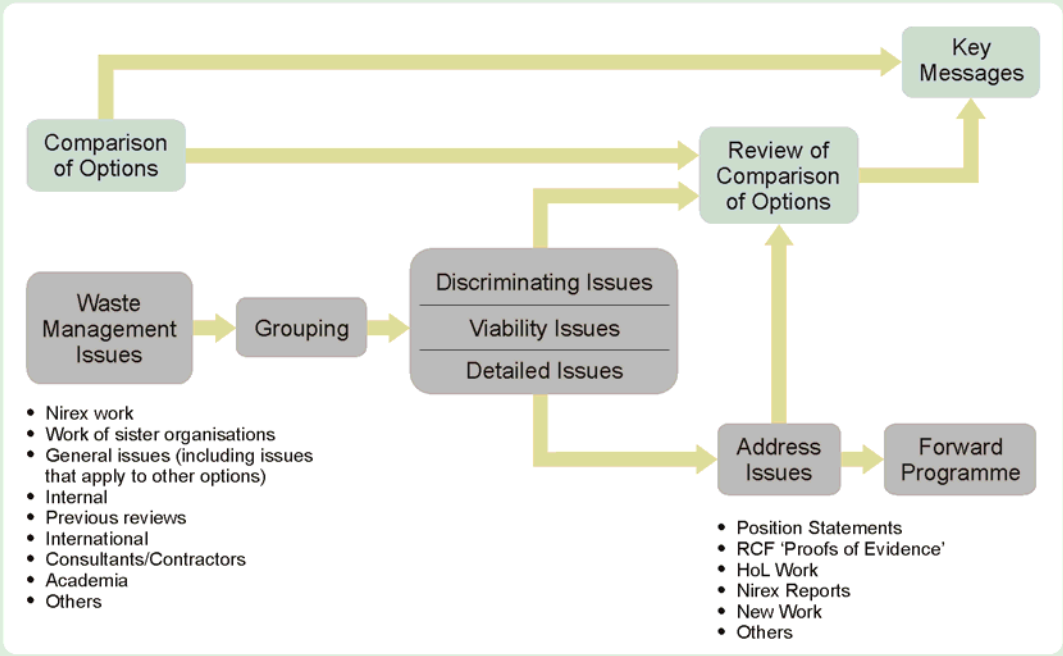
Nirex has conducted specific programmes of work to prepare for its participation in the MRWS consultation process, e.g. to provide information that may be needed by CoRWM. This has included an extensive collation of issues related to Nirex programmes of work and the Nirex Phased Geological Repository Concept (PGRC) identified from both external and internal sources (see Figure A1). These issues have been screened, categorised, evaluated and used:

- as an aid to making qualitative assessments and comparing various options that have been proposed in the past for the long-term management of radioactive waste;
- as the basis for a detailed examination of the Nirex PGRC and assessment of its viability (this report); and
- as an aid to identifying any significant gaps in Nirex's ongoing and future research and information programmes.

This report is concerned only with the second point above – the detailed examination of the PGRC and assessment of its viability. In particular, this Appendix summarises how issues were identified, categorised and evaluated as input to this examination, and the results of the examination.

The process is described in more detail in a Technical Note [128], and the detailed evaluation of issues is documented in a series of 31 "Context Notes", each covering a topic area relevant to the PGRC.

Figure A1
Concept review



The identification of issues

Issues were identified from a range of external and internal sources (see Figure A2).

'External' sources included:

- Examination of selected independent and critical reviews of the Nirex proposals and work programmes since 1987. Initially over 50 reviews and critiques were examined and on this basis ten main sources (reports or sets of reports) were selected for detailed examination. These included review reports authored by The Royal Society, Friends of the Earth, Her Majesty's Inspectorate of Pollution, the Inspector overseeing the RCF Local Planning Inquiry, the OECD Nuclear Energy Agency and the RWMAC.

- Examination of additional, more recent, documents that would be likely to form a starting point for CoRWM's considerations – this included documents from Defra and the DETR related to the consultation process and strategy for radioactive waste management in the UK.

- Discussion with key scientific and technical advisors and academics – these were meetings held between October 2003 and January 2004 to elicit relevant issues and develop ways of obtaining continued input to Nirex's work to prepare for the MWRS process.

'Internal' sources included:

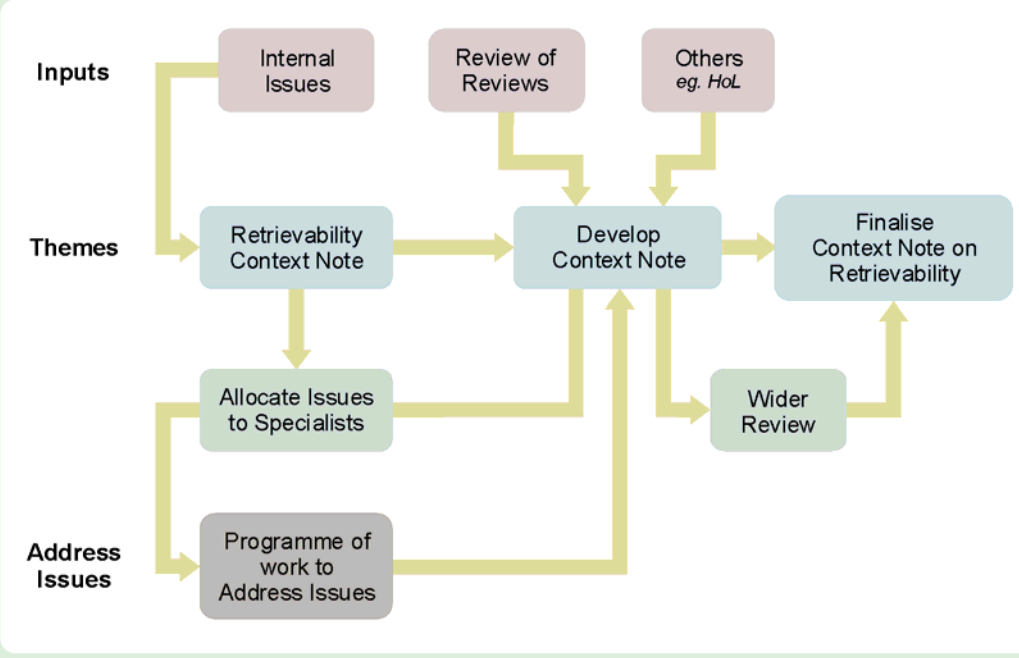
- Re-examination of an internal review held by Nirex following the RCF Local Planning Inquiry.

- An internal review of the current realisation of the PGRC as documented in the Nirex Generic Documents, including input from previews of the draft documents with waste producers and other stakeholders in 2000/1 and in 2003, and a review by a Nirex contractor.

- Input from experience with the Nirex waste package specification and advice process, i.e. the Letter of Compliance (LoC) assessment process.

- An internal workshop held to 'brainstorm' potential issues related to the PGRC, held in May 2003.

Figure A2
Identification, Grouping and Addressing Issues



The evaluation of issues

Inevitably, when drawing on such a variety of sources for relevant information, the quality of the documentation and level of detail in which issues were specified varies. The general approach, however, was as follows.

- Each issue was recorded together with its source and any available expansion on its motivation, implications or interpretation.
- Issues from each source were reviewed and assigned to one of about 30 topic areas concerning the PGRC.
- Nirex experts in each topic area examined the issues against the general background of the state of knowledge and experience in that topic area and made a qualitative 'evaluation' of each issue.
- Some issues were determined to be no longer relevant to the Nirex PGRC as now developed or a duplication of other issues, but, in principle, the aim was to assign each issue as either a 'viability', 'discriminating' or 'detailed' issue, see Box A.1.
- The assignment and evaluation of issues and associated arguments was then reviewed internally and some transfers of issues between topic areas and rationalisations of evaluations were made.

Box A.1: Issue evaluation terminology	
Term	Definition
Viability	An issue with the potential to threaten the viability of implementation of the Nirex PGRC. It may be solvable, however, either by setting site or design requirements so as to limit or avoid the problem, or by R&D which may better define the problem. The issue may be 'common' to, i.e. also undermine the viability of, other waste management options, and this should be noted.
Discriminating	An issue that only occurs for geological disposal or changes very significantly between waste management options, although not with the potential to undermine the technical viability of the Nirex PGRC. These issues can be used to help discriminate between the options.
Detailed	An issue related to geological disposal that can reasonably be taken account of in future R&D or assessment cycles for the PGRC. These issues would need to be addressed in order to develop and implement a waste management option. They do, however, not challenge the viability of the PGRC or serve to discriminate between options.

The aim of these evaluations was to sort issues as to whether they might be relevant to comparing various options for long-term management of radioactive waste (discriminating), relevant to assessing the viability of the Nirex PGRC (viability), or relevant to reviewing Nirex's ongoing and future research and information programmes (all three issue classes to be considered).

Documentation – the Context Notes

The detailed evaluation of issues in each topic area formed the basis for the development of a set of "Context Notes". These each describe the importance of a given topic area, the experience to date and future work planned by Nirex in the area, plus a summary evaluation of key issues in the topic area. Here, 'key issues' are issues that might have some potential to undermine or affect the viability of the Nirex PGRC. The work in hand or needed to confirm the viability in the light of the given issue is also identified.

The objective of the Context Notes is to provide a statement of the key issues and their status within the topical areas that are relevant to the development of the Nirex PGRC.

Each context note provides:

- a well-founded summary of the more important issues in each topical area;
- a traceable basis for this overview report, which provides a summary level understanding of the issues and their relative importance.

Issues identified as ‘viability’ have been distilled out from the Context Note to a summary table provided in each Context Note. Key issues may be expressed in a more generic form than that in which they were originally raised. Additional issues may also have been introduced over and above those coming from the various internal and external sources, if in the judgement of the Context Note author this is needed.

Box A.2: Summary evaluation method of issues used in the Context Notes		
Issue	Evaluation	Status
Concise statement of the issue. Issues can be grouped as far as possible and expressed generically.	Its implications. Its evaluation: viability or discriminating or detailed for the PGRC or all waste management options.	What needs to be done: comments on actions, work, discussion or what is needed (not necessarily by Nirex) to clarify or handle the issue. What is being done about it or planned to be done?

The Context Notes have been subjected to a formal review and QA process.

Product

The Context Notes, see Box A.3, provide a bank of information to establish the current status of the Nirex PGRC and to respond to questions regarding the Nirex PGRC that may be posed by CoRWM and others. The identification and evaluation of the issues has also been used to assist in defining research priorities and the forward programme of Nirex.

Whilst the approach used for the compilation of issues cannot be guaranteed as comprehensive, a wide variety of sources have been examined and analysed in a traceable manner. It is considered that the process has been sufficiently comprehensive to ensure that all of the important potential viability threats to the Nirex PGRC have been identified.

Box A.3: List of Context Notes

Nirex strategy, policies and management	
1.1	Radioactive waste management policy
1.2	Environmental and safety policies and strategy
1.4	Cost of the Nirex Phased Geological Repository Concept
1.5	Communication issues
1.6	Licensing and regulation
1.7	Social science
1.8	Additional radioactive wastes and materials
1.9	Other waste management options
Step-by-step development of the PGRC	
2.1	Waste packaging (WPS and LoC assessments)
2.2	Waste transport safety
2.3	Site selection
2.4	Site investigation
2.5	RCF role and functions
2.6	Repository design and construction
2.7	Repository operation and safety
2.8	Long-term and post-closure institutional arrangements
2.9	Environmental assessments
Long-term safety assessments and R&D programme	
3.1	Waste Inventory
3.2	Near-field research
3.3	Geosphere research
3.4	Biosphere research
3.5	Gas generation and its effects
3.6	Human intrusion
3.7	Post-closure performance assessment
3.8	Safety case arguments
Additional issues	
4.1	Retrievability
4.2	Monitoring
4.3	Criticality
4.4	Safeguards
4.5	Security

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COMMITTEE ON RADIOACTIVE WASTE MANAGEMENT

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Responses to CoRWM questions arising from the Nirex Viability Report

1. Time Period

We asked what period of time Nirex would justify as the time period that should be covered by a post-closure safety case and why? Paragraph 6 on Page 52 suggests that Nirex is addressing up to one million years but that predictions up to 50 million years can have little basis. What is the answer to our original question?

We believe that the answer to the question is contained in the Nirex Technical Note "Summary Note for CoRWM on Timescales considered for Assessment of Long-term Management of Radioactive Waste". The relevant material is summarised below.

Nirex proposes that one million years is a reasonable time cut-off for post-closure assessments of quantified annual individual radiological risk. As part of an overall post-closure safety case, more qualitative arguments would be presented to cover the period beyond that.

Nirex's approach for its Generic Post-closure Performance Assessment (GPA) of the Phased Geological Repository Concept has been informed by regulatory and other guidance in this area. Responding to the specific guidance in the environment agencies' Guidance on Requirements for Authorisation (GRA) that it is for the proponent to justify an appropriate time period for post-closure safety assessment, the releases of radionuclides under the conditions imposed by the repository conceptual design and assumed site characteristics were analysed in the GPA to inform consideration of this issue. These calculations support the view that one million years is a reasonable time cut-off for post-closure assessments of annual individual risk, on the basis that:

- the bulk of the radionuclide inventory would have decayed within the engineered system;
- the radionuclide flux out of the engineered system would have fallen to less than one ten-thousandth of its peak value;

- the peak flux of radionuclides into the biosphere occurs within one million years;
- the peak risks for chlorine-36 and iodine-129 have occurred and the longer term risk, due to daughters of uranium do not show a significant increase according to the reference case model.

In line with the environment agencies' guidance, further work is planned to look at additional indicators of repository performance that may be more useful at very long timescales such as:

- comparisons of the quantity of naturally occurring radionuclides (such as uranium and its daughters, which dominate the calculated risks after one million years) present in the geosphere with those arising from a repository;
- comparisons of concentrations of naturally occurring radionuclides in the environment with concentrations of repository-derived radionuclides.

In the event that a repository project were to be progressed at a real site, this justification would be developed as part of a site-specific safety case that took account of the relevant characteristics of the site.

2. Worst and Best Case Scenarios.

We asked for an indication of the annual dose for best and worst case scenarios. The Viability report does not do this apart from the gas pathway. On Page 53, it points out that the peak risk from the daughter products of Uranium-238 is dominated by a small number of 'realisations' in the probabilistic assessment. For each one of these, the contribution to the risk is presumably calculated from the dose associated with each 'realisation' multiplied by the estimated probability of each realisation. What is requested is the annual dose that is estimated from the best and worst realisation. It would also be helpful to have the same information for the annual dose for Cl-36 and I-129.

The same information is requested for the HLW and spent nuclear fuel waste streams that are discussed in Section 7.

Figures 1 to 5 below show histograms of the percentage of the 1000 realisations carried out in the probabilistic simulation of the groundwater pathway that give rise to a peak conditional dose (up to 10^6 years) falling within each of a specified range of values. In a probabilistic calculation, the conditional dose for a particular realisation is the dose conditional on the values of the uncertain parameters that were sampled for that realisation.

Figure 1 shows the histogram for the total peak conditional dose (summed over all radionuclides), and Figures 2 to 5 show histograms for the individual radionuclides: chlorine-36, iodine-129, uranium-238 and radium-226 respectively.

In Figure 1 the highest total peak conditional dose for any realisation (summed over all radionuclides) is 10mSv/yr (10^{-2}Sv/yr) and the lowest is 0.18 microSv/yr (1.8×10^{-7} Sv/yr).

In Figure 2 the highest peak conditional dose from chlorine-36 for any realisation is 32 microSv/yr (3.2×10^{-5} Sv/yr) and the lowest is 0.016 microSv/yr (1.6×10^{-8} Sv/yr).

In Figure 3 the highest peak conditional dose from iodine-129 for any realisation is 50 microSv/yr (5.0×10^{-5} Sv/yr) and the lowest is 0.16 microSv/yr (1.6×10^{-7} Sv/yr). The fact that this is the lowest conditional dose for any realisation for iodine-129 effectively puts a lower bound on the histogram for the total dose (summed over all radionuclides) shown in Figure 1.

A wider range of peak conditional doses are observed for uranium-238, only those doses above 10^{-11} Sv/yr are shown in Figure 4. Many (879) of the 1000 realisations, give rise to a peak dose up to 10^{6} years of less than 10^{-11} Sv/yr. (In fact doses of less than this value are largely numerical noise in the calculation, and should be taken as approximately zero, i.e. there would be zero dose under the relevant conditions). The highest peak conditional dose from uranium-238 for any realisation is 73 microSv/yr (7.3×10^{-5} Sv/yr).

The similarly wide range of peak conditional doses observed for the daughter product of uranium-238 decay, radium-226, was treated in the same way to produce Figure 5. The highest peak conditional dose from radium-226 for any realisation of 7.4 mSv/yr (7.4×10^{-3}Sv/yr) (together with a contribution from other daughters of uranium-238) effectively establishes the upper end of the histogram for the total dose (summed over all radionuclides) shown in Figure 1. This is just one realisation out of 1,000 and the next highest realisation equates to a dose that is ten times less.

The indications from the preliminary assessment for the HLW/SF concept are that the peak mean risk from the groundwater pathway for all radionuclides would be very substantially below the risk target , being about 100,000 times less than that calculated for the ILW/LLW repository.

The highest peak conditional dose calculated for the PGRC of 10mSv/yr equates to the dose currently received by people living in areas of relatively high natural radiation background in the UK and is largely contributed by the same radionuclides, i.e. those in the naturally-occurring uranium-238 decay chain. The conditional dose calculated for the repository groundwater pathway is that for a hypothetical individual member of a small group of people (numbering of order ten) living many thousands of years in the future. The hypothetical group is placed at greatest risk by being assumed to live and farm on the land area that is subject to the greatest contamination by releases from a repository and to rely for their water supply upon a water abstraction well that intercepts the calculated plume of groundwater contaminated by radionuclides from the repository.

Figure 1 Histogram of percentage of realisations giving rise to ranges of peak conditional dose – total (all radionuclides)

All 1000 realisations shown.

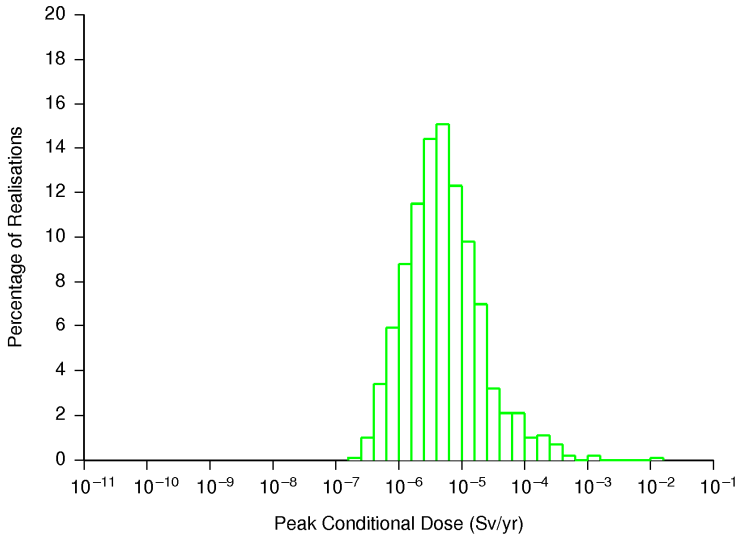


Figure 2 Histogram of percentage of realisations giving rise to ranges of peak conditional dose – chlorine-36

All 1000 realisations shown.

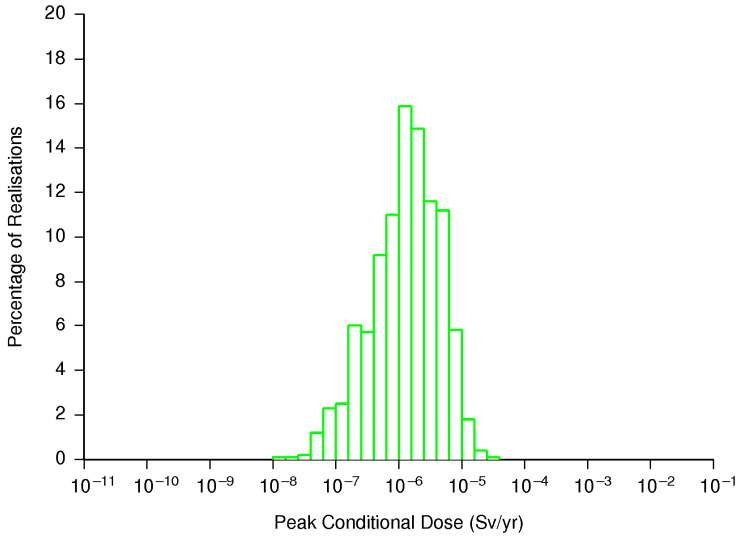


Figure 3 Histogram of percentage of realisations giving rise to ranges of peak conditional dose – iodine-129

All 1000 realisations shown.

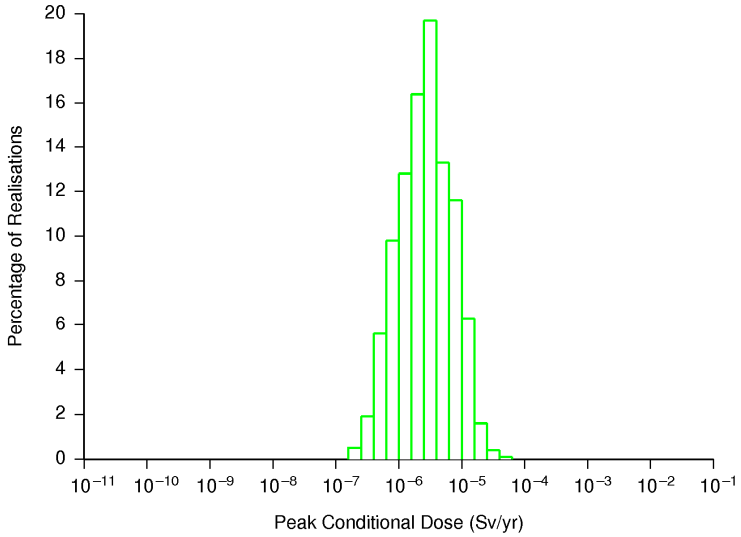


Figure 4 Histogram of percentage of realisations giving rise to ranges of peak conditional dose – uranium-238

121 realisations shown.
The other 879 realisations gave a peak dose (up to 10^6 years) from uranium-238 of less than 10^{-11} Sv/yr.

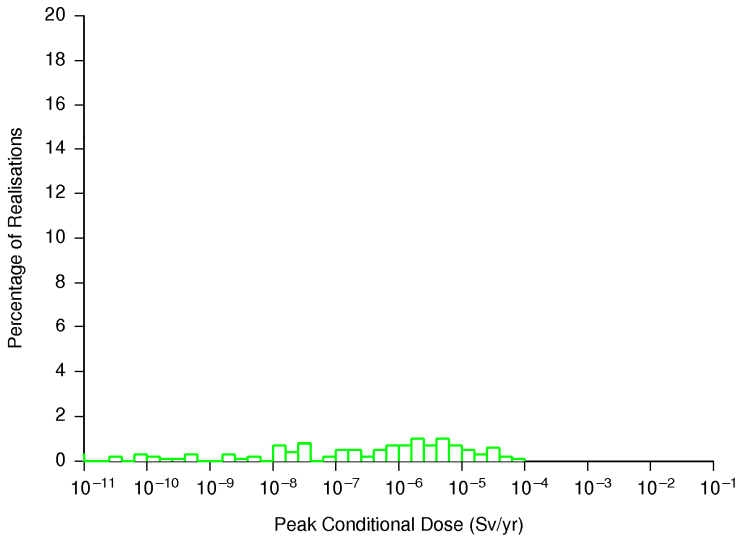
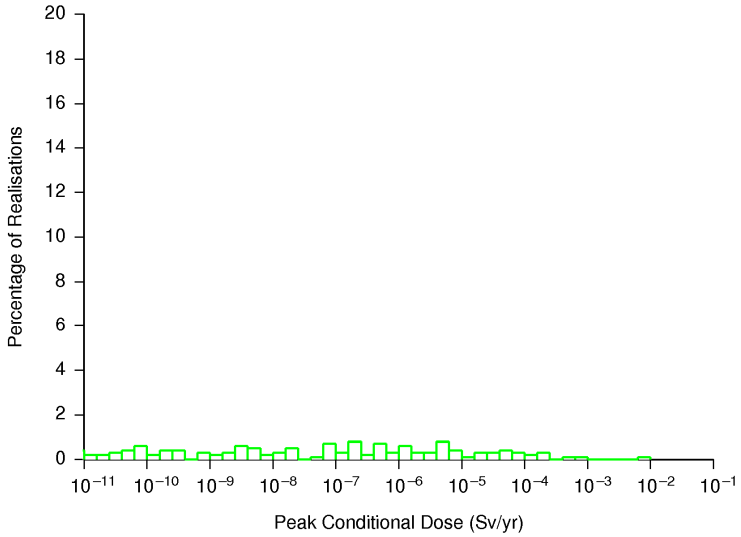


Figure 5 Histogram of percentage of realisations giving rise to ranges of peak conditional dose – radium-226

133 realisations shown.
The other 867 realisations gave a peak dose (up to 10^6 years) from radium-226 of less than 10^{-11} Sv/yr.



3. Isolation of depleted uranium and spent nuclear fuel from ILW complexants.

We asked about the extent of isolation of uranium and ILW that would be required to ensure that the ILW did not have a material impact on the mobility of the uranium. The last paragraph on Page 53 does not provide any more information on this aspect than the previous version. Do we know that the co-disposal of depleted uranium and spent nuclear fuel is practicable without significantly increasing the potential annual dose?

We have carried out studies on the implications of geological disposal of both depleted uranium and spent fuel at the same location as a repository for ILW/LLW. These show such disposal of these materials to be practicable without significantly increasing the potential annual dose. This is because the release of uranium from wastes into groundwater would be controlled by its very low solubility, so that the total amount of uranium in the wastes does not determine the calculated dose/ risk. This is a robust position provided that the geochemistry of the uranium is not perturbed by the presence of materials derived from the intermediate- and low-level wastes, in particular the organic complexants produced from the breakdown of cellulosic wastes (paper, wood etc).

In common with many other national waste management organisations, the proposed means of ensuring that the undesirable perturbation would not occur involves the development of a modular repository design. In this design a sufficient amount of rock would separate the ILW/LLW disposal vaults from those containing the other uranium-bearing wastes to ensure any release of contaminants did not reach them.

The assessment of what would be sufficient in terms of separation is strongly dependent upon the nature of the repository host rock and in particular the hydrogeological controls on contaminant transport through the rock. This topic was discussed specifically at the 3rd International TRU Workshop held in Oxford in January 2005. where programmes such as the French and Swiss, working on known rock-types ("mudrocks"), showed that separations of order a few tens of metres would be sufficient to prevent the contents of one ILW vault interacting with those of another. This information was summarised in a paper presented by Alan Hooper at the ICEM05 conference held in Glasgow in September 2005. (Paper 1377, Review of International Progress in Transuranic and Long-lived Intermediate-level Waste Disposal).

Vault separations of tens of metres are routinely envisaged in typical ILW repository designs considered by Nirex, so such a requirement would have insignificant implications, for example on the areal extent of the site required. Nirex has previously considered a more conservative case where a separation between vaults containing ILW/LLW and other wastes of hundreds of metres might be used.

4. Research into C14

We asked about the timescales associated with the ongoing research into the mobility of C-14. However, no information is given on Page 58 or in any other part of the report on this or any of the other research that is in progress to reduce uncertainties.

Section 9.2 of the Viability Report summarises the remaining challenges that need to be resolved to confirm viability. It states that these are being given priority, and proposes that, with appropriate funds and resources, these could be addressed within the next five years.

5. The Dose due to Human Intrusion

We asked for the predicted doses due to human intrusion. This information is not given on Page 59.

In a site-specific assessment of the human intrusion pathway, information from a potential repository location would be used to derive scenarios for the human intrusion pathway. These scenarios could reflect how, for example, site-specific geology, agricultural practice and human habits might influence activities that could lead to a radiological risk, as a consequence of inadvertent human intrusion at the site. Investigation of such scenarios would form part of a performance assessment of that potential repository location.

In the GPA and Viability Report, two example scenario representations arising from exploratory drilling (the geotechnical worker and site occupier scenarios respectively) are considered.

On the basis of information reported in the GPA, the Viability Report notes a calculated peak risk for the geotechnical worker scenario of 6.6×10^{-9} per year. This occurs at 100 years after the closure of the repository, after the period of institutional control to prevent human intrusion is assumed to have ceased. The associated dose is 24 mSv/yr.

On the basis of information reported in the GPA, the Viability Report notes a calculated peak risk for the site occupier scenario of 9.3×10^{-7} per year. This occurs at 200,000 years after the closure of the repository; the associated dose is 31 mSv/yr.
However, if the intrusion events were distributed over the vault plan area, but contaminated material were then left on the surface at the point of extraction, then this calculation of peak individual risk is pessimistic, as a 'resource area' would then contain less contaminated material than assumed in the calculation presented above. In this situation, peak individual risk and the associated dose would be less than the 9.3×10^{-7} y^{-1} value reported above.

Although these results provide generic illustrations of the assessment of the human intrusion pathway, further development of the approaches and methodologies to be used needs to be undertaken, particularly given the availability of any site-specific information.

6. Stability of Pores and Fractures

We asked for evidence on the extent to which Q, T & F can be predicted for very long times into the future and the associated uncertainties. At the top of Page 63, Section 5.1 helpfully addresses some changes that could alter the magnitude of these parameters. However, there is no discussion on the potential magnitude of these changes over the timescales of interest and how these have been taken into account in the values that have been given to the BGS, and thus on the available area that is suitable, or in Nirex, 97.

The fact that areas are known where Q, T and F have been stable for long periods does not, in itself, preclude the possibility that there are other areas where this may not be the case. This aspect is not addressed.

As stated in the Viability Report, *"Potential changes that might alter Q,T and F in the long term are mainly those that might affect the volume and connectivity of pores and fractures in the rock mass and in the forces that drive groundwater movement*". Ultimately, the stability of the groundwater flow system will be dependent upon the characteristics of a specific site, but the low permeability, mechanically stable rock-water systems that are suitable for a repository are, by their nature, resistant to rapid and extreme changes.

When considering potentially suitable geological settings in the absence of site-specific information, as the BGS has been asked to do, the uncertainties in the characteristics that control the modelling parameters Q, T and F, and the long-term stability of those characteristics, are factors that have to be taken into account. However, in the event that a repository programme were initiated, the evidence for the likely evolution of the rock-water system would be an important component of the investigation of a site.

We gained experience from the investigations at Sellafield that, alongside equivalent work in other countries' repository programmes, gives confidence that changes in hydrogeological properties can be evaluated.

The volume and connectivity of pores and fractures is potentially changed by the dissolution or precipitation of minerals. We were able to show that the geochemical

reactions in the deep rock-water system at Sellafield were close to equilibrium and had remained so over millions of years, such that porosity and permeability would not be expected to change significantly over the timescale of relevance.

An exploratory study of time-dependent groundwater flow and radionuclide transport modelling capability was carried out in connection with the groundwater flow and performance assessment models developed for the Nirex 97 assessment. (See I.C.S. Cox, C.P. Jackson, M.J. Poole, S.J. Todman and W.J. Worraker, AEA Technology report AEAT/R/ENV/0238, 2001). This showed that time-dependent changes to the forces that drive groundwater movement, particularly those resulting from climate change, can be incorporated into mathematical groundwater flow models. It also showed that the conclusions of the Nirex 97 performance assessment concerning the radiological risk from the groundwater pathway for a potential repository at Sellafield remained valid when these changes were taken into account.

A more detailed response to this question will be contained in a Geological Society of London publication co-authored by Professors Neil Chapman and Charles Curtis to be published shortly.

7. The Sedimentary Rock Cover

We asked about the extent that credit be taken for the sedimentary rock cover in the groundwater pathway and the uncertainties associated with the stability of this rock over many ice ages. This does not appear to be addressed in the viability report.

The possible changes that could lead to an alteration of the hydrogeological modelling parameters Q, T and F have been discussed in the answer to Question 6. In the GPA reference case, the sedimentary cover rock provides the major part of the groundwater travel time, T, and the whole of the mixing flux, F. This answer deals with the physical stability of the sedimentary cover rock. In this respect, research shows that the two main factors to consider in respect of ice ages are glacial erosion and glacially-induced seismic activity.

Glacial Erosion

Extrapolating past glacial erosion rates and glaciation frequencies into the future, between 100 and 200m of cover rock might be eroded over a period of a million years in areas subject to glaciation (northern Britain) and between 25 and 60m in areas not subject to glaciaton. Since these are averaged values, the extent of erosion in the 100,000 years when the radioactivity in some wastes is greater than that in uranium ore, might be one tenth of these values.

Glacially Induced Seismic Activity

The United Kingdom lies in a geological intraplate setting and the historical record confirms that this equates to a seismically quiet zone. Using Sellafield as an example, it has been possible to date the last movements on geological faults at 74 million years ago.

However, in areas such as Fennoscandinavia and northern Canada, that have been covered by thick ice caps, there appears to be evidence for a period of locally enhanced seismic activity on pre-existing faults following the melting of the ice and glacial unloading. There is also some limited evidence of such processes having

occurred on a smaller scale in northern Scotland. Since a number of glacial advance (loading) – retreat (unloading) cycles are expected to occur in the next million years, it is reasonable to assume such localised activity may occur in the future, although this is more likely to occur in mountainous areas subject to the thickest ice accumulations that are not well-suited as repository locations (for which low geographical relief is favoured).

Temporary and very localised alteration of the groundwater flow regime may occur as a result of such earthquakes. Although this is not thought to be significant for repository safety, the dating of movements on geological faults intersecting the possible groundwater flow pathline would be conducted as part of a site characterisation programme.

8. Acceptable UK Geological Systems

We asked about the extent that uncertainties in the methodology and data could impact on the proportion of the UK that would have a suitable geology. The third paragraph from bottom on Page 78 in Section 6.4, addresses how some uncertainties can be reduced by the appropriate choice of geology, but the report does not address the extent to which existing uncertainties impact on the proportion of the UK that is suitable.

For the groundwater pathway, uncertainties in the models and data are taken into account in identifying the proportion of the UK that would have a suitable geology.

- In the probabilistic calculations of risk for the Generic Performance Assessment (GPA), uncertainty ranges of an order of magnitude either side of the central values were applied for the groundwater flux through the repository (Q) and the groundwater travel time (T).
- For soluble and mobile radionuclides such as iodine-129, these uncertainties (particularly that on T) would be expected to be the main contributors to the uncertainty in calculated dose. This is addressed by the use of probabilistic safety assessment to calculate a peak expectation value of dose/ radiological risk.
- For daughter products of uranium-238 that dominate the calculated peak risk, the key uncertainties in the solubility and sorption of uranium-238 in the repository near field and in the sorption of uranium-238 and its daughter products in the geosphere are also taken into account by probabilistic analysis when determining suitable site characteristics.

A key uncertainty potentially impacting on the proportion of the UK that is suitable for long term radioactive waste management relates to possible site requirements regarding gas generated in a repository. Work undertaken subsequent to the GPA has identified the consequences of carbon-14 bearing gases as a key issue in the PGRC (see Section 5 of the Viability Report). Nirex has an ongoing programme of research on carbon-14, which is improving our understanding of the related issues. Dependent on the outcome of this further work, it could be necessary to establish additional siting criteria to ensure that significant gaseous release to the biosphere would be unlikely.

If it is necessary to impose such constraints, then the effect could be to reduce the proportion of the UK that is suitable for long term radioactive waste management.

This is currently being addressed as part of the BGS review of the suitability of geological settings in the UK.

9. The Biosphere

We asked about the extent that creditable uncertainties can be obtained from current studies on the biosphere. This does not appear to be addressed in Section 6.5. Thus, the paper does not address the extent that uncertainties associated with the biosphere would impact on predictions for the long-term safety of the repository.

The work conducted over the past twenty years or more in the UK and internationally to study the biosphere with respect to geological disposal of radioactive wastes gives a sound scientific basis for treating the relevant uncertainties. For some of these uncertainties it is necessary to develop a stylised approach that can be shown to be cautious in estimating the possible impacts on people and the environment, and for others it is possible to explore sensitivities of the impacts to specific features or processes of a possible future biosphere.

Uncertainties in evolution of the biosphere are addressed by considering a range of potential climate states and associated reference biospheres (e.g. Temperate-terrestrial, Boreal- terrestrial etc.). For the GPA we have used the climate- biosphere state that gives rise to the highest calculated radiological risk to a member of the reference community whose habits are consistent with the relevant biosphere characteristics.

A great deal of detailed research is available on the biological pathways for uptake of radionuclides so that the sensitivity of calculated radiological doses and risks to the parameters used for key features and processes can be explored in detail. This is discussed in the GPA with respect to one of the more significant features, the soil characteristics that can determine the extent of radionuclide uptake by food crops. However, the sensitivity of calculated risks and doses to these factors is relatively small compared with that derived from the choice of a climate- biosphere state.

10. Copper Canister Integrity

We asked about the current status of SKB's programme to demonstrate that the canisters can be manufactured to below the required failure rate. This is not addressed on Page 85 nor is any figure given for the design basis failure rate.

Pending results from the copper canister sealing and testing processes, SKB have assumed in recent safety assessments (SKB report TR-04-11) that canisters are to be fabricated, sealed and inspected to guarantee that no more than 0.1 percent of the finished canisters will contain discontinuities that are greater than that permitted by the acceptance criteria. This means that no more than one canister in a thousand will leave the encapsulation plant with a minimum copper thickness of less than 15mm at the top seal.

An account of the development of material and fabrication technology for copper canisters with cast iron inserts during the period from 2000 until the start of 2004 is given in SKB report TR-04-23. This report also describes the further work on

development of fabrication technology and quality assurance that SKB will continue over the next few years.

The Swedish nuclear regulator (SKI) has stated that prior to the time of a permit application, SKB must have demonstrated that methods for fabrication and inspection are available and are suitable for serial production. This means that a sufficiently large number of canisters must have been fabricated and inspected and shown to satisfy stipulated requirements. In response, SKB state that the account of work done in SKB report TR-04-23 "*shows that fabrication methods are available for all canister parts. The results to date also show that it is highly probable that these methods can be developed and gain acceptance for use in serial production*".

The recently published (November 2005) SKB booklet "Encapsulation: When, where, how and why?" gives a useful summary of the status of work on non-destructive testing techniques and explains why SKB is confident that the required quality of canister fabrication and sealing can be assured.

11. Reversible Concepts such as CARE

We asked about reversible concepts. These are not mentioned on Page 86 of the report although there is a reference to CARE in the response to Q2 on retrievability in Ann's letter of 02.12.05. However, this does not answer the points raised in our earlier query namely; if a reversible concept were to be incorporated into UK policy, how much delay would be introduced into the programme for an HLW repository and do any of the stainless steel concepts, other than CARE, allow reversibility?

We would not envisage any change to the programme shown in Figure 36 in the Viability Report to accommodate a particular policy requirement in respect of reversibility. Ongoing work in Sweden and Finland on the reversibility of the KBS-3 concept provides information relevant to our reference repository concept for HLW/SF. Further work is envisaged to determine whether this represents the optimised concept for UK HLW/SF, and reversibility would be just one aspect of such an evaluation.

Other concepts do consider reversibility. The Belgian (ONDRAF/NIRAS) Super Container for HLW/SF disposal has an outer stainless steel container and is envisaged for emplacement in an open horizontal tunnel that could be backfilled with cement-based material at some later stage. The French (Andra) HAVL repository concept is based on the use of steel containers for HLW/SF and steel tunnel liners such that reversibility could be maintained readily for a period of 300 years. Nirex has good links with both these programmes and is involved in co-operation with them and others (such as SKB, Sweden, and Posiva, Finland) in the area of reversibility through the EC ESDRED Integrated Project. Nirex also has a co-operation agreement with Numo, Japan through which we are able to keep abreast of work on the CARE concept.

12. The Suitability of the Sellafield Site

The last paragraph on Page 91 in Section 8.4 states that Nirex and the BGS believe that Sellafield is a suitable site for a repository. How does this relate to the statements in the third paragraph from the bottom on Page 78, which refers to the advantages of a site that is simple and can be easily

characterised, has a low groundwater colloid population and a low concentration of naturally occurring complexants?

The statement that Sellafield is a suitable site relates to the fact that there was confidence in the models for groundwater flow at the site developed from the results of the geological investigations. The models were tested successfully by obtaining a good match between their outputs and field observations that had not been used in their development. When the models were used in the Nirex 97 repository performance assessment, there was a significant margin of safety in the calculated peak risks compared with the regulatory target. There was also important evidence that the groundwater flow system at depth had not been significantly perturbed by recent glaciations and in particular that there had been very little mixing of the deep saline water and the near-surface, fresh waters.

In relation to the observations on page 78 of the Viability Report, the site had clearly been capable of sufficient characterisation. The ability to treat spatial heterogeneity through the modelling approach applied at Sellafield was specifically tested with an expert group that might be viewed as one of the key stakeholders in this area (as referred to in the Viability Report) and their review endorsing the approach has been published (Nirex's Approach to Spatial Heterogeneity – Report of the Peer Reviews Undertaken by the Spatial Heterogeneity Peer Review Group, Nirex Report N/039, 2003)

The concentrations of colloids and naturally-occurring organic material in the groundwater at Sellafield were low, being respectively similar to and less than those in equivalent deep rock-water systems elsewhere that had been subject to a similar level of analysis. (See "Colloids in the Geosphere: A Thematic Review of Nirex Research", Nirex Report N/053,2002). Expert geochemical advice was that the concentrations were sufficiently low that they would not affect the calculated transport of radionuclides at Sellafield, and did not require to be included in the assessment models in Nirex 97.

TYPOLOGY OF PUBLIC AND STAKEHOLDER ENGAGEMENT METHODS

Type of engagement	Purpose	Role in decision-making	Building blocks (methods)	Contribution to consensus building	Level of participation
Information giving	To provide information, raise awareness	Informs people about the issue	Press statements, newspaper ads, web sites, exhibitions.	Usually very little – reaction depends of expectations and history of issue.	None, but often provides essential support to other types of engagement.
Public opinion surveys	To identify public opinion on an issue and track changes over time	Can be taken into account by a decision-maker.	Opinion polls, telephone/postal surveys, deliberative opinion polls, research panels. (Use representative samples of population).	Usually very little.	Very limited, but depends on method chosen.
Front End Consultation (FEC)	To identify and explore basic views, concerns and opinions	Helps frame an approach to decision-making. Can inform development of a decision-maker's proposals.	*Intensive methods*: focus groups, citizens panels, using representative samples. Stakeholder workshops. *Extensive methods*: Interactive web sites, free telephone numbers, drop-in days. (ie open access)	Some potential if output informs further stages of consultation, deliberation or dialogue.	High for small numbers of people in intensive methods. Moderate for those in extensive methods.
Participative consultation	To identify and explore views and concerns about a decision-makers proposals	Could lead to adjustment, revision or abandonment of proposals.	*Intensive methods*: focus groups, citizens panels, stakeholder workshops. *Extensive methods*: Interactive web sites, free telephone numbers, drop-in days. *Existing processes*: discussion in eg local authority environment forums, parish/town/community councils.	Some potential (particularly if initial proposals informed by a FEC)	High for small numbers of people in intensive methods. Moderate for those in extensive methods.
Public deliberation	To identify and develop proposals through public discussion	Decision-maker should give serious consideration to adopting proposals so developed.	*Intensive methods*: workshops, citizens panels, consensus conferences (using representative samples of members of the public). *Extensive method*: maybe through interactive web site	Good potential (but not if overall process excludes key stakeholder groups).	High for small numbers of people.
Bounded stakeholder 'dialogue'	To develop agreed way forward on issue identified by decision-maker	Decision-maker should give serious consideration to adopting agreed way forward.	Sustained collaborative negotiation between representatives of stakeholder groups – in workshops/working groups.	Good potential (but not if stakeholders do not accept boundaries of the dialogue).	High for stakeholders involved.
Open stakeholder 'dialogue'	To develop agreed way forward on issues identified by stakeholder.	Decision-maker could adopt agreed way forward, but issue may not genuinely be "up for grabs".	Sustained collaborative negotiation between representatives of stakeholder groups – in workshops/working groups.	Good potential if decision-maker genuinely open to influence	High for stakeholders involved

CORWM

Committee on Radioactive Waste Management

Meeting summary - document 1700

Please could one CoRWM Member complete this for each meeting attended and e-mail it to Sam Bains who will give it a document number.

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1. Date, place and title of meeting attended:

13 March 2006, Royal Academy of Engineering, London; Review of scientific and technical coverage provided by CoRWM's work.

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2. Who attended for CoRWM:

Gordon MacKerron, Wynne Davies (Chairing), Fiona Walthall, Andy Blowers, Pete Wilkinson, Lynda Warren, Mark Dutton (all members), Adam Scott, Steve Mansfield, Tamara Baldwin, Sam Bains (all secretariat), Lisa Albino (NNC; part of meeting).

Geoffrey Boulton, Norman Haste, Robert Mair (external members of CoRWM Quality Assurance Group).

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3. Others present:

Bill Gelletly, Steve Sparks, Peter Guthrie, John Sherlock (members of the Defra Chief Scientific Advisor's expert panel).

Malcolm Wakerley (Research Manager, RAS Division, Defra).

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4. Purpose of attending meeting:

To provide advice on technological and scientific coverage in CoRWM's final report and key references for any issues that are not covered in detail.

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5. Main points discussed / information acquired:

a. The aim of the meeting was a strategic check that coverage and referencing of final report are scientifically robust and will meet the expectations of the science community. The report has to be fit for purpose - essentially a support for policy. Many issues will be downstream of the final report - in the implementation phase.

b. Long-term interim storage: the engineering is relatively straightforward - no technical challenges that appear insurmountable; planning is a significant issue, permission might be difficult to achieve but appears to be realisable; there are

uncertainties about the long-term behaviour of waste packages - you need to be able to review the status of work over time.

c. Geological disposal: Dealing with uncertainties is an important issue. A lot of sites overseas are highly characterised for disposal; the UK has a uniquely varied geology and there is no reason to believe that sites which cannot be characterised to the same standard do not exist in the UK. But the way this is described in the report will have to be carefully phrased according to the various constituencies of CoRWM's audience and supporting statements will need to be carefully referenced.

d. Phased geological disposal: Keeping a repository open can provide a lot of data but puts greater demands on both geology and engineering. Voids can create pressure points and encourage inward groundwater flows and rock expansion could occur with increased conductivity. These effects can be tested, and uncertainties managed, by use of underground rock laboratories (URLs). There is the possibility of a flexible concept - URL - store - repository. In science terms, PGD is, to an extent, an artificial concept, for which the benefits are not clear, and the main advantage may be one of societal perception.

e. Boreholes: The technological challenges associated with making boreholes wide enough to resist criticality could be exaggerated. At greater depths, the risk of failure increases and what is permissible as a technical response to failure in, for example, oil and gas exploration (such as drilling around a blockage) would not be acceptable for radioactive waste. The need for substantial R&D appears to point towards a watching brief.

f. Non-Geological Disposal: The reactor materials and their location are important. The graphite is nearest the reactor core and becomes porous. It contains Ch-36 and C-14 which are long-lived. EA have indicated that they do not consider it suitable for near surface disposal. Steel supports the reactor shield. Techniques exist for re-melting and it might be possible to use recycled steel in underground structures. By contrast, the flux varies a lot across the concrete shield. Disposal is the least preferred approach in the waste management hierarchy. Unnecessary waste transport is also undesirable. Free release and recycling of concrete, for example in sea defences is desirable where it can be achieved.

g. Watching briefs: Reject the idea of watching briefs for ice sheets and subduction zones as hostages to fortune. There are strong pointers in favour of watching briefs for P&T and boreholes. Examination of the watching briefs issue could help expose the issue of maintenance of the nuclear skills base, and also the unavoidable need for a substantial period of storage before a long-term facility is put in place. It also offers the prospect of commercial opportunity which will drive investment in the scientific skills base.

h. General conclusions: Nothing has been identified that need cause CoRWM to take a completely different course and no significant gaps in scientific or technical coverage have been identified. An important "flag" is to match the language of technical descriptions to the needs of the audience.

Actions for CoRWM (what, when, whom):

None.

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6. This note written by: SM; a longer report, prepared by SM and TB, records attributable comments by those present. It was agreed with participants that this record would not be made publicly available.

nirex

TECHNICAL NOTE

REVIEW OF CONSULTATION TECHNIQUES FOR RADIOACTIVE WASTE MANAGEMENT

Prepared by:	E. Atherton and J. Hunt	E. Atherton,
Approved by:	A. McCall	Am McCall

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PROVISONAL or INTERIM status means this Technical Note is 'work in progress' and has been prepared to facilitate Nirex's work programme and does not necessarily reflect the company's final position.

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STATUS	**REVISION**	**ISSUE DATE**	**COMMENTS**
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Draft	2	4/7/01	Sent to Jane Hunt (JH) for review and A. Littleboy
Draft	3	23/11/01	Incorporating some of JH's comments, sent to JH for more comprehensive review
Draft	4	28/1/02	Incorporating more of JH's comments, sent out to J. Dalton and A. Littleboy for review
Draft	5	28/1/02	Modified to amend tables and include some review comments
Interim	6	March 2002	Modified to incorporate A. Littleboy's and A. McCall's comments and to reformat the headings and front sheet and

This Technical Note is part of an ongoing programme of research conducted by Nirex and its contractors. It is a component of the research into options for the long-term management of radioactive waste in the UK.

Nirex want to develop the thinking outlined in this Technical Note through discussions with others. Therefore, this Technical Note should be viewed as 'work in progress' (i.e. interim or provisional status) and Nirex would be grateful for any comments on the ideas put forward. Nirex recognises that the Technical Note only outlines our view and that others may have different views on the issues.

Bibliography

A complete bibliography of Nirex publications is available at the Nirex website, www.nirex.co.uk, or from Nirex Corporate Communications at the address below or e-mail: info@nirex.co.uk.

Feedback

We welcome feedback on our reports. Readers are invited to provide comments to Nirex on this Technical Note.

Feedback should be addressed to:

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1 PREFACE

Nirex produces a number of Technical Notes, on a variety of subjects, to inform the debate on what the UK should do with its radioactive waste. These are often accurate at a particular point in time and will change as a result of further thinking, comments from other interested parties and the results of further research. They are thus regarded as 'work in progress', but we feel that given the nature of the debate that it is beneficial to release them at this stage. It must be recognised that they may be updated and amended over time.

The development of a long-term solution to radioactive waste is a social, ethical, political, technical and scientific problem. All these aspects need to be addressed when developing a long-term solution. This Technical Note has been prepared to support Nirex's response to the Government Consultation paper [1], 'Managing Radioactive Waste Safely'. The Consultation paper asks which consultation processes could be used at different stages in the programme to develop a long-term solution to radioactive waste to engage with stakeholders.

This Technical Note outlines the advantages of engaging with stakeholders, especially at the early stages of the decision making programme and goes on to outline the principles that should underpin consultation and what can help to builds its legitimacy. Characteristics of different consultation techniques are explored and then related to the indicative programme set out in the Government Consultation paper. Detailed descriptions of a number of consultation processes are included in Appendix 1, 2 and 3. Appendix 4 outlines some of the stakeholders that should be included in the debate about radioactive waste management.

2 REVIEW OF CONSULTATION TECHNIQUES FOR RADIOACTIVE WASTE MANAGEMENT

3 INTRODUCTION

This technical note has been produced to support Nirex's input to the Government consultation on radioactive waste management [1]. Section 2 outlines good practice in consultation, the advantages of identifying stakeholders' issues and the principles that a consultation process should adhere to. Section 3 looks at the keys to developing a legitimate consultation and the importance of responding to consultation, providing information and having independent oversight and evaluation of processes. Section 4 describes some of the different characteristics that consultation processes can have, it goes on to evaluate which consultation processes have which characteristics. Section 5 looks at the different stages in the indicative programme set out in the Government consultation and which consultation techniques may be suitable in each stage. Section 6 is a summary of the key points in the paper. Appendices 1, 2 and 3 contain detailed descriptions of a number of consultation processes. Appendix 4 outlines some of the stakeholders that should be included in the debate about radioactive waste management.

4 GOOD PRACTICE IN CONSULTATION

4.1 The 'New' Consultation Processes

Two important concepts are incorporated in most of the consultation processes that have been developed over the past few years:

The first is the significance of 'framing' or problem definition and the importance of widespread consultation to establish the problem definition [2]. Framing refers to the way in which a problem is construed and what are considered to be the important elements of the problem (and by whom). Radioactive waste management has historically been framed as a scientific, technical, regulatory and economic problem by responsible authorities, whilst others have emphasised, for example, the ethical, social, and relational dimensions. Identifying the different framings of a problem, people's issues and concerns and establishing what needs to be addressed is therefore important at the beginning of the process. This is often called a Front End to consultation 3

The second is the concept of deliberation. This goes beyond the idea of dialogue, in that it requires that participants <u>develop</u> positions (through appropriately structured interactions) rather than having measurable positions, which are not responsive to the context in which they are articulated. Thus, opinions, positions, preferences, concerns and values are understood as products of consultation, rather than inputs.

These two concepts emphasise the dynamic aspects of consultation, and stress the interactive and contextual dimensions in which opinions are produced, rather than assuming that opinions and views are external to the process in which they are articulated. In turn, this emphasises the need for recognition of the ways in which different consultation processes structure deliberation towards different outcomes, and hence careful selection of the processes used.

4.2 Advantages of Identifying Stakeholder Issues

There are numerous potential benefits, to both commissioning institutions and participants, of identifying the issues that the public and other stakeholders consider relevant to the problem under discussion. Chief amongst these is the ability, through appropriate responses to the issues identified, of producing more democratic decisions, which reflect the concerns of citizens. Other benefits include:

Defining the Problem – asking stakeholders to express their issues allows them to define the problem and includes them at the beginning of the decision-making process.

Influence – allows stakeholders to influence the process and have their issues addressed.

Increased Understanding – helps stakeholders to understand more about their differences and the situation and identifies common ground.

Increased Involvement – if debate focuses on the technical issues of a decision or options this can exclude the public. Including broader issues involves the public in the decision-making process and allows them to express their concerns.

Wider Ownership – involving stakeholders in the process increases their ownership of the outcomes.

Information Provision – highlight what information is required and where and how research needs to be conducted.

Option Development – helps the implementer to develop solutions that address stakeholders' issues.

Option Evaluation – stakeholder issues can be used to develop criteria against which options can be evaluated.

4.3 Principles of Consultation

Research and experience in the UK, USA, Canada and Sweden [4, 5, 6, 7] into controversial issues, including radioactive waste management, has shown that there are key principles to which a legitimate and effective consultation process must adhere. These include:

Clear Purpose – people (including those organising the consultation) need to be clear about the overall aims of the process, and how the process fits within the broader decision-making context.

Commitment – it must be possible to keep the consultation going throughout the life time of the decision-making process and its implementation. Whilst it is contradictory for a responsive consultation process to define all subsequent stages at the outset, an overall commitment to its continuance, with associated budgetry provision, is essential.

Openness of information – the debate must take place in the public domain and there should be open access to as much relevant information as is possible; if information is withheld from the public domain the reasons for this should be clearly justified. Information should be provided to stakeholders in a form that is accessible to them.

Openness of process - to be legitimate, and to have credibility, the process must be open to be adjusted by participants.

Openness of outcomes – outcomes must be open to influence from participants with differing opinions and perspectives.

Transparency – the reasoning behind actions, deliberations and decisions should be made available. It must be clear from the outset how stakeholders and the public can be involved in the decision making process and how their opinions will be taken into account and used.

Inclusion – all stakeholders should be given the opportunity to be involved, and a wide range of views should be actively sought. It is never possible to obtain a truly representative sample of stakeholders, but the consultation process should enable all those who wish to participate to do so. Inclusion refers not only to people, but to views and ideas.

Early Involvement – it is important to engage with the public and other stakeholders at the beginning of a process. This avoids the criticism that stakeholders have only been involved once decisions have been made; more importantly, it enables stakeholders to frame the nature of the problem being addressed (i.e. to define and scope the problem). Widespread acceptability of decisions may not be possible unless this problem framing is sufficiently inclusive.

Deliberative – consultation processes should enable participants to actively discuss and debate the issues, and develop positions and viewpoints.

Collaborative and interactive - consultation is most effective if it is based on the premise of attempting to engender collective responsibility for a problem which requires a collaborative response. Such collaboration may well transgress traditional institutional boundaries, and stakeholder dialogue provides a mechanism for instituting such collaborative responses. Two-way communication is necessary – the process should enable both those who are being consulted, and those who are consulting, to ask questions and listen to the answers.

Devolved Process – it will not be possible to talk to every group of stakeholders in the same way, therefore the process must seek to reach people in a way that engages them and enables them to express their opinions, if they want to. It is important to recognise the differences between various groups in the population and their experience of the issues.

Accountability – those responsible for the process should be accountable for their actions to all parties. This includes publicising the reasoning behind decisions, and justifying the selection and conduct of consultation activities.

Feedback – stakeholders must be given feedback to show how their views have been taken into account or why they have not been included. A clear response, that demonstrates how the results of consultation have been taken into account, is required.

Alongside principles of good practice, several practical issues need to be considered when thinking about the mechanisms to use for consultation. These include:

Independence – the management and reporting of the consultation process should be seen to be independent of established interests in order for the consultation to be seen to be widely credible.

Time – a balance needs to be struck between a number of important considerations. It is important to capture public and stakeholder interest in the consultation per se and provide them with sufficient time to reflect and respond. However, too long a period of consultation could dissipate interest and inhibit overall progress. Different consultation techniques have advantages and disadvantages in balancing this trade-off between stakeholder engagement and time requirements.

Timeliness – intense periods of consultation should take place at appropriate stages in the policy and decision process.

Sufficient Resources – it may be necessary to make resources available to allow people to take part in the consultation process. People will need resources to be able to attend meetings and may need to be compensated accordingly. There will also be the need to provide information from several perspectives and this will need both co-ordination and funding.

5 KEYS TO A LEGITIMATE CONSULTATION

The legitimacy of a consultation process depends on several factors, especially the behaviour of those running or commissioning it. The following sections outline some important issues that can increase the legitimacy of a consultation process.

5.1 Responding to Consultation

A fundamental requirement of legitimate consultation is that the outcomes of consultation are clearly taken into account in reaching decisions. If this is not the case – if the preferences and positions of the consultees are not visibly taken into account – the consultation will be seen to be an empty exercise and serve no purpose in gaining the confidence of participants in relation to the overall policy and decision process. Rather, it can be counterproductive, alienating participants and embedding adversarial positions.

Aims and legitimacy cannot be properly identified and achieved without establishing how the outcomes of consultation will be used. It is pointless, for example, to identify preferred criteria for judging the relative merits of management options, if these criteria are not then utilised in the decision making process.

Commitment to transparency, and to efficiency, demand that certain questions are answered:

- How the outcomes of consultation will be used?
- How the consultation contributes to the development of a publicly supported policy?
- How the merits of one argument will be judged against another?
- How feedback will be provided to those who participate?
- What further opportunities there are for participation?

Commitment to the principles of good practice in consultation suggests that the answers to these questions should be provided with the invitation to consult.

The development of a long-term solution to radioactive waste requires scientific research. It is important that consultation results contribute to the definition of the scientific research agenda and to defining what will constitute a satisfactory knowledge base on which to proceed with particular management options. This is especially true because of contested nature of scientific research in this domain, and the wider 'science and society' issues [8].

5.2 Information and Communication

Information provision is accepted as being essential to legitimate consultation. However, this requires that information is provided in a form which is accessible to the intended users. Good practice further requires that consultees should be able to ask questions, to have access to information from a range of sources, and that information should not pre-frame the issue in a way which does not encourage open debate and deliberation.

‘Balanced’, ‘unbiased’ information is often stated as a pre-requirement of consultation. However, this is difficult if not impossible to produce; not least because one person’s ‘unbiased’ information can be another’s propaganda. It is often simpler to provide a range of information from different perspectives. If a primary information source is used, it is likely to need to be agreed by proponents of different perspectives to be secure from the challenge of bias.

Information provision necessarily frames a problem in a particular way (by providing technical information, for example, the problem is presented as being technical). It is therefore good practice to develop information after a Front End consultation, where the problem is defined by the consultees and thus the areas on which information is required are also defined by consultees.

5.3 Overseeing and Evaluation

The conduct of consultation can usefully be overseen by a group convened either specifically for that purpose or as part of a larger remit (see also Appendix 2). Experience to date [9, 10 shows a strong preference for such panels to include independent members as well as representatives of the range of interest groups. Use of such a panel can enhance the legitimacy of a consultation.

Both participants and independent observers should evaluate consultation activities. Participants’ evaluations are important: should they not consider the consultation valid, its outcomes are not legitimate. Evaluations should be used to increase institutional learning, enhance capacity building, and develop best practice.

5.4 Building on Existing Initiatives

Existing consultation experience, using new processes, in the field of radioactive waste management includes:

- DETR/Nirex/EA Consensus Conference on Radioactive Waste [11]
- BNFL Stakeholder Dialogue [12]
- Nirex Focus Groups [13, 14]
- HSE Focus Groups and Questionnaire [15]
- Environment Agency Magnox discharge authorisations [16]
- Nirex Stakeholder workshops on Monitoring and Retrievability [17, 18]
- MoD Project ISOLUS Front End Consultation [9]
- Nirex independent stakeholder review [19]
- Nirex Citizens’ Panel on Partitioning and Transmutation [20]
- Safegrounds stakeholder consultation [21]
- RISCOM II [10]

The Government Consultation paper asks how DEFRA and the Devolved Administrations can build on the previous consultations. What has been learnt from these consultations and research activities should obviously be taken into consideration when selecting and designing processes for consultation in relation to the development of policy and decision-making. The outcomes of the previous consultations should also be used as inputs to the Government Consultation.

However, it is important that a national level consultation programme, initiated by DEFRA and the Devolved Administrations, should develop its own identity and momentum. Consultation which contributes to national policy development in the area of radioactive waste clearly needs to be commissioned by them and undertaken by independent third parties, in order to be credible. We therefore support their plans to undertake focus groups, workshops and to reconvene the UKCEED Citizens' Panel members.

6 CHARACTERISING AND SELECTING CONSULTATION PROCESSES

The previous sections have outlined the advantages of stakeholder involvement and the principles that should underpin it. The following sections look at factors that are important when developing appropriate consultation processes for various situations. The section starts by describing some of the different characteristics that consultation processes have and goes on to outline which processes have which characteristics.

6.1 Structure and Content

It is worth noting that their structure, rather than their content generally, but not always, define consultation processes. That is, it is the form of the meeting (or other communication medium), rather than what takes place within it that makes a process recognisable as one thing or another.

In terms of structures, the basic structure of a discussion group, for example, is that of a small meeting moderated by a facilitator with a topic identified for discussion. Within that structure, a number of different activities can take place – open or guided discussion, identifying and ranking priorities, etc.

In terms of activities, there are, for example, a range of introductory activities which have different emphases. A simple 'my name is and I'm from this organisation' immediately defines the participants as having an organisational, rather than an individual, identity. An introductory round which asks what participants hope to get out of the process helps to set the agenda for what should be discussed, but sets it differently to a round which asks participants to say what they think is important about the nature of the problem.

It should not be overlooked, though, that there are also a range of activities which can take place within the structure of different processes, and that parts of different structures can be amalgamated to form new processes.

These examples demonstrate the way in which the different elements of different processes both require attention to purpose, and can be combined to fulfil particular purposes.

Consultation processes are thus highly malleable, and it is generally worthwhile considering the precise design of consultation processes in relation to the aims of the consultation, and adapting consultation processes accordingly.

6.2 Characteristics of Consultation Processes

Various consultation processes have different characteristics (although these can change as the process is adapted for specific uses). Below, we identify and describe a number of these characteristics, and go on to describe some of the more well known processes in terms of these characteristics. The consultation processes are described in detail in Appendix 1, 2 and 3.

6.2.1 Features of the Processes

Framing - Processes differ in the extent to which they enable participants to define the nature of the problem being addressed; best practice dictates that the framing of the problem should be open to definition by participants.

Deliberative - Most new processes are more deliberative in nature, especially when compared to opinion polling, which only captures immediate reactions to the question posed. Radioactive waste management is not something that people consider everyday, therefore they need time and space to consider the issues and develop their views. This can be achieved by using deliberative consultation processes.

Inclusive of views - If a range of views is sought, processes should be selected accordingly. If the full range of views is sought, more extensive consultation, with processes repeated with different participants, is likely to be necessary.

Empowers participants - The empowerment of participants – through building their confidence and ability to participate – can be a significant function of some processes, both in relation to the specific issue under consideration, and in relationship to developing a more widespread culture of citizenship.

Capacity building - Both in the general societal sense of empowering and enabling people to participate, and in the more specific sense of building experience and understanding within responsible institutions, different processes can contribute to capacity building.

Consensus building - Some processes aim to produce a consensual outcome, whilst others aim to map out the issues, preferences, and concerns of participants.

6.2.2 Features of the Participants and Their Recruitment

Voluntary or actively recruited participation - Many consultation processes require participants to 'opt-in', rather than encouraging participation. This means only those with a pre-existing desire to participate, and the means to do so, respond; this is particularly significant in relation to members of the public who generally exclude themselves from participation for a number of reasons.

Active recruitment of participants overcomes this problem. Active recruitment should not exclude voluntary participation, although different consultation processes may be required. Where the views of 'ordinary' members of the public are sought, it is generally necessary to actively recruit participants, and to provide incentives.

Inclusive of people - If consultation with a range of different groups and individuals is required, consultation processes should be selected accordingly, with a view to actively recruiting those participants who are unlikely to participate voluntarily.

Representativeness - A small number of participants generally means that a process is less representative, except in exceptional circumstances. Even when panel members are recruited to represent different demographic characteristics, the participants cannot be said to be representative of different demographic groups. Neither can the views articulated be seen to be representative of the variety of views held more widely; indeed, where the process is deliberative, views and positions may well change during the process. A process with a large number of participants is only more likely to cover a fuller range of views, however, if participants represent different groups.

Roles of participants - Different processes provide different roles for the participants – for example, as users of a service, as self-interested individuals, as citizens within a collective, as interactive group members, or as individuals with fixed views or people who can debate and develop views. Most of the new consultation processes are more deliberative, enabling participants to develop positions and consider issues in relation to the common good rather than individual interests, and thus act as citizens.

6.2.3 Other Features of the Processes

Familiarity - The new consultation processes are largely unfamiliar to the public and to many official stakeholders. Where this is the case, in order to comply with the requirement for openness and transparency, the structure and intent of the process needs to be clear to participants.

Outputs – Different consultation processes can produce different outputs. Some processes do, or can, produce firm recommendations as an output, whilst others do, or can, produce decisions, criteria, or more general 'maps' of the issues of concern to consultees.

Information - Processes provide information in different ways; some give greater opportunities for questioning experts and seeking further information, and some provide information from different perspectives. Given the importance of accessible information for effective deliberation, and the centrality of contested information in many environmental disputes, the ways in which information is provided is an important consideration.

Knowledge gathering - Processes differ in the extent to which they enable participants to contribute knowledge which they have themselves, be this lay and local knowledge or specialised technical expertise.

Institutional credibility - Institutional credibility can be enhanced through interaction with other participants. However, credibility is most strongly associated with the extent to which institutions visibly respond to consultation outcomes.

6.3 Which Processes Have Which Characteristics?

The table below identifies the particular characteristics of various consultation processes.

It should be noted that the comments in the table below reflect current experience with these processes; as discussed above, most processes can be used in different ways, to be, for example, more or less deliberative, or to produce different outputs.

Research panels, community issues groups not, of themselves, processes they are groups of stakeholders who are used in various consultation processes. The comments below refer to the ways these frequently operate.

Table 1 Features of the Process

	Features of the Process					
Process	**Framing**	**Deliberative**	**Inclusive of views**	**Empowers Participants**	**Capacity building**	**Consensus building**
Opinion Polls	Closed framing	Not deliberative	Unlikely	No	No	No
Consultation Papers	Closed framing	Does not encourage deliberation, although can generate detailed consideration of issues	Only includes views of invited and voluntary participants	Rarely	Rarely	No
Public Meetings	Framing generally pre-set but challenged by respondents	Tends to be 'point scoring' rather than deliberative	Tends to leave many views unarticulated	Can empower some, but be disempowering for others	Yes, but tends to be uncomfortable for official representatives	No
Open Houses	Pre-frames the issue, but this is open to challenge	No	Dependent on nature of material and staffing, and sites visited	Can be empowering	Can build capacity; direct interaction with public often provides useful learning	No
Citizens' Jury	Specifies question but does not frame possible answers	Yes	Not necessarily, although wide range of views generally articulated	Often very empowering	Can generate substantial insight into public views	Yes: generally agreed recommendations or conclusions are produced
Consensus Conference	Specifies questions but does not frame possible answers	Yes	Not necessarily, although wide range of views generally articulated	Often very empowering	Can generate substantial insight into public views	Yes: generally agreed recommendations or conclusions are produced
Ongoing Stakeholder Dialogue	Generally specifies issues but leaves framing open	Yes, but dependent on participants' commitments	Can include wide range of views, but often excludes lay public	Can be empowering	Can generate insight into wider network of stakeholders and map issues	Generally conceived of as consensus building, although this takes considerable time and may not be possible
Stakeholder Workshops	Provides initial framing which is open to challenge	To some extent, often limited by time available for discussion	Can include wide range of views, but often excludes lay public	Possible	Can generate insight into wider network of stakeholders and map issues	Unlikely, though common ground can emerge
Multi-criteria mapping	Dependent on variation of process used; can be either	Limited, but dependent on variation used and can be high	Can include wide range of views	Possible	Can enhance understanding of issues	Possible
Community Issues Group	Framing established by participants	Yes, although dependent on conduct of group	Dependent on membership	Likely	Tends to build capacity within community rather than within institutions	Possible

Table 1 (Continued) Features of the Process

	Features of the Process					
Process	**Framing**	**Deliberative**	**Inclusive of views**	**Empowers Participants**	**Capacity building**	**Consensus building**
Interactive Panel	Framing open, although issue generally pre-set	Yes	Dependent on membership	Likely	Can enhance understanding of issues	Possible
Focus/discussion Groups	Open, although can be constrained	Yes	Tends to be wide range of views; if multiple groups held, comprehensive coverage of views can be obtained	Likely	Can enhance understanding of issues	Unlikely, though common ground can emerge
Deliberative Opinion Poll	Open to some extent	Yes, to some extent: limited by time and large number of participants	Wide range of views can be expressed	To a limited extent	Can enhance understanding of issues, but poll outcome likely to be overemphasised at expense of range of views expressed	No; inherently adversarial
Research Panel	Tends to be closed, dependent on processes used by panel	Dependent on processes used with panel	Dependent on processes used with panel	No	Limited	No
Public hearing/inquiry	Dependent on conduct of inquiry; official inquiries tend to have narrow, pre-set framing	Within limited framing, can be deliberative	Narrow range of issues; many issues generally excluded from debate, but can be open and wide-ranging	Dependent on process used	Dependent on process used	No, but could be possible with modifications
Internet consultation	Dependent on form used; generally implicit framing open to challenge	Dependent on form used.	Can be wide ranging	Possible	Possible; use of IT in communication with public likely to be enhanced	No

Table 2 Features of the Participants and their Recruitment

	Features of the Participants and their Recruitment			
Process	**Voluntary or actively recruited participation**	**Inclusive of people**	**Representativeness**	**Roles of participants**
Opinion Polls	Actively recruited against specifications	Inclusive against demographic criteria	Can be used as representative of demographic groups or other specifications	Individuals with fixed and accessible opinions
Consultation Papers	Voluntary and invited participation, tends to be 'clubbish'	Tends to be exclusive as inaccessible/unknown to many people	No	As stakeholders prepared to engage with the terms of debate as set; assumes norms of literacy and western rationality
Public Meetings	Voluntary participation	Can be exclusive; only a minority with pre-existing views tend to speak,	No	As self-interested individuals; tends to be confrontational
Open Houses	Voluntary participation	Can be relatively inclusive, especially if sites are selected carefully	Likely that some groups will self exclude	As interested citizens
Citizens' Jury	Actively recruited participation	Exclusive, although can include people often excluded in other processes	No, although can be taken as a measure of public preferences once issues considered fully	As deliberative citizens with legitimate views and concerns, capable of reaching reasoned positions
Consensus Conference	Actively recruited participation	Exclusive, although can include people often excluded in other processes	No, although can be taken as a measure of public preferences once issues considered fully	As deliberative citizens with legitimate views and concerns, capable of reaching reasoned positions
Ongoing Stakeholder Dialogue	Invited and sometimes voluntary participation	Tends to be exclusive; lay public are not usually participants	Can represent stakeholder interests	As interested stakeholders capable of identifying common ground
Stakeholder Workshops	Invited and sometimes voluntary participation	Tends to be exclusive; lay public are not usually participants	Can represent stakeholder interests	As interested stakeholders
Multi-criteria mapping	Recruited or invited	Can include people excluded in other processes	Limited	As interested individuals
Community Issues Group	Voluntary	Can be exclusive, or can actively encourage participation	Limited	As members of a community
Interactive Panel	Recruited	Can be exclusive, or can actively encourage participation	No	As citizens

Table 2 (Continued) Features of the Participants and their Recruitment

	Features of the Participants and their Recruitment			
Process	**Voluntary or actively recruited participation**	**Inclusive of people**	**Representativeness**	**Roles of participants**
Focus/discussion Groups	Recruited	Exclusive	If sufficient groups held, can be taken to be broadly representative of range of views	As deliberative citizens with legitimate views and concerns, capable of reaching reasoned positions
Deliberative Opinion Poll	Recruited and/or voluntary	Dependent on recruitment strategy	Can be used as representative of demographic groups or other specifications	As self interested individuals
Research Panel	Generally recruited	Dependent on recruitment strategy	Can be used as representative of demographic groups or other specifications	As demographically representative 'average people'; research subject
Public hearing/inquiry	Required and voluntary	Tends to be exclusive as inaccessible/unknown to many people	Unlikely to be representative although local authority participation gives some democratic representation	Dependent on process used
Internet consultation	Voluntary	Open access, but restricted to those with skills, facilities, and time.	Unlikely	As interested individuals

Table 3 Other Features of the Processes

	Other Features of the Processes				
Process	**Familiarity**	**Outputs**	**Information**	**Knowledge gathering**	**Institutional credibility**
Opinion Polls	High	Data on how people answer pre-selected questions	Generally no information inputs	Does not generally invite knowledge input	Generally not relevant
Consultation Papers	High	Mixed responses requiring interpretation	Provides pre-framed and selective information	Can invite knowledge inputs	Can be counter-productive due to narrow terms and exclusivity
Public Meetings	High	Record of views expressed	Some information generally provided; information can be requested by participants	Participants often provide local knowledge	Often counter-productive as relationship between institutions and participants is often adversarial Often highly dependent on the individual representatives as well as institutional parameters
Open Houses	High	Record of views	Information provided but predetermined; staff can provide information but tends to be one-sided	Participants can input knowledge, but this is frequently not recorded	Can enhance credibility, but may be counter-productive if highly framed.
Citizens' Jury	Low	Report, generally with recommendations or conclusions. Can produce decisions or generate criteria.	Information provided and can be requested. Selection and examination of witnesses allows participants to identify relevant information	Generally high level of participants knowledge and experience brought to bear	Often enhances credibility as demonstrates institutional commitment to eliciting public views; in the longer term this credibility can be undermined if no response is visible.
Consensus Conference	Low	Report, generally with recommendations or conclusions. Can produce decisions or generate criteria.	Information provided and can be requested. Selection and examination of witnesses allows participants to identify relevant information	Generally high level of participants knowledge and experience brought to bear	Often enhances credibility as demonstrates institutional commitment to eliciting public views; in the longer term this credibility can be undermined if no response is visible.
Ongoing Stakeholder Dialogue	Medium	Can generate recommendations or decisions	Information generally provided by participants	Generally high level of participants knowledge and experience brought to bear	Can enhance credibility, but dependent on nature of relationships developed within dialogue process

Table 3 (Continued) Other Features of the Processes

	Other Features of the Processes				
Process	**Familiarity**	**Outputs**	**Information**	**Knowledge gathering**	**Institutional credibility**
Stakeholder Workshops	Medium	Generates issues	Information provided, questions and participants' input possible	Generally high level of participants' knowledge and experience brought to bear	Can enhance credibility by demonstrating interest and willingness to listen
Multi-criteria mapping	Medium	Maps and weights issues, can produce a decision	Information tends to be limited	No	Dependent on institutional responses
Community Issues Group	Medium	Can produce recommendations and decisions	Information tends to be provided by participants	Generally high level of participants' knowledge and experience brought to bear	Dependent on institutional responses
Interactive Panel	Low	Can produce recommendations and decisions	Some information generally provided; information can be requested by participants	Generally high level of participants' knowledge and experience brought to bear	Often enhances credibility as demonstrates institutional commitment to eliciting public views; in the longer term this credibility can be undermined if no response is visible.
Focus/discussion Groups	Low	Generates and maps issues, can be used as a forum for generating criteria	Some information generally provided; information can be requested by participants	Generally high level of participants' knowledge and experience brought to bear	Often enhances credibility as demonstrates institutional commitment to eliciting public views; in the longer term this credibility can be undermined if no response is visible.
Deliberative Opinion Poll	Low	Produces majority vote	Some information generally provided; information can be requested by participants	Some contribution of participants' knowledge, but limited	Can enhance credibility
Research Panel	Low	Dependent on processes used, generates range of data	Dependent on processes used	Unusual	Experience is varied; possible resistance to being treated as research subject

Table 3 (Continued) Other Features of the Processes

	Other Features of the Processes				
Process	**Familiarity**	**Outputs**	**Information**	**Knowledge gathering**	**Institutional credibility**
Public hearing/inquiry	Medium, but expectation is for formal process such as a public inquiry in the planning system	Produces decision or judgement, but not collectively	Information generally provided by witnesses who can be cross examined	Lay and local knowledge can be elicited	This depends on the institutions behaviour in the meeting and interaction with participants. Their response after the event is also important.
Internet consultation	Growing	Can generate issues, or be used to vote, weight criteria, etc.	Provides pre-framed and selective information	Possible	Can enhance credibility as demonstrates institutional commitment to eliciting public views; in the longer term this credibility can be undermined if no response is visible.

7 THE DECISION AND CONSULTATION PROCESS: SELECTION OF METHODS

Consideration of the attributes of consultation processes in conjunction with decision making needs can assist the selection of appropriate consultation strategies. The DEFRA and Devolved Administrations' consultation paper [1] on radioactive waste management outlines an indicative programme for action. The table below describes consultation characteristics in relation to the different stages in the indicative programme and which consultation processes may be appropriate in each stage.

A full assessment of the policy development and decision process is beyond the remit of this Technical Note. It would also be premature, as it is to some extent dependent on the outcomes of Stage 1 of the DEFRA and Devolved Administrations' consultation (as are the details of science review and options selection). The example is therefore illustrative rather than determinative.

Table 4 Stages of the Programme and Consultation Processes

Stage	Aims of Stage	Outcomes	Key Consultation Characteristics Needed	Consultation Outcomes Needed	Possible Consultation Techniques	Notes
Stage 1: Front end consultation on: public participation, scientific research and institutional arrangements	Identify - issues, concerns, preferences - define the problem - requirements for institutional reform - requirements for legitimate scientific research	Better understanding of the issues which need to be addressed in developing policy	Open framing Deliberative Inclusive of range of people and views Empowers participants Capacity building Vol & Act Recruit Accessible Information Knowledge gathering Build institutional credibility	Wide ranging map of issues, concerns and preferences Identification of information needs Problem definition	Discussion groups Citizens' panels/juries Stakeholder workshops Internet	Need for variety of techniques to cover wide range of participants and views involving substantial publicity to enable potential participants to identify the opportunities to participate
Stage 2: Research on the feasibility of waste management options	Identifying: Legitimate means to conduct science review Criteria to evaluate options against Establish the feasibility of different waste management options	Agreed process to conduct scientific review of options Evaluation of options against agreed criteria	Open framing Deliberative Inclusive Consensus building Participants as citizens Informed discussions Knowledge gathering	Produces recommendations for process and criteria of science review Reviews waste management options against agreed criteria Report on options evaluated against criteria	Citizens panel / interactive panel Discussion groups Stakeholder workshops / dialogue Internet	Requires focussed discussion, including public input.

Table 4 (Continued) Stages of the Programme and Consultation Processes

Stage	Aims of Stage	Outcomes	Key Consultation Characteristics Needed	Consultation outcomes needed	Possible Consultation Techniques	Notes
Stage 3: Consultation of the feasibility of waste management options	Establish clear preference for the waste management strategy to be implemented	Assessment of the feasibility of waste management options	Deliberative Inclusive Consensus building Participants as citizens Informed	Produces recommendations on the option(s) to go forward for development	Consensus Conference Discussion groups Consultation paper Internet Workshops	If, as is necessary, siting requirements are identified in the consideration of options, it is sensible to conduct consultation on potential sites at this stage.
Stage 4: Decision and Announcement of waste management strategy	Government decide on and announce the waste management strategy	Announcement of the Government decision	Information provision Wide dissemination Engages stakeholder	Wide dissemination of the decision	Publish decision and justification Press releases Internet publication	This is not a consultation stage, but one of publicising the decisions on strategy
Consultation on implementing the strategy	Establish criteria and methodology for implementing the management strategy	Identification of the issues to be addressed for successful implementation	Deliberative Inclusive of people and views Inclusive of local communities	Recommendations on how to carry out successful implementation	Citizens' panels Discussion groups Stakeholder workshops Internet	If siting has not already been addressed, this phase of consultation will need to include issues such as the process of site selection and compensation provision
Stage 5: Legislation (if required)	Legislation on the implementation of the management strategy	Legislation	Information provision Open process	Wide dissemination of the legislation	White Paper Press releases Stakeholder meetings Internet publication	Again, this is not of itself a stage of consultation, but any legislation will clearly need to reflect (and be justified in relation to) consultation outcomes

8 SUMMARY

A combination of consultation processes will have to be used to enable people to engage at the appropriate level and to gain a comprehensive perspective on the range of views.

Clear identification of the aims of consultation at different stages of the programme will enable the selection of appropriate methods.

The decision making process must be open, transparent, inclusive, and deliberative. Stakeholders must be given the opportunity to influence the programme itself, as well as inputting to the decisions made.

The ways in which the outcomes of consultation are to be used in the development of policy and the decision process needs to be clear from the outset. Decisions need to be justified in relation to the consultation outcomes, and to clearly take these into account.

It is crucial to conduct a widespread 'Front End' consultation, to ensure the problem is defined appropriately.

In relation to this, we stress that some of the presumed 'givens' of the DEFRA consultation paper are themselves contested, and require consultation. For example, the principles in Appendix 5 of the Consultation paper, and more particularly, the ways in which these principles are interpreted and applied, require stakeholder support. The institutional restructuring is also fundamental to development of widespread confidence and should be developed with stakeholder input.

It will be important to identify stakeholders' issues and concerns at the beginning of the programme and to use these to develop how the programme develops.

APPENDIX 1 CONSULTATION PROCESSES AND TOOLS

Table A1 Consultation Processes

Process	Description	No. Participants	Information inputs	Duration	Time taken to set up, run, report and evaluate [1]	Advantages	Disadvantages	Use in relation to decision making process
Questionnaire	Closed and open questions	1000s	Usually none, although can be used in conjunction with information provision	N/A	Can usually be conducted in a matter of weeks	Can reach large number of people Can have open ended questions Useful for benchmarking views Can reach people who would not attend meetings	Can give knee jerk reactions Does not encourage debate Quantitative not qualitative Can be difficult and costly to design and implement	Benchmarking Quantitative data Nation-wide In the early phases
Consultation Paper	Paper outlining issues and asking for comments	Unlimited	Summary information provided within paper	6 months	1 year plus	Summarises key issues Can be sent to interested parties Can be put on the web	Can have poor response rate May only reach 'usual' stakeholders Does not encourage debate between stakeholders	Simulate interest Obtain views Nation-wide In the early phases
Free Phone Lines	Phone line providing information	Unlimited	Information provided by telephonist requiring good knowledge of the subject from different perspectives	N/A	As required	Easy to set up Can be good source of information Not intimidating	May need to be manned May need advertising Staff may not be able to answer enquiries	Information source Obtain views Nation-wide Throughout the process

[1] This period is an estimate of the length of time period needed to conduct the activity, including, for example, pre-activity periods for publicity. It is not an estimate of the hours of work needed to prepare, conduct and evaluate a process.

Table A1 (Continued) Consultation Processes

Process	Description	No. Participants	Information inputs	Duration	Time taken to set up, run, report and evaluate	Advantages	Disadvantages	Use in relation to decision making process
Newspaper Column	Column providing information and comments from readers	Readership of the paper	Concise information briefings required	N/A	Ongoing	Easy and cheap to set up Can stimulate debate	May be biased by editorial view Only reaches the paper's readership	Information source Obtain views Local / National Throughout the process
Public Meetings	Open meeting to discuss an issue	Up to 500	Generally provided by speakers, who should provide different viewpoints	Few hours	3 weeks plus (some lead in time is required for publicity)	If well facilitated can give insights into stakeholder views Brings stakeholders together	Can be high-jacked by vocal parties May not be representative May have poor attendance Can be adversarial May not encourage dialogue	Provide information Obtain views Stimulate interest Local / National In the early phases to obtain views and throughout to give feedback
Open Houses	Touring display outlining the issue with staff to answer questions	Unlimited	Information generally provided by commission ing body, but could be multi-sourced	1 day at each venue	Months plus	Useful for providing information and giving access to the proponent Can reach people who would not attend meetings	Can be costly in terms of staffing and preparation	Provide information Obtain views Stimulate debate Local / National In the early phases to obtain views and throughout to give feedback
Electronic Democracy	Web site providing information and asking for comment	Unlimited	Use of links can provide wealth of information	6 months plus (can be ongoing to provide updates)	Weeks	Easy to set up Can be made interactive Is available 24/7 Easy to access and can reach wide audience	May get poor response rate (response rate tends to be higher when website is linked to other activities) Needs to be monitored Anonymous responses Wide access is not common in the UK	Provide information Obtain views Stimulate debate National Throughout the process

Table A1 (Continued) Consultation Processes

Process	Description	No. Participants	Information inputs	Duration	Time taken to set up, run, report and evaluate	Advantages	Disadvantages	Use in relation to decision making process
Consultation workshop	Meeting with invited participants to discuss issues, including facilitated small groups	Up to 40	Introductory information may be necessary, but largely dependent on participants' own knowledge	1 day	6 weeks	Encourages deliberation Useful for complex subject Can be targeted at stakeholders Beings stakeholders together	Reaches limited numbers of people Attendance may be poor Participants may need paying	Obtain views Stimulate debate Bring people together National In the early phases to obtain views and throughout to give FB.
Citizens' Jury	Group of citizens come together to discuss an issue, question expert witnesses and write a report	12-16	Initial briefing materials, Expert witnesses	usually 3-5 days or two weekends	c. 3 months	Encourages debate and deliberation Gives the public access to experts Gives considered responses	Time consuming and costly Only reaches a few people May be difficult to get experts	Engage public Obtain considered views Local / National In the early phases to obtain views
Consensus Conference	Panel of citizens question experts and produce a report	Up to 20	Briefing materials, Expert witnesses	4-5 days plus several introductory weekends for panel	c. 4 – 6 months	Can be held openly giving more access Gives considered responses Gives the public access to experts	Time consuming and needs lots of preparation Only reaches a few people May be difficult to get experts	Engage public Obtain considered views National In the early phases to obtain views

Table A1 (Continued) Consultation Processes

Process	Description	No. Participants	Information inputs	Duration	Time taken to set up, run, report and evaluate	Advantages	Disadvantages	Use in relation to decision making process
Ongoing Stakeholder Dialogue	Repeat meetings between stakeholders for discussion of issues	Unlimited	Access to information necessary to informed discussion Stakeholders contribute information	Unlimited	Dependent on number and complexity of meetings	Shares views and information between participants Can build relationships and constructive dialogue by greater understanding between participants Can generate decisions/ways forward from deadlock	Limited participation Time consuming and costly Key stakeholders can refuse to participate	Possible uses in developing detail of strategies and providing peer review
Multi-criteria mapping	Group of stakeholders go through a structured process to analyse an issue	12	Dependent on participants	1 day plus dependent on form of process used	4 weeks plus	Evaluates issues in a structured way Encourages deliberation Investigates assumptions and views in detail	Only reaches a few people Is resource and time intensive	Engage stakeholders Obtain considered views Local / National In the early phases to obtain views or could be used for the whole process
Community Issues Group	Group of citizens who meet several times to discuss and issue, generally used for community specific issues	8-12	Accessible information from range of sources required as requested	Ongoing	Dependent on number and complexity of meetings	Gives time to reflect on issues Opinions can develop over time Can involve experts	Time and resource intensive Reaches a limited number of people	Engage public Obtain considered views Local In the early phases to obtain views and throughout the whole process

Table A1 (Continued) Consultation Processes

Process	Description	No. Participants	Information inputs	Duration	Time taken to set up, run, report and evaluate	Advantages	Disadvantages	Use in relation to decision making process
Interactive Panel	Standing group of people who meet regularly to discuss an issue	12	Access to wide range of information required as requested	3 or 4 times a year	Ongoing	Enables increased understanding and debate Can change the panel membership	Reaches a limited number of people Several would be needed countrywide	Engage public Obtain considered views Local / National Throughout the whole process
Focus Groups	Facilitated meeting of stakeholders to discuss a topic	6-8	Introductory but carefully phrased information needed	Up to ½ a day in 2 sessions	3 weeks	Encourages debate and deliberation Can be given access to experts Cheap to run Obtains a considered response	Can be time consuming Several needed to reach lots of people	Engage stakeholders Encourage debate Obtain considered views Local / National In the early phases to obtain views
Deliberative Opinion Poll	People are questioned about a topic then debate it, question experts and are questioned again	250-600	Introductory material and expert witnesses	2-4 days	3 months plus	Reaches large numbers of people Brings people together Encourages debate Gives a considered view	Can be costly It may be difficult to bring such large numbers of people together	Obtain considered views Encourage debate Local / National In the early phases to obtain views
Research Panel	Group of local people used as a sounding board	500-3000	N/A	N/A	N/A	Can track changes in opinions over time Can obtain more informed views Can be used for several consultations Reaches large numbers of people Once set up are cheap to run	Are only a source of people, consultation techniques have to be used with them	Varied In the early phases to obtain views and throughout the process

Table A1 (Continued) Consultation Processes

Process	Description	No. Participants	Information inputs	Duration	Time taken to set up, run, report and evaluate	Advantages	Disadvantages	Use in relation to decision making process
Overseeing Panel	Group of independent stakeholders who oversee a project	6-8 people	As requested	Length of the project	Length of the project	Gives independent scrutiny of a project Can represent different stakeholder interests	Can be costly to set up and run Only involve a small number of stakeholders	Independent scrutiny of a project Throughout the process, though separate panels could be set up for different phases

A 1.1 Traditional Techniques

A 1.1.1 Questionnaires

Questionnaires surveys are widely used to gauge public opinion, can have several formats: face to face interviews, telephone interviews, they can be performed on the street or in people's homes. Closed questions usually require yes or no answers and may not obtain the reasoning behind people's views. Open ended questions usually ask for some sort of reasoning from people and can give more detailed information.

Advantages and Disadvantages

Questionnaires are often criticised for giving knee jerk reactions to complicated topics and not providing the reasoning behind people's answers. However, if they consist of open ended questions and are not conducted 'on the street' but at people's homes over a longer discussion period, then they can provide insights into people's thinking. They are an easy way to reach a large number of people quickly. However, designing a 'good' questionnaire can be time consuming and difficult.

Examples of Use of the Technique

Nirex commissioned the Future Foundation to conduct a 'bench marking' questionnaire and HSE used telephone interviews to investigate people's understanding and concerns about radioactive waste management [13, 15]. Both studies showed that radioactive waste is not a key concern to people, but that they feel uninformed and would like more information to be available in an easily understandable format.

Potential Use in the Consultation on Radioactive Waste Management

Carefully designed questionnaires could be used at the beginning of the decision making process to benchmark people's views and to provide an indication of people's issues and concerns about radioactive waste. Repeated over time, this would give an indication of overall trends.

A 1.1.2 Consultation Papers

This is the traditional form of consultation and can include sending the paper to interested parties and placing it on a web site asking for comments. Although it is important to create a paper to stimulate debate, it must be part of a suite of techniques used to obtain people's inputs, as the traditional consultation paper is generally exclusionary and only obtains input from a narrow range of stakeholders

Advantages and Disadvantages

Consultation papers do not always have a high response rate and will probably only reach stakeholders who already have an interest in the subject, or are expecting their release. They also rely on stakeholders having the time and ability to construct a written response to the paper.

Examples of Use of the Technique

Consultation papers are used in most Government and Environment Agency consultations. The Cabinet Office has issued guidelines for the use of written consultation of this type.

Potential Use in the Consultation on Radioactive Waste Management

Consultation papers can be used at the beginning of any decision making process to outline the issues and ask for comments, and as part of a suite of techniques at subsequent stages It is important that the paper does not contain subjective information or bias the debate. Including different perspectives in the paper could enhance its credibility and responses to it.

A 1.1.3 Free Phone Lines

These can be used to record people's opinions, give them access to experts and to request further information.

Advantages and Disadvantages

They are easy to set up and cheap to run. The line does not have to be manned continually, but there has to be a commitment to reply to people quickly.

Examples of Use of the Technique

Phone lines have been used in Canada and the USA [22] to provide information, advertise future events, record people's opinions and allow people to request information. The phone line for the WIPP repository was available in English and Spanish. The Environment Agency in the UK provided a phone line as part of their consultation about Magnox stations [23].

Potential Use in the Consultation on Radioactive Waste Management

A phone line could be run throughout the decision making process and can be interactive if discussion is allowed or enabled.

A 1.1.4 Newspaper Columns

People debate issues via newspapers on a day to day basis. It would be possible to sponsor a column in a newspaper to promote debate about radioactive waste management. This could be proceeded by the provision of information about the subject and the opportunity to obtain information.

It would be relatively cheap to run and could be set up in a variety of papers, to reach a wide section of the population. All responses could be kept and analysed and topics of particular interest could be printed in the column. This technique could be used on a national or local level, depending on which newspapers were used.

Advantages and Disadvantages

Using newspapers suffers from the same problems as the Internet, it is not possible to stop special interest groups biasing the results, or ensure that people are who they say they are. Additionally, given the ownership patterns of print media in the UK, there are likely to be problems with both gaining the agreement of a newspaper to run a debate column, and the way in which it is subsequently managed. The discussion is likely to reflect the positions of the editor, as well as their perceptions of the intended audience.

Examples of Use of the Technique

Newspapers are often used to advertise forthcoming events or consultations. They have been used at local levels to discuss issues.

Potential Use in the Consultation on Radioactive Waste Management

Newspaper articles could be used at the beginning of the decision making process to obtain input from people and stimulate interest in the consultation. Throughout the process newspapers could be used to advertise forthcoming events, provide feedback and keep people up to date with the process.

A 1.2 Interactive Techniques

A 1.2.1 Public Meetings

The more informal these are the more successful they tend to be. They are especially useful when a project is in the detailed planning and implementation phases.

Information can be distributed prior to the meeting to enable participants to prepare and formulate questions about the issue. There would need to be a series of meetings at several locations to reach a wide section of the population. Meetings need to be advertised in advance using several mediums, so that people know that they are going to take place. The time of the meetings should also enable people who work to attend and it may be useful to discuss with people in an area to develop a time that would be most suitable for them.

Advantages and Disadvantages

Public meetings can be adversarial and promote the dichotomy between 'experts' and the 'general public'. Meetings can sometimes be 'high-jacked' by vocal participants, or those with a particular view of the situation. Meetings may also only attract attention from those who already have an interest in the subject or have strong opinions and may not be well attended. However, public meetings can give access to those involved in the project and do bring stakeholders together and can be opportunity to clarify issues and address people's concerns. Meetings can be relatively easy to set up and can be cheap to run.

Examples of Use of the Technique

Most consultations involve some sort of public meetings. The Environment Agency used public meetings to discuss Magnox plants and technetium discharges, although the Agency believes the 'surgeries' that it held were more effective than the public meetings [23].

Potential Use in the Consultation on Radioactive Waste Management

Public meetings could be used at a local level to stimulate debate, though the smaller and more informal these meetings are the more successful they are likely to be. Using stakeholder workshops would probably be more constructive and enable more detailed debate.

A 1.2.2 Open Houses

Information is put on display and representatives from the authorities involved are on hand to answer questions. The public are also encouraged to leave written comments and can take information away with them to read and comment on later. It would be possible to provide questionnaires for people to fill in and computers could be provided to give people access to further information and any Internet site that has been set up.

Advantages and Disadvantages

Open houses would have to be set up at several locations around the country if they were to be used for national consultation, which might make the method expensive; alternatively a travelling open house could be used, which would visit several areas. However, this method may provide little space for deliberation, and the public can be placed in a particular relationship with the 'experts' which may constrain responses. Open Houses can attract people who would not attend a public meeting and are less formal than meetings, which may also appeal to people. Open Houses can be used to target several age groups, by providing several displays and can stimulate debate and interest in the topic.

Examples of Use of the Technique

Open houses were used successfully in Canada to discuss radioactive waste management issues and were held in shopping malls and railway stations. The initiative enabled the Government Department to engage in dialogue with people who would not attend organised meetings. SKB in Sweden have a ship that they take around ports in Sweden. The ship includes activities for all age groups and has thousands of visitors each year. They have found it very useful for initiating dialogue with people.

Potential Use in the Consultation on Radioactive Waste Management

Open Houses could be used at the beginning of the decision making process to stimulate debate and obtain insight into people's opinions. They could also be used throughout the process to provide feedback to people. Open Houses are one way of engaging with schools, as a travelling display could be used. Once the issue of radioactive waste management becomes site specific an Open House would be a good way to engage with the local community.

A 1.2.3 Electronic Democracy

The Internet is becoming an important forum for debate and communication. Chat rooms allow people to discuss many diverse topics and there are numerous groups who use the Internet to promote their causes.

Access can be given to several sources of information using hyperlinks and people can be exposed to different points of view and different debates. It would be important to represent all sides of the debate on the page and to provide a balanced view of what is going on. It is easy to monitor input on the web and to provide 'chat rooms' for people to discuss issues, these can be set up for a set length of time to allow focused debate. Another possibility is to allow people to pose questions to experts using the page, which would encourage interaction with a wider spectrum of people.

Advantages and Disadvantages

Using the Internet gives easy access to thousands of people from all over the country and various walks of life. The disadvantages are that:

- You cannot be certain that people are entering accurate information or that special interest groups are not encouraging their members to bias the results (although this is a factor in many forms of consultation).
- Some members of the public do not have access to the internet (particularly groups who are already disenfranchised to some extent).
- Response rates, to date, have been low (although this can potentially be overcome to some extent by the use of widespread publicity in other media during the consultation period).
- It is not clear whether people act differently while using the 'virtual world' of the Internet than they would in 'real' life [24].
- The Internet could also be seen as exclusive, as the people who use it may be the wealthier, more educated groups in society.
- People who are not used to using computers may also find it difficult to access the site. To overcome this problem local resources, for example libraries, have been used to house computers dedicated to access of the site. This would enable those without their own computers to give their opinions, and on site help can also be provided.

Using the Internet is an inexpensive method of encouraging and monitoring debate between different members of the population, though it can be difficult to regulate. Given the current growth in Internet use, this medium offers substantial potential for development.

Examples of Use of the Technique

Most organisations have web sites that contain information and the opportunity to contact them. Web sites have been used in local consultations conducted by Lancaster University and Leeds University about environmental issues. Nirex is working on the RISCOM II project, which includes the development of an interactive web site aimed at teenagers to try and engage them in the debate about radioactive waste management.

The ISOLUS [9] project has a web site which includes a questionnaire and opportunity to make comments via the site. Web sites have also been used in the USA to discuss radioactive waste management issues.

Potential Use in the Consultation on Radioactive Waste Management

The Internet could be used throughout the decision making process to provide information, advertise events and ask for feedback. It could also be used to allow people to make inputs into the consultation and could include questionnaires and open ended questions to stimulate input. Chat rooms could also be provided and key players in the debate could go 'on-line' to communicate with interested parties.

A 1.3 Deliberative Techniques

Deliberative consultation techniques bring different stakeholders together and provide opportunities for deliberation and interaction. They aim to obtain considered and developed views from the participants.

A 1.3.1 Consultation Workshops

These can be targeted at key stakeholders, e.g. NGOs, industry, activist groups and the scientific and research community. Or can be used to address key themes, e.g. environmental assessment procedures, community equity and compensation issues. They can be structured as follows:

- Up to 40 invited stakeholders;
- Meeting for one day;
- Either one stakeholder group or a mix of representatives;
- Mix of plenary sessions and small facilitated groups;
- Report outlining the outcome of the discussions.

The format of the meetings are usually:

- Presentation by the organiser;
- Clarification of issues;
- Discussion in small, facilitated groups;
- Plenary session to report on issues identified and stimulate discussion.

At the beginning of a consultation process key stakeholders can be invited to attend and present their views and listen to others' views about the consultation. The objective is to have non-adversarial meetings either with the stakeholder groups separately, or possibly together, to talk about the issues that they have and to work on specific contributions that they want to make. The plenary session may need to be facilitated to enhance the dialogue and splitting the attendees into small groups would also increase the debate that occurs.

It is customary to pay participants' travel and subsistence expenses, it may also be necessary to pay for people's time if that enables them to attend the meeting. This may be especially important if the workshop includes members of the general public or people working for charitable organisations.

Advantages and Disadvantages

This form of early participation by organised interest groups could result in useful substantive contributions. Additionally, it could help to form allegiances and further productive relationships with a number of groups who are otherwise likely to be antagonists. Useful intelligence on potentially problematic areas, and the arguments and positions of these interest groups can be obtained from the meetings.

Examples of Use of the Technique

A variety of similar exercises have been used to draw together potentially opposed positions. The public inquiry process has often encouraged "side room meetings" between opposing experts and independent advisors. These have been chaired by Inquiry Assessors to make progress on both procedural and substantive issues. It is now common place for the public inquiry process to hold a "procedural meeting" at the outset of an inquiry. This enables parties to make their preferences known regarding the key topics to be covered, the order of subject matter, the "batting order" of witnesses, the location and timing of hearings, and so on. Sir William Stewart's Independent Expert Group on Mobile Phones held sessions to hear expert evidence around the country in a non-adversarial manner [25]. The Brent Spar Dialogue process held interactive workshops to elicit stakeholder views prior to identifying a more publicly acceptable solution for the Spar.

Nirex has used similar techniques, two workshops were held on Monitoring and Retrievability [17, 18]. The reports of the days were produced independently by the facilitators and were reviewed by the participants prior to publication to ensure that they captured their comments accurately. Using a mixture of plenary and small group sessions enabled the stakeholders to discuss the subject in detail as well as sharing a summary with the whole group. A similar format has been used in the MoD ISOLUS project [9].

Workshops have been used in Germany as part of the AkEnd project to develop a site selection process and criteria [26].

Potential Use in the Consultation on Radioactive Waste Management

Workshops would be particularly useful at the beginning of the decision making process to enable stakeholders to define the problem, express their issues and concerns and to bring together different stakeholders in a non-adversarial way. Workshops are also a way of providing feedback to participants and assessing the progress made during the consultation.

A 1.3.2 Citizen's Juries

These involve:

- the recruitment of a group of 12-16 people to be broadly representative of their area;
- the group meet for up to four days to consider policy proposals and local impacts (assisted by independent moderators);
- the group can select and cross examine witnesses;
- a report, containing conclusions, recommendations, and/or decisions, is written by the group and submitted to the organisation(s) who set up the jury.

Citizens' Juries involve ordinary members of the public in their capacity as citizens and give them the opportunity to represent their community in a serious debate.

Advantages and Disadvantages

One advantage is that this method gives people the opportunity to talk to experts and to review the information available. It is very people intensive and requires significant amounts of time and effort. It can also be difficult to secure the time of experts to participate.

Being a one off event, citizens' juries may not give people the opportunity to fully understand the issues surrounding a subject. This can be overcome by giving people background material and preparation weekends. On the other hand only meeting briefly prevents people from becoming entrenched and the group stagnating; it may also help to focus debate on the key issues.

Citizens' juries are valuable in terms of developing a sense of citizenship, and in contributing directly to decisions. When subject to further analysis, the discussions that have taken place are also useful in providing insights into the ways in which members of the public think about and, for example, respond to information relevant to, a particular issue. However, they are a relatively resource intensive method.

Examples of Use of the Technique

Numerous Citizens' Juries have already been held in the UK [27, 28, 29]; they have proved particularly useful for local government and health authorities.

Potential Use in the Consultation on Radioactive Waste Management

Citizens' Juries could be used at the beginning of the decision making process to identify the issues and concerns of the general public. Once an issue impacts at a local level, then Citizens' Juries are a good way to engage with local people.

A 1.3.3 Consensus Conferences

This technique involves a panel of between ten and twenty volunteers, sometimes recruited through advertisements, who develop their understanding of technical or scientific issues in dialogue with experts. The panel attend preparatory weekends where they are briefed on the subject and identify the questions that they want to address in the conference

The conference itself lasts for 3-4 days and gives the panel a chance to ask experts any outstanding questions. The conference is open to the public and the audience may also have the opportunity to ask questions. The panel retire and prepare a report, copies of which are made available to the conference audience, and panel members present key sections to the audience. Consensus conferences allow panel members to control the content of the process, seek consensus, and are open events.

Advantages and Disadvantages

Consensus conferences can be time consuming and costly, but they do however bring together people from different areas of the country to talk about the issues. Due to their short duration they may not give people enough time to understand and comment on the information they receive. It is not possible to reach a representative sample of the population through this method, nor is it possible to extrapolate the results to the wider population.

The method does give people access to experts and is open to the wider public, however obtaining the time of experts can be difficult.

Examples of Use of the Technique

Consensus conferences have been used widely in Denmark and two consensus conferences have been held in the UK [30].

Potential Use in the Consultation on Radioactive Waste Management

A consensus conference could be used at the beginning of the decision making process to allow the general public to input into the debate and identify some of their issues and concerns.

A 1.3.4 Ongoing Stakeholder Dialogue

Ongoing stakeholder dialogue comprises meetings, generally between representatives of interested groups, over a longer or shorter time period. The principle is that through dialogue, areas of convergence and divergence can be identified and addressed. It is important that the process is open and that all parties are invited. The dialogue must also make a difference otherwise participants may leave and remove their support for the work.

Advantages and Disadvantages

Ongoing Stakeholder Dialogue can produce much greater understanding between people, and can identify solutions and ways forward in the place of controversy and conflict. However, it is also time consuming and expensive, and requires participation by all relevant parties to be properly effective.

Examples of Use of the Technique

The BNFL Stakeholder Dialogue, convened by the Environment Council [12], is the best known example in the field. However, it has been criticised for excluding some stakeholders and for being quite a closed process.

Potential Use in the Consultation on Radioactive Waste Management

There are two obvious potential uses for ongoing stakeholder dialogue: firstly in relation the consultation and decision process itself, and secondly in relation to the development of policy. Certainly, any comprehensive consultation strategy will require ongoing communication with a range of stakeholders, and a structured dialogue process is probably the best way to attempt to develop a coherent and widely accepted way forward in relation to interested parties. However, it is important that it is undertaken in conjunction with widespread public consultation.

A 1.3.5 Multi-Criteria Mapping

This technique brings together a group of stakeholders and takes them through a structured process designed to elicit their values and priorities in relation to a particular question. Results can be summarised in a quantitative form, although the validity of this is arguable.

Advantages and Disadvantages

Multi-Criteria Mapping can only target a small number of people in any one process, and can be time and resource intensive, although not necessarily so. One value of multi-attribute techniques is that they start with a 'clean slate', and allow participants to define the criteria through which they assess the issue. Multi-criteria mapping is in some ways similar, but takes individuals through a defined process which allows their positions to be identified along a number of dimensions. The advantage of multi-criteria mapping is that it allows the analysts to change the underpinning assumptions and see what effect this has on the decision. This could highlight that even though two groups have very different opinions they would still choose the same solution and can help to build common ground between groups, if the process was developed in this way.

Multi-Criteria Mapping is very structured and follows a clear agenda. This might help the debate, as people would be able to see what they were aiming for and how their opinions would be used [31, 32]. However, it is not always desirable to have a group of stakeholders make a decision in isolation. In a nation-wide consultation it will be important to include other stakeholders' issues and concerns and judge the relative importance of these through a clear process. It may also be difficult to feed decisions into the wider process, whereas issues and concerns could be used more easily. Ranking issues and concerns may be useful to determine their relative importance, as an input to the consultation process.

Examples of Use of the Technique

Multi-criteria mapping has been used to discuss genetically modified crops [33].

Potential Use in the Consultation on Radioactive Waste Management

Multi-criteria Mapping may be a structured way to identify stakeholders[1] issues and concerns at the beginning of the decision making process, however it may not be necessary to progress through the whole process and get participants to make decisions.

A 1.3.6 Community Issues Groups

These involve the recruitment of between 8 and 12 people in a series of meetings for around 2-3 hours to discuss designated issues. The group is not intended, however, to be a standing committee.

Advantages and Disadvantages

These have the advantage of giving people the ability to reflect and digest the information discussed. The discussion can also develop as new information becomes available and as people develop their understanding over time. There is also the opportunity to involve experts. It suffers from the same problems as citizen's juries, in that the time and resource commitments can be large and it only reaches a small proportion of the population. However, several groups could be set up around the country.

Examples of Use of the Technique

Community groups have been used in relation to specific issues directly of concern to a local community. Community groups can also be used by 'communities of interest' who share a concern with an issue that is not geographically defined. Most nuclear power stations have community liaison groups who meet regularly to discuss issues relating to the plant. Hospitals and health authorities have also been using this technique.

In Belgium local partnerships have been set up in the areas interested in hosting a radioactive waste facility. The partnerships are made up of representatives from stakeholder and interest groups and are facilitated by an independent mediator. Working groups form the active basis of the partnership. Working groups have also been used in the Netherlands as part of their LLW siting process.

Potential Use in the Consultation on Radioactive Waste Management

Community issue groups are most useful when an issue affects a local community and can be a good mechanism to engage with a local group and keep them involved in a process over time.

A 1.3.7 Interactive Panels

Interactive Panels have a standing membership which meets regularly to deliberate on issues. Health panels provide the main example in the UK. They have the following features:

- 12 members of the ordinary public, meeting three times a year or so to discuss topics set by a Health Authority;
- There are a number of Health Panels for each authority, each discussing the same topics, to provide some confidence in the results;
- Panel members are recruited by quota sampling to cover a range of demographic characteristics;
- There is a regular turnover of membership to bring in new voices;
- Meetings are facilitated by an independent researcher;
- Panels are given information about the topics they discuss;
- The discussion is tape recorded and transcribed, providing qualitative information on members' views;
- Each member completes a decision sheet (ie votes) on each issue at the end of the discussion, providing quantitative information on members' views;
- A report is prepared by the researchers/facilitators for the commissioning body.

Advantages and Disadvantages

The long standing nature of these panels enables members to develop their understanding of the issues and debate them fully. Bringing in new people also prevents the group stagnating and becoming more like 'experts' than a public group. It is only possible to involve a small number of people and the method does not promote discussion between different panels around the country, although meetings could be set up involving representatives of the different groups to encourage wider debate. The panels may not be too expensive to set up, however it is likely that the panel will need to meet several times a year to keep up with developments and discuss the issues.

Examples of Use of the Technique

There is a reasonable amount of experience of health panels in the UK [34].

Potential Use in the Consultation on Radioactive Waste Management

Interactive Panels could be used throughout the decision making process. At the beginning of the process they could be used to obtain people's issues and concerns, they could then be used to provide feedback, keep people up to date with the process and develop a wide understanding of the subject.

A 1.3.8 Focus Groups / Focussed Group Discussions / Deliberative Focus Groups

Focus groups have been widely used as a research method in the social sciences and in marketing. Essentially, a focus group brings together 6-8 people (recruited according to relevant criteria) with a facilitator/researcher and, using a variety of materials as discussion prompts, generates discussion and/or the articulation of opinions on the issue at hand. Focus groups have been developed for more deliberative and consultative purposes, whereby, rather than trying to elicit opinions, facilitators encourage deliberation and reflection. Focussed group discussions are generally taped, transcribed and analysed and reports produced.

Advantages and Disadvantages

Focus groups are relatively resource efficient, and (as is usually the case) when they are repeated with different cultural and demographic groups, can provide an effective means of accessing the views of a wide range of groups.

Examples of Use of the Technique

Focus groups are widely used in market research and more recently social scientific research and consultation. CSEC at Lancaster University have used focus groups to investigate a wide range of issues including siting hazardous facilities, perceptions of risk, GM food and environmental indicators. Several sets of focus groups have been held on the subject of radioactive waste including studies carried out for Nirex and the NII [13, 14, 15]. The research undertaken for Nirex showed that:

- The public can, will and want to engage with the issue of radioactive waste management. This includes engaging with the ethical debate. To facilitate this those involved in waste management need to:
  - provide information in a neutral form outlining the pros and cons and including various people's opinions;
  - use proactive techniques to allow access and space for people to discuss the issues; and
  - demonstrate how people's opinions have been taken into account.
- A key to finding a way forward is to involve people in the debate at the beginning and take their opinions into consideration.
- People may have negative associations with the word nuclear and do not distinguish between nuclear, radiation, bombs and waste.
- People may understand the issues very differently to the way institutions understand them. There is a need for institutions to learn to understand public concerns and the ways in which the public understand issues, as well as for the public to understand the institutional positions better.

Potential Use in the Consultation on Radioactive Waste Management

Focus groups are a cheap and effective way to engage with a large number of the general public. They could be used at the beginning of the decision making process to identify stakeholders issues and concerns and to help them to define the problem and the way they would like to engage in the consultation. Focus groups could be used throughout the process whenever stakeholder input is required.

A 1.3.9 Deliberative Opinion Polls

Whereas an ordinary opinion poll reflects the public's views on subjects about which they might know little, a deliberative poll examines what they think when they have had the time and information to consider the matter more closely. It involves:

- 250 - 600 participants;
- a base-line survey of opinion and demography**;**
- participants are then recruited to resemble the wider group both in terms of demography and attitude;
- provision of written briefing material;
- 2-4 days deliberation in smaller groups and composition of questions to put to experts and politicians in plenary discussion groups;
- the measurement of views on a given subject before the process begins and again once it has finished; and
- changes in opinion are measured and incorporated into a report.

Advantages and Disadvantages

Proponents argue that deliberative opinion polls:

- Provide a scientific random sample of a population and therefore represent the wider population in terms of attitudes and demographics;
- Can tell decision-makers and the media what the public would think if they had enough time and information to consider views carefully;
- Bring together people from diverse social backgrounds;
- Enable participants to control the agenda; and
- Demonstrate a wide range of individual views and how these change after informed deliberation.

This technique reaches a wider sample of the population and has the potential to bring together people from different backgrounds and areas of the country. It can give people access to experts and allow them to interrogate them. Bringing so many people together to talk to experts decreases the amount of time that the experts have to commit to the process.

It could still be a very costly process, as people would need to be put up in hotels for the duration of the poll. It might also be difficult to bring together such a large number of people at once. A more simple derivation of the technique is to conduct a poll with a (demographically representative) group of people, then to provide expert information and space for deliberation, and then to re-poll, within the space of one day.

Examples of Use of the Technique

Deliberative polls have been designed and used mainly as a social research tool [2].

Potential Use in the Consultation on Radioactive Waste Management

Deliberative polls could be used at the beginning of the decision making process to identify people's issues and concerns and throughout the process to provide feedback.

[2] Professor James Fishkin developed deliberative opinion polls and pioneered their use in the UK with Social and Community Planning Research. By the beginning of 1998 ten deliberative opinion polls had been held. These were held in conjunction with television companies measuring opinion on a range of national issues such as 'crime' and 'Europe'.

APPENDIX 2: OTHER CONSULTATION TOOLS

A 2.1 Overseeing Panel

The perceived legitimacy of the consultation process is very likely to be dependent, at least in part, on the people who are seen to be overseeing it. It is worth consulting on whether an overseeing panel could or should be set up to guide and oversee the consultation process. The membership of the panel should be created through consultation with stakeholder groups A panel could involve the following:

- a group of 6-8 independent people;
- representative from a range of stakeholder groups;
- meet at regular intervals (bimonthly or quarterly);
- oversee the process and comment on its implementation;
- ensure all stakeholders have the opportunity to participate;
- provide quality assessment; and
- review the outcomes of the process.

To give an overseeing panel more credibility with the general public it would be advisable to include representatives from the Non Government Organisations (NGOs) and other respected quarters, such as the religious community. It is also essential for such a panel to bring together diverse knowledge and expertise, and to provide a conduit for the exchange of information, as well as providing legitimacy. It would therefore be useful to include academics with relevant expertise in planning and consultation procedures (social sciences, law, town planning, and environmental sciences, for example). The panel could also include representatives from the Trade Unions and members of the general public.

Advantages and Disadvantages

Having an overseeing panel can increase the legitimacy of a process. However, this will depend on the membership of the panel and their remit and power. Panels can provide useful input and direction and enhance the consultation process. Panels can be difficult to set up and getting all the members together can also be difficult.

Examples of Use of the Technique

Panels representing different interests are often employed to guide important pieces of research on behalf of government. Such a panel was set up to oversee the overview of high-level waste research work carried out by QuantiSci. The panel included representatives from the Department of the Environment Transport and the Regions, the Department of Trade and Industry, the nuclear industry, Nirex, the Environment Agency, the Scottish Environment Protection Agency, Scottish Office, Health and Safety Executive, Nuclear Installations Inspectorate, Radioactive Waste Management Advisory Committee and the Royal Society.

Other examples of the use of panels include:

- MoD ISOLUS project
- EC funded RISCOM II project

An advisory committee will be set up to liase between NAGRA and local residents at Wellenberg if site selection is successful.

Potential Use in the Consultation on Radioactive Waste Management

An overseeing panel could be used throughout the consultation to ensure that all stakeholders have the opportunity to participate and to increase the legitimacy of the process.

A 2.2 Research Panels

A research panel is a large sample of a local population used as a sounding board by a public sector organisation. It is a form of opinion research which tracks changes in opinion over time. It consists of:

- 500-3,000 participants;
- member recruitment either through the post or by telephone;
- a standing membership, but with a proportion replaced regularly; and
- regularly asking participants about different issues over a period of time.

Advantages and Disadvantages

Proponents argue that:

- The panel is large enough to be representative of a whole local population and offers a wider public view on specific issues;
- Panel members develop an informed public view;
- Once the panel has been set up it is cheaper than a series of large one-off opinion surveys;
- Panels provide a flexible methodology;
- The same panel can be surveyed using questionnaire techniques, or used to seek a more informed view on some issues; and
- The panel can also be brought together in focus groups and workshops.

Research panels have the advantage of reaching a large number of people and are relatively inexpensive.

Examples of Use of the Technique

Various research panels have been used around the UK [35, 36, 37].

Potential Use in the Consultation on Radioactive Waste Management

Setting up several groups around the country could use this method on a national basis. Meetings could be arranged to bring representatives from the various groups together to discuss issues in greater depth. The technique could be extended to involve experts and allow the participants to pose questions to them. Basically, a research (or standing) panel provides an already recruited population with whom a variety of methods can be practised.

APPENDIX 3: INFORMATION PROVISION

A 3.1 Background Information

Leaflets, brochures, web sites and other media can be produced to outline background information about a subject. Although they do not necessarily ask for comments they may be necessary to enable stakeholders, who do not know much about the subject, to engage with the issues and participate in more deliberative techniques.

Several levels of information will be required to allow people to engage with the topic at the level they feel comfortable. Several mediums could also be used including paper, the Internet, electronic transmission, cd rom, video and face to face contact. People recognise that information is biased by the motivations of the people providing it, therefore they want to have information from several sources to enable them to judge between different views of a situation. Research carried out for Nirex [13] showed that people wanted to see information from several sources and did not like information that contained subjective judgements. Information is judged by recipients in terms of the perceived interests of the information producer, meaning that several information sources are likely to be required. This in itself could involve sponsoring a range of bodies to produce the necessary information. Information is both a fundamental component of consultation, and a problematic one. To be credible and authoritative, information needs to be both professionally produced and come from trusted sources, which will vary for different groups.

A 3.2 Information Processes

Radioactive waste management is a technical subject and it can be difficult to communicate technical information to people without being patronising or using jargon. Technical editors can be used to help to develop information in a format that is accessible to people and the information can be tested using focus groups to ensure that it meets people's needs. Focus groups can also be used to determine the sorts of information people would like and the format they would like to have information presented. Focus groups carried out for Nirex by the Future Foundation and Lancaster University have given insights into the information people would like [13, 14].

Advantages and Disadvantages

Providing background information is important to enable people to engage with the issues being discussed. It is important to set the context of the consultation and define technical terms and issues. Background information can be used to stimulate interest in a subject and can reach lots of people.

However, providing background information can be a passive way of communicating and may not stimulate feedback. It can be difficult to judge how much information should be provided and the level of detail. The information may not be easily understandable and could be viewed as biased or misunderstood.

Examples of Use of the Technique

Most organisations produce leaflets and brochures about themselves and their work and Government departments often develop leaflets to inform people about issues. Nirex is developing a series of leaflets about radioactive waste in response to the questions people wanted addressed in the focus groups.

Potential Use in the Consultation on Radioactive Waste Management

Background information will be important to set the context of the consultation, to obtain feedback and stimulate debate. It will be important to provide people information about the decisions that need to be taken and the way that they can input into the consultation. The information should reflect different views of the situation and be from several sources.

A 3.3 Educational Material

The issue of radioactive waste management will impact over many thousands of years and decisions may have to be taken by future generations. Engaging with young people is important, as they are tomorrow's decision makers. One way to engage with young people is to link information to the National Curriculum

Advantages and Disadvantages

To engage with young people the information and its presentation must be interesting and stimulating. The information should be developed in conjunction with teachers this can be time and resource intensive.

Examples of Use of the Technique

Waste management organisations in some countries have an educational department that focuses on producing material for use in schools. SKB in Sweden have developed an educational pack that is sent to teachers and they regularly visit schools whose areas are being investigated as potential repository sites. Arranging for children to visit exhibitions and visitors centres is also used to stimulate interest in radioactive waste management. SKB have been keen to enable students to have access to various views of the situation and have organised meetings with various stakeholders, so that children can talk to them and ask questions.

Nirex has started work with the Oxfordshire Education and Business Partnership to investigate how we can help teachers develop material in aid of the various parts of the National Curriculum. The initiative will also look at how Nirex can become more actively involved in school initiatives and may involve members of Nirex giving presentations at schools.

Part of the RISCOM II project needs explanation involves the development of a web site aimed at teenagers. The site will be run with six schools during the project and could be extended to other schools at a later date.

Potential Use in the Consultation on Radioactive Waste Management

It will be important to engage with young people throughout the decision making process. Obtaining their issues and concerns about radioactive waste management will be important, as they may have different views to older members of the population.

APPENDIX 4: STAKEHOLDERS

The issue of radioactive waste management involves a variety of stakeholders with different backgrounds and experience of discussing the topic. Moreover, different stakeholders have both different contributions and different consultation needs at different stages of the decision process.

Key stakeholders include, in particular order:

- the General Public
- Community-Based Organisations
- Local Government Organisations
- Young people
- Government departments
- Non-Governmental Organisations
- Scientific Research Community
- Regulators
- Trade Unions
- the media
- the implementing organisation
- the nuclear industry
- Contractors
- Waste producers,
- National government
- International organisations

The wide range of stakeholders identified above will have different needs and levels of knowledge about radioactive waste management; therefore a range of consultation techniques will be required.

In order for consultation to be, and to be seen to be, legitimate, consultation with a wide range of stakeholders is essential.

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37 Kirklees Metropolitan Council established *Talkback* in 1994. The panel is a joint project with Calderdale and Kirklees Health Authority to consult the public on council services and health issues. The panel is made up of 1,000 residents who are surveyed mainly by post.

CoRWM Document Number: 1921

PEER REVIEW OF CoRWM SPECIALIST WORK PACKAGES.
COMMENTS BY THE ENVIRONMENT AGENCY

TITLE OF REPORT:

Disposal in Space: Cost (CoRWM Document 629)

GENERAL COMMENTS:

While this may seem a very unlikely option, we are pleased that, for completeness, CORWM have made some effort to describe and give indicative costs for it.

The costs are obviously very uncertain. There is little that can be done at this stage to firm up on the costs.

One could argue that some of the costs might reduce – for example if there were a significant commitment from many states to dispose of waste in this way, then costs could fall, due to advances in technology, or economies of scale. Equally one could argue that such an increase in usage of this route would lead to competition for launch scarce slots and consequently bid up the costs of disposal.

Therefore we do not believe that there is much to be gained by trying to make these costs any more certain.

SPECIFIC COMMENTS:

No specific comments

Environment Agency
March 2005

Notes:

1. These comments are provided voluntarily and in good faith by the Environment Agency, to assist CORWM's work programme. The Environment Agency makes no warranty in respect of the adequacy of these comments. In particular, they may not provide a complete and comprehensive review of every aspect of the report, nor do they bind the Environment Agency to follow any particular course of action. The absence of comment should not be taken as an endorsement by the Environment Agency of the views expressed.

2. The following staff have contributed to the comments in this note: Ronan Palmer

United Kingdom Nirex Limited
Nirex Report no. N/112
February 2004

Nirex Report

Generic Repository Studies

Responses to Feedback Received at Follow-up Workshop on Monitoring and Retrievability

nirex

Nirex Report N/112

Generic Repository Studies

RESPONSES TO FEEDBACK RECEIVED AT FOLLOW-UP WORKSHOP ON MONITORING AND RETRIEVABILITY

S Barlow

February 2004

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Bibliography

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Feedback

Readers are invited to provide feedback to Nirex on the contents, clarity and presentation of this report and on the means of improving the range of Nirex reports published. Feedback should be addressed to:

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EXECUTIVE SUMMARY

United Kingdom Nirex Limited (Nirex) is responsible for providing the United Kingdom with safe, environmentally sound and publicly acceptable options for the long-term management of radioactive materials generated by the nation's commercial nuclear power generation, medical, research and defence activities. This includes all intermediate level waste and some long-lived low level waste unsuitable for near surface disposal.

One management option for long-lived, solid radioactive waste is to isolate it from man by placing it in a repository deep underground. To ensure that options are not foreclosed, that process should be carried out in a staged, reversible way. This means the waste should be capable of being monitored and retrieved.

In essence, this is a concept for an underground store that provides future generations options for final closure, whilst taking positive steps towards a long-term solution. The facility would have to meet the same, stringent criteria as a permanent repository as well as allowing extended monitoring to give society the extra assurance that the waste was secure and stable. At each stage of development, time would be available to build sufficient confidence before moving to the next stage, whilst retaining the ability to retrieve waste and pursue an alternative option if that were available and preferred.

Nirex has carried out work to examine the technical implications of retrievability on concepts for deep disposal of radioactive waste and has set about seeking inputs to its developing programme from a wide range of stakeholders. This process commenced in December 2000 and February 2001 with workshops held to debate the issues. A follow up workshop was held in February 2002 with the objective of updating previous attendees on progress made in the intervening period.

Feedback from the earlier workshops has been recorded in two reports written by UK CEED and published on the Nirex bibliography. Nirex has in addition issued separate reports that respond to the issues raised. This report follows the previous examples and has been produced to record the background to the workshop, issues raised by attendees and in addition provides a response from Nirex on how the issue is envisaged to be addressed. The responses have been compiled as a series of sheets each containing the issue raised (in its original wording) and the Nirex response to that issue. Broadly speaking, the issues raised fall into three categories: issues which can have a direct effect on the monitoring or retrievability work programme; issues which do not have a direct effect on the monitoring and retrievability work but could influence other aspects of the Nirex work programme; and, broader issues that are in some respects outside the remit or control of Nirex. In all cases a response has been provided but it should be recognised that Nirex are only in a position to do something about issues that fall into the first two categories.

LIST OF CONTENTS

1. INTRODUCTION

Nirex is examining options for the long-term management of the United Kingdom's radioactive waste. One option, which Nirex has concentrated on in the past, is deep geological disposal. That experience is now being applied in the development of a generic disposal concept for intermediate-level waste (ILW) and certain low-level waste (LLW). The concept is based on a phased, reversible approach to disposal of the waste.

In such an approach, waste would be conditioned and packaged at waste producers' sites and transferred for interim storage in engineered surface stores. As a first step towards deep disposal, the waste would be transferred underground to a repository for a period of underground storage. The underground storage environment would be carefully controlled to ensure continued package integrity.

Throughout the underground storage period the waste would be retrievable using the systems and equipment that had been used to emplace the waste. Provision would be made during that period for monitoring of the waste, the host rock and the environment within and outside the repository.

This report has been produced as a record of the Nirex response to feedback received at a monitoring and retrievability workshop held in February 2002. The report summarises issues raised and describes the Nirex position and where appropriate the actions planned to take issues forward.

2. BACKGROUND

Monitoring and retrievability are key issues in the long-term management of radioactive waste. The House of Lords report [1] on management of nuclear waste concluded: "the preferred approach is phased geological disposal in which wastes are, following surface storage, emplaced in a repository in such a way that they can be monitored and retrieved." The UK National Consensus Conference on Radioactive Waste Management [2] concluded: "Radioactive waste must be removed from the surface and stored underground, but must be monitorable and retrievable."

Nirex has considered these views and undertaken technical studies to determine how monitoring and retrievability can be accommodated within its phased disposal concept for long-term management of radioactive wastes. In order to inform decision making Nirex has sought views on the issues associated with monitoring and retrievability from a wide range of stakeholders drawn from a variety of backgrounds. To this end Nirex commissioned two workshops in December 2000 and in February 2001 at which these issues were debated. The outcome of the workshops has been reported by the facilitators [see references 3, 4]. Following the second workshop, Nirex compiled and issued a report that addressed the issues raised and provided a formal response [5].

An important element of the Nirex strategy is to ensure that dialogue with stakeholders is not a one-off event, rather that feedback is sought and maintained as the process evolves. So it was in the case of monitoring and retrievability that Nirex held a repeat workshop in February 2002. Attendees from previous sessions were invited to a follow-up event at which Nirex would report on progress made in the intervening period.

3. MONITORING AND RETRIEVABILITY FOLLOW-UP WORKSHOP

The format chosen for the meeting was the same as that adopted previously; that is a workshop format, held at a neutral venue, in which participants could work in "syndicate groups". All previous attendees were invited.

The selection of participants originally had been based on seeking representation from a wide range of stakeholder groups. Participants included members of the original citizens' panel from the consensus conference described earlier. The participants were drawn from the following stakeholder groups:

- General public (represented by the citizens' panel);
- Local Authorities;
- Non-Governmental Organisations (NGOs);
- Scientists/Engineers;
- Social Scientists;
- Regulators;
- Other National Waste Management Organisations;
- Government Radioactive Waste Management Advisors;
- UK Nuclear Industry.

The workshop was held on 8-9th February 2002 at Manchester Town Hall. Independent facilitation services were provided by Forth Road Limited and the Centre for the Study of Environmental Change (CSEC) Lancaster University; technical secretariat was provided by UK CEED.

Issues raised at the two proceeding workshops could broadly speaking be classified as falling into one of three groups;

- issues which can have a direct effect on Nirex's monitoring or retrievability work programme;
- issues which do not have a direct effect on the monitoring and retrievability work but could influence other aspects of the Nirex work programme; and,
- broader issues that are outside the remit or control of Nirex, for which Nirex might reasonably be expected to have a view.

For each of the above groups, Nirex staff gave presentations on the present Nirex position, prior to syndicate groups being requested to discuss what they had heard. Over the two-day period, three breakout sessions were held. Groups were asked to address the following:

1. Views were requested on key waste management issues, key issues of importance to long-term waste management and how the consultation component of each should be handled.
2. Views were requested on the Nirex report *The Proposed Nirex Forward Programme* [6]. This report had been issued to participants before the meeting.
3. Views were requested on addressing technical issues alongside societal aspects.

Feedback from the syndicate groups was presented at plenary sessions and a report on the outputs has been compiled and published by UK CEED [7]. Following the example of previous workshops, Section 4 of this report reproduces the issues raised by the groups and for each provides a summary of the Nirex position in relation to the issue raised. For simplicity the issues and responses are recorded on a series of proforma sheets of a standard format.

4. NIREX RESPONSE TO ISSUES RAISED AT THE WORKSHOP

The issues raised by the syndicate groups and responses from Nirex are collated on proforma sheets given within this section.

Questions and responses are grouped as shown below:

	Group 1	Group 2	Group 3	Group 4	Group 5
Session 1 Views were requested on key waste management issues, key issues of importance to long-term waste management and how the consultation component of each should be handled	Sheet 1.1	Sheet 1.2	Sheet 1.3	Sheet 1.4	Sheet 1.5
Session 2 Views were requested on *The Proposed Nirex Forward Programme* (Nirex Report N/015)	Sheet 2.1	Sheet 2.2	Sheet 2.3	Sheet 2.4	N/A
Session 3 From the perspective of monitoring, views were requested on addressing technical issues alongside societal aspects	Sheet 3.1 (all groups)				
Views were requested on the dialogue process for radioactive waste management	Sheet 3.2 (all groups)				
Views were requested on suggestions for future work	Sheet 3.3 (all groups)				
Views were requested on the need for monitoring and retrievability	Sheet 3.4 (all groups)				

The different responses make reference to various documentation including the following:

- The Proposed Nirex Forward Programme, Nirex Report N/015;
- Managing Radioactive Waste Safely. Proposals for developing a policy for managing solid radioactive waste in the UK. September 2001. Consultation document issued by Department for Environment, Food and Rural Affairs (Defra) and Department of the Environment, National Assembly for Wales and Scottish Executive. Referred to as “MRWS” issued by Defra and Devolved Administrations (DAs);
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- Intermediate Level Radioactive Waste Storage in the UK: A Review. HM Nuclear Installations Inspectorate, November 1998.

Sheet No. 1.1	Group 1 - Syndicate Exercise 1 Views were requested on key waste management issues, key issues of importance to long-term waste management and how the consultation component of each should be handled

Comment:

The group thought that the major challenge in radioactive waste management is the absence of a solution. There is a lack of processes in place that would lead to a solution as well as a lack of commitment to find a solution, especially within government. It was recognised that there is no common view on the issues so there is a need for clarification and robust processes to be established.

The organisation dealing with the waste should look towards the long term as well as the short term to ensure the waste is packaged in such a way that it will not jeopardise any future plans.

Public debates were seen to be important but the group asked whether these were always practical. There must be some sort of focused deliberation and people would become interested in the issue as soon as they realised how it may affect them, for example when the potential sites are identified.

Response:

Nirex believes that the processes Defra and the DAs have set in place as part of the MRWS programme will address the first issue. The consultation process aims to enable stakeholder involvement in the development of a solution for radioactive waste in the UK. Nirex believes it is essential that everyone has the opportunity to contribute to the debate and that views should be actively sought. In relation to its own work Nirex will continue to consult with a wide range of stakeholders.

Nirex agrees that the organisation dealing with the waste should look towards the long term as well as the short term. One of the key responsibilities is to highlight the long-term implications of decisions taken now. We have also been undertaking work to evaluate the robustness of Nirex's packaging advice to waste management options other than the phased disposal concept to ensure we are not foreclosing options.

Further Actions:	Responsibility:
Nirex and the Government are aware of the difficulty of engaging the public in the debate about radioactive waste management. Pro-active consultation techniques will have to be used to enable this to happen and both Nirex and the Government are committed to doing this.	

Sheet No. 1.2	Group 2 - Syndicate Exercise 1 Views were requested on key waste management issues, key issues of importance to long-term waste management and how the consultation component of each should be handled

Comment:

This group wanted more clarification on the exact definition of radioactive waste. There was no clear explanation of this and the group felt that people need to know what they are dealing with. They also need to know the current state of the waste and whether it is safe and secure. It was seen as a necessity for the public to be able to voice their opinions by saying what it expects Nirex to do with the waste.

The relationship between the industry and Nirex needs to be clarified, as Nirex is often perceived to be part of the nuclear industry. Nirex should be independent of both the industry and government, although government would need to provide information and support to determine the direction to take.

The issue of compensation to host communities was considered a good idea but not if it entailed personal compensation to individuals. Homeowners should be compensated through increased level of services in their area for example building a swimming pool or leisure centre in order to entice people to the area.

The group realised that many people were sceptical about science and scientists, and therefore the public must be reassured that the science behind the possible options is sound and that radioactive waste is safe. All options must be looked at for the safe storage of the waste.

Response:

Information on materials currently declared as waste is given in the UK Radioactive waste inventory published and available from Nirex. The latest version gives details of LLW, ILW and high-level waste (HLW) in-stock and predicted to arise in the future. An update was published in October 2002. The potential to classify other radioactive materials as waste has been raised, by for instance the House of Lords Select Committee, and is raised as an issue for consultation in MRWS. Her Majesty's Nuclear Installations Inspectorate (HMNII) have published details of the state of radioactive wastes currently in store. Nirex will continue to canvas the general public and other stakeholders for their views on radioactive waste management. The first step of Stage 2 of the MRWS programme will be to agree the wastes to be considered as the consultation process is taken forward. Nirex has also developed a leaflet outlining the wastes in the UK and their origin and characteristics. This is aimed at a 'non-technical' audience.

Nirex is seeking independence from the nuclear industry but recognises that there is a principle that the polluter should pay. Nirex has made this point to the MRWS programme. Independence from Government would be difficult to achieve, however provided the processes and organisational responsibilities for radioactive waste management are clearly defined this objective should be able to be achieved. The Government announced in July 2003 that they are going to make Nirex 'independent of the industry and under greater Government control'. This will address the independence issue.

Nirex has undertaken research on the issue of compensation to host communities and the powers they have in the decision-making process (veto and volunteerism). We have also commissioned research on the ethical issues associated with compensation. Nirex believes these issues need to be debated at a National level as part of the process for developing the implementation strategy for radioactive waste management solutions. This will be organised by Defra and the DAs as part of Stage 4 of the MRWS.

Nirex agrees that a fundamental review of options for radioactive waste management should be undertaken and supports Government proposals to do this as part of Stage 2 of the MRWS consultation. The point about scepticism of science and scientists is recognised. Nirex believes independent and rigorous reviews of the scientific work underpinning the various options will help.

Nirex is commissioning research to investigate how it can build more legitimacy and public confidence in the work we undertake.

Further Actions:	Responsibility:

Sheet No. 1.3	Group 3 - Syndicate Exercise 1 Views were requested on key waste management issues, key issues of importance to long-term waste management and how the consultation component of each should be handled

Comment:

The group approached the issue of the Liabilities Management Authority (LMA) and asked whether it would trade off liability against cost. It asked who would be financially accountable for decommissioning plants and where the money would come from. In the 1970's money was set aside to deal with decommissioning but it is unclear where this money is now. The group wondered whether plants would be re-commissioned simply because they couldn't afford for them to be decommissioned.

The group considered there to be an absence of government policy or statement of intent with regard to radioactive waste. The question was asked as to what would happen at the next election especially if a different government came to power.

A high degree of openness and accountability is needed with regard to radioactive waste management as well as a clear programme and timescale set out. Clear roles also need to be defined for everyone within the programme including stakeholders.

The group saw the need to break away from the party political arena and set up an independent organisation that is able to call upon ministers for help and support. This would produce an organisation with the ability to survive a change in government. The legacy of waste and who should take responsibility for it should also be considered. So far there has been a failure to deal with radioactive waste and take responsibility for it by current and previous governments.

Presently there is a lack of trust in the industry as well as a lack of understanding. The public don't know where to go or who to approach for information as there are too many people involved with unclear roles. This needs to be addressed.

Response:

Details of Government proposals regarding the LMA were initially published in a White Paper *Managing the Nuclear Legacy. A Strategy for Action*. This document provided an initial view of Government thinking and an opportunity for feedback to influence the detailed implementation. The Government then developed its proposals to set up the Nuclear Decommissioning Authority (NDA) and consulted on those. The proposals have now been developed into the Nuclear Decommissioning and Radioactive Sites Bills programme.

The MRWS programme is ultimately aiming to develop and implement a radioactive waste management programme that inspires public support and confidence. Provided the procedures and responsibilities for implementation are clearly defined at an early stage we believe it should be possible to establish a process that can be followed and not be affected by changes in Government. Nirex believes that through the formation of the NDA, the MRWS programme and making Nirex independent, Government is addressing the decommissioning and long-term waste management issues in the UK.

Nirex agree with the statements about organisational structure. In the Nirex response to MRWS we have argued that the organisation responsible for long-term radioactive waste management should be independent of the nuclear industry. We believe this is an essential prerequisite to development of respect and trust from the wider general public. The Government are taking action to address organisational structure through setting up the NDA and making Nirex independent of the industry..

Further Actions:	Responsibility:

Sheet No. 1.4	Group 4 - Syndicate Exercise 1 Views were requested on key waste management issues, key issues of importance to long-term waste management and how the consultation component of each should be handled

Comment:

The group began by saying that the public perceives radioactive waste to be only an industry problem when it is actually the public's problem as well. The public's perception of safety and risk also needs to be sought, maybe through a debate or some sort of consultation as this may differ from the industry's perception. The relative risk of a project should also be considered, as the public has not chosen this risk, it has just been imposed on them.

The timescales of these proposed projects should be explained to the public as it often thinks that 50 years is a long time but in radioactive waste management terms it is only a very short time. Mechanisms need to be in place to empower the public to act as advisors on these issues. The best available technology should be used in any project to reduce risk as far as possible. Institutions and mechanisms, which engender trust, should be created to gain the public's views and get them involved at an early stage.

The group said that any consultation should be proactive, for example Defra could be more proactive in carrying out the consultation through placing notices in newspapers. Any decision that is made should have a clearly identifiable audit trail so the public can see how and why certain decisions were made. This will make the whole process more transparent and result in a higher lever of public trust.

Response:

We would agree that a solution to this problem is needed for the UK and not just for the nuclear industry. The radioactive waste exists already and it is in everybody's interest that it be dealt with properly. Dealing with it properly means dealing with the concerns of a number of stakeholders not just industry and regulators.

We would agree that communication with the public is essential and must take place from an early stage. This is not only to provide information such as timescales, but to allow stakeholder input to the programme. Nirex has adopted the principles of "preview" whereby external stakeholders are given the opportunity to influence the work programme (before it is implemented, rather than after the event). We are committed to enabling all stakeholders to make an input through the Nirex involvement programme.

Nirex supports the views on the Government process and believes the MRWS programme will address these issues. Stage 1 of the MRWS programme used a variety of techniques to engage the public. The Government are also committed to justifying its decisions in this area. It is noted that the UK CEED citizens' panel that had originally looked a radioactive waste management issues was reconvened and prepared and issued a report giving its views regarding MRWS. The Government is committed to conducting the rest of the MRWS programme in an open and inclusive way. The DTI have also developed plans to ensure the NDA engages with a wide range of stakeholders about its work.

Further Actions:	Responsibility:

Sheet No. 1.5	Group 5 - Syndicate Exercise 1 Views were requested on key waste management issues, key issues of importance to long-term waste management and how the consultation component of each should be handled

Comment:

The group decided that to answer the questions, it needs a clear definition of radioactive waste. It thought that different strategies were needed for different types of waste, however these would still require an integrated approach. The group also looked at the interrelationship with a "nuclear future" and noted that a lack of action today could prevent future governments from developing nuclear power if the imperative is strong enough. If a workable way forward to deal with radioactive waste is demonstrated, then nuclear power will look much more attractive to the public. The group believed that there were some people totally opposed to nuclear power who would never agree with any proposal that represented a way forward with the waste, therefore consensus will never be reached.

It is important for Nirex to be independent of the industry but not necessarily from Government as well. It was unclear as to what disassociation from Government would imply. Public input is also very important and there needs to be mechanisms in place to involve them right from the start.

A "Catch 22" situation would occur with the "Polluter Pays Principle" where polluters should pay for not only the clean up costs but also for further research. The problem with this is that the research could be tainted. The research would need to be carried out by an independent organisation. With regard to September 11th, the group wondered if there was much time to approach all these issues due to the risk of copycat attacks. It was concluded that there was a need for either consensus or political leadership but as it was not definite that either of these could be achieved, the Nirex consultative approach was the best option.

Response:

We would agree that an integrated approach to radioactive waste management is required and that different strategies may emerge for different categories of waste. The first step of Stage 2 of the MRWS programme will agree the wastes to be considered. We believe that plans should be developed for all radioactive materials that could require long-term management. The points relating to "nuclear future" are valid but regardless of this, waste exists now and a solution for its long-term management is needed.

The Nirex position with respect to its relationship to the nuclear industry and proposals for independence are discussed on Sheet 1.3. Nirex agrees that there need to be mechanisms to enable public input. Nirex will continue to do this in its own work, as will Government, as part of the MRWS programme.

It should be possible to ensure that the "polluter pays" but to remove direct control of the research programme from the polluter. The Nirex response to MRWS outlines a possible means of achieving this. With respect to September 11 Nirex believes that it is essential that a legitimate decision-making process must not be 'speeded-up' by external pressures and therefore prevent the process being open and inclusive.

Nirex also believes that the processes it uses to advise on the treatment and packaging of ILW could and should be applied to all radioactive wastes in the UK.

Further Actions:	Responsibility:

Sheet No. 2.1	Group 1 - Syndicate Exercise 2 Views were requested on *The Proposed Nirex Forward Programme* (Nirex Report N/015)

Comment:

The group firstly looked at whether the Forward Programme Document actually achieved its aims. It suggested that the document only concentrated on a single option for the long-term management of radioactive waste, although it was known that Nirex was doing other work not included in the document. The group felt there was a requirement for a more strategic document giving broader aims of research and looking at the social issues as well as the technical ones. The role of Nirex should be updated showing the boundaries of Nirex's remit and its interface with Defra. The question was also asked as to how research will interface with the consultation process.

With regard to the scope and level of detail of the Document, the group felt that Nirex should make it clear how it will continue the consultation process now that it has begun. The scope of the processes needs to be broader as the group were aware of other topics not included in the document.

The structure and presentation of the document should take a two-tier approach. The top level should set out that broader aims and indicate key areas of research, and the lower level should give detail on the different key areas of research. The present document would be useful as an appendix for planned research on a single topic (phased deep disposal) and be put with other appendices outlining other possible options.

The group felt there needed to be stakeholder involvement to identify a list of relevant topics for research. These topics should be prioritised to decide which could be funded at any particular time given financial constraints. It was recognised that people did not always read documents so other alternatives for communication should be looked at including websites and discussion groups.

Response:

When *The Proposed Nirex Forward Programme* report was developed it was recognised that the report was focussed on technical studies supporting Nirex's historical phased disposal concept and role to provide packaging advice to the nuclear industry. Aspects of the work programme to develop dialogue with stakeholder groups and to investigate other waste management options were not covered by the report. The report was published in October 2001 specifically with the objective of seeking feedback and enabling external influence on the programme.

The points raised in the above discussion are accepted. Nirex is now working towards to a revised Forward Programme document and the feedback received from the workshop is being taken account in formulating the revised document.

In respect to Stakeholder dialogue, Nirex will continue to preview its work to help to prioritise the programme. Nirex is also investigating Visual Language techniques as a way to make information more accessible.

Further Actions:	Responsibility:
Production of revised issue of *The Proposed Nirex Forward Programme*.	Nirex

Sheet No. 2.2	Group 2- Syndicate Exercise 2 Views were requested on *The Proposed Nirex Forward Programme* (Nirex Report N/015)

Comment:

The group felt that the Nirex Forward Programme did not give a clear explanation of the deep disposal concept or the differences between that and other options. There needs to be more information given on interim storage even though they acknowledged that this was not under Nirex's control. The LMA must have holistic responsibility for the waste to ensure that one organisation is responsible for it from cradle to grave. The document doesn't show how things have changed since 1997, and this was considered an important issue.

The group thought that a programme is a management framework for achieving an objective and should detail a timescale, an end point and various decision points along the way. The Nirex Forward Programme does not achieve this. It doesn't give the reader a clear idea of what will be done; neither does it have an effective summary. It was recognised that Nirex has become more open but the document fails to reflect this.

It is not clear who the document is aimed at, as it is too technical for the general public and not interesting to experts. There needs to be a better mechanism for gaining the views of a range of people. It was suggested that one good way to capture people's interest in the subject would be to name proposed storage sites.

Section 10 of the document, showing the main outputs from the programme, does not indicate how the larger picture objectives will be achieved. It highlights a lot of research but this is what feeds into the programme, it is not the programme itself. The impression given by the document is that nothing has changed since 1997, as it doesn't give a view of the current situation or how Nirex is moving forward.

Response:

When *The Proposed Nirex Forward Programme* report was developed it was recognised that the report was focussed on technical studies supporting Nirex's historical phased disposal concept and role to provide packaging advice to the nuclear industry. Aspects of the work programme to develop dialogue with stakeholder groups and to investigate other waste management options were not covered by the report. The report was published in October 2001 specifically with the objective of seeking feedback and enabling external influence on the programme.

The points raised in the above discussion are accepted. Nirex is now working towards to a revised Forward Programme document and the feedback received from the workshop is being taken account in formulating the revised document. The document will be reflective of the Government's future timetable for the MRWS programme.

Nirex believes that long term waste management should be dealt with independent from short term waste management. The Government is implementing this by making Nirex independent of the industry, including the LMA (now NDA). This will help to ensure that the long term is taken into account in decision making.

The UK is not currently investigating potential sites for waste management facilities. Therefore, there are no site names to disclose.

Further Actions:	Responsibility:
Production of revised issue of *The Proposed Nirex Forward Programme*	Nirex

Sheet No. 2.3	Group 3- Syndicate Exercise 2 Views were requested on The Proposed Nirex Forward Programme (Nirex Report N/015)
Comment: The group did not think that the target audience for the programme document was very clear. In some places it is very detailed and in other places it is very brief making it fairly hard to read. The executive summary does not present the document well and the conclusion seems weak. There were too many condensed sentences in the document and this could be intimidating to the public. The glossary doesn't help with this either. The group thought that the best way forward would be to produce two or three versions of the document targeted at different audiences. One could be a general public document, another could be for the strategy/decision makers and another could be the full technical document. The presentation of the document should include more text boxes and diagrams to make it easier for the reader, as well as a glossary on the same page as the text. The structure of the document does not follow a logical timescale so it doesn't show any milestones or where activities are leading.	
Response: When *The Proposed Nirex Forward Programme* report was developed it was recognised that the report was focussed on technical studies supporting Nirex's historical phased disposal concept and role to provide packaging advice to the nuclear industry. Aspects of the work programme to develop dialogue with stakeholder groups and to investigate other waste management options were not covered by the report. The report was published in October 2001 specifically with the objective of seeking feedback and enabling external influence on the programme. The points raised in the above discussion are accepted. Nirex is now working towards to a revised Forward Programme document and the feedback received from the workshop is being taken account of in formulating the revised document. Consideration is being given to production of a top tier summary document that would be accessible to a wide readership, with a more detailed technical version supporting it. Several of the above comments relate to how Nirex can best communicate its work. This is an area that Nirex is investigating.	
Further Actions: Production of revised issue of *The Proposed Nirex Forward Programme*	Responsibility: Nirex

Sheet No. 2.4	Group 4- Syndicate Exercise 2 Views were requested on The Proposed Nirex Forward Programme (Nirex Report N/015)

Comment:

The group found it hard to answer the question about whether the document achieved its aims because it didn't know what the aims were. Nirex needs to find out why there was a lack of response regarding the document and maybe look towards other methods of getting the information out. The group felt that the document was too narrow and wasn't sure who it was aimed at. It was also felt that the document had been overtaken by recent events.

Nirex has to be seen to be thinking about the present issues but the Forward Programme often seemed like a historical document. If the public isn't getting to grips with the issue and becoming involved in it, then the debate needs to be broadened. There are mixed messages being sent from the industry to the public and Nirex should distance itself from this.

The group felt that the future role of Nirex should be to take a multi format approach where different techniques are considered. Another method of communication would be to produce an exhibition to show what is happening. BNFL has already done this but it is industry related and needs to be independent

The group thought that more money should be spent on getting the information out to the public. Every library should have a copy of the forward document with a summary in pictures and words. Another idea would be to put a statement at the bottom of electricity bills stating how much low and intermediate level waste has been produced in generating the electricity. This will alert people to the issues and make them realise their role, albeit indirect, in producing waste.

A TV programme could be produced in the form of a documentary that would give an unbiased view of the current situation. Most importantly though, the group felt that Nirex needs to know where it is going.

Response:

When *The Proposed Nirex Forward Programme* report was developed it was recognised that the report was focussed on technical studies supporting Nirex's historical phased disposal concept and role to provide packaging advice to the nuclear industry. Aspects of the work programme to develop dialogue with stakeholder groups and to investigate other waste management options were not covered by the report. The report was published in October 2001 specifically with the objective of seeking feedback and enabling external influence on the programme.

The points raised in the above discussion are accepted. Nirex is now working towards to a revised Forward Programme document and the feedback received from the workshop is being taken account in formulating the revised document. The updated version will report on the complete spectrum of Nirex activities rather than being focussed purely on work in support of the phased disposal concept.

Nirex is continuing to investigate various mechanisms for communicating its work. It will continue to use a range of mechanisms to enable a wide range of stakeholders to engage with its work programme.

Further Actions:	Responsibility:
Production of revised issue of *The Proposed Nirex Forward Programme*	Nirex

Sheet No. 3.1	Syndicate Exercise 3 - All groups From perspective of monitoring, views were requested on addressing technical issues alongside societal aspects

Comment:

Group 1 believed that technical and social issues should be taken together in an integrated approach. They both share common objectives - for example compliance with regulations and information requirements for continued waste management and therefore should be monitored in a similar way. The dialogue process is useful but needs to be more inclusive – for example during this workshop there was a low representation from NGO's and industry. The reasons need to be looked at to see whether it is because there was disenchantment with the process or a lack of commitment.

Group 2 asked as to whether monitoring should be carried out for societal reasons. These would include: the stability of society; public acceptance of an issue; and who monitors the monitors. One view is to design society out of the programme so if society collapsed, the waste would still be safe. Other options are to design a repository that could be backfilled, or to make the waste retrievable.

Group 2 thought that there is a perception that it is the job of the Environment Agency to monitor the waste. The group was aware that many local authorities did not trust the data which was presented to them, so to ensure confidence, local authorities could set up their own individual reporting system to make sure the data given to them is correct. The group had a difference of opinion with regard to whether reversibility should be built into the design of the repository and this was largely due to the mix of representatives in their group. Some people agreed with making the process reversible as a way to achieve management of liabilities whereas other people said it was not necessary to incorporate reversibility.

The group thought that monitoring systems should be designed to show that the waste is deemed safe for at least 250 years.

Group 3 noted that the public perception of monitoring and retrievability is two-sided. On the one hand, monitoring is carried out to show the waste is safe, but on the other hand the need for monitoring can imply that the waste is not safe.

Monitoring itself needs to be very broad and should include: the environment; waste integrity, safety issues and geotechnical and hydrological aspects of the process.

In certain countries, it was thought that safety had been compromised as a result of break down of society. Therefore society itself needs to be monitored over a very long timescale. Monitoring must also be linked to retrievability and reversibility otherwise there is no point monitoring the waste at all.

Group 4 decided that technological issues should be addressed alongside the social ones. It was deemed important to tackle these together to make people aware of all the issues. Retrievability was considered a necessary component of public acceptability but was thought unlikely to be needed. Monitoring can confirm technical predictions and help instil public confidence if these are correct.

Group 5 thought that there was a need for monitoring and retrievability for both technological and societal reasons. Societal needs should be the drivers of technological research.

Response:

Nirex is generally in accord with the views expressed. Monitoring should be broad and encompass both technical and societal aspects. In order to help in the development of a strategy for monitoring within the context of the phased disposal concept, Nirex has implemented two initiatives.

- A report has been commissioned and published entitled *Options for Monitoring during the Phased Development of a Repository for Radioactive Waste*. The report was produced by Safety Assessment Management Ltd., working in co-operation with NNC Ltd., the National Cooperative for Disposal of Radioactive Waste, Switzerland, and the Centre for Study of Environmental Change (CSEC), Lancaster University. The report has been issued as report SAM-J078-R1, and is available on request from Nirex.
- Nirex is also taking part in an international study looking at the role of monitoring within the context of a phased approach to deep geological disposal. The study group comprises representatives from most of the key organisations involved in management of national radioactive waste programmes with Europe. The study is organised as a "Thematic Network" funded by the European Commission. The group will produce a report in 2004.

The specific roles and responsibilities for monitoring have yet to be defined. However we would agree that the results of any monitoring should be available for independent review and interpretation.

Further Actions:	Responsibility:
Continue work of Thematic Network and publish results when study completed in 2004.	Nirex

Sheet No. 3.2	Syndicate Exercise 3 Views were requested on the dialogue process for radioactive waste management

Comment:

Group 1 thought that the "Chatham House" rules were very good as they enabled the participants to speak openly and freely, and to seek other people's views. The mix of participants in Group 1 was not representative as it did not include a mix of stakeholders and for effective debate the group thought that this would be important.

Group 2 valued dialogue with society highly and this is Nirex's responsibility to implement and follow through. This dialogue must continue for a long time even after the waste has been backfilled. The group questioned why Nirex was organising this workshop. It suggested that future workshops could be organised by UK CEED, as it is an independent organisation.

Group 3 thought that children should be educated about nuclear waste from an early age so that they can grow up understanding the issues involved. The group thought that Nirex has made a positive move forward in setting up workshops like today encouraging dialogue with a mix of people. This is moving away from the old Nirex's "secretive past".

Group 4 thought that more front-end consultation and dialogue is needed to ensure the strategy is in line with public concerns. Once a site is determined, continuous monitoring will help to reassure the local community of its safety. The regulators should be demonstrably transparent and independent of the industry.

Response:

The views expressed on the dialogue process are welcomed and will be actively considered as Nirex develops plans for future dialogue processes.

Nirex uses independent organisations to organise and facilitate some of its stakeholder dialogues to ensure the independence of the events.

Nirex is working with South Oxfordshire Education Business Partnership to help to integrate information on radioactive waste management into the National Curriculum and is participating in the programme being undertaken by DTI to develop videos for use within schools.

Nirex agrees with the need for front-end consultation and will continue to use preview as a way to identify issues and concerns early.

Further Actions:	Responsibility:

Sheet No. 3.3	Syndicate Exercise 3 - All Groups Views were requested on suggestions for future work

Comment:

Group 2 thought that Nirex must continue dialogue as a part of its future work and must focus on the big issues rather than detailed interpretations. Confidence in Nirex must be built and then maintained. This can be achieved by being open and transparent. People need to know and understand what the situation is today. They already know the volumes and activity levels but nothing regarding the state of the waste, for example the drums, the building and the integrity of these.

Group 5 concluded that future work should include research into what society want. The day's workshop was a good step towards this but needs to be extended. The issue of monitoring and retrievability allows the community some control as opposed to technical issues which they may not fully understand or have control over.

Group 4 thought that future work should link monitoring to decision points and show how to build on the assessment of the monitoring results to decision making. The aim must be to gain passive safety so that even though monitoring is carried out and retrievability is a possibility, they should be demonstrated to be irrelevant.

Response:

Nirex is developing a strategy to build on the dialogue process that has been established for issues such as monitoring and retrievability. In addition Nirex has also held dialogue workshops on issues such as social science and its interface with technical studies and on options for long-term waste management. The programme of workshops and such processes to engage in dialogue are now an integral part of the Nirex way of working and are co-ordinated under the Nirex Involvement Programme.

To identify issues and concerns held by the general public, a series of discussion groups were held specifically on the phased disposal concept. Nirex has developed answers to the questions raised in the groups and has updated the "Frequently Asked Questions" part of the Nirex website. We are also looking at how the issues raised can be addressed more specifically by the safety assessments we undertake. A report describing this project and the questions and concerns posed by the discussion groups has been published by Nirex (see "Answers to Public Questions about the Phased Disposal Concept for Radioactive Waste", Nirex Report N/069).

The suggestions for future monitoring work fit well within our current plans. The Thematic Network described earlier (see Sheet 3.1) is giving much emphasis to the role of monitoring within a phased approach and how the monitoring can and should, be linked to the decision making process. The overall aim to provide safety by passive means and to use monitoring to give information and confidence and not a means to assure safety, is a central tenet to the work.

Further Actions:	Responsibility:
Continue Nirex involvement programme and use a range of dialogue mechanisms to engage stakeholders.	Nirex
Develop strategy for monitoring via Thematic Network	Nirex

Sheet No. 3.4	Syndicate Exercise 3 - All groups Views were requested on the need for monitoring and retrievability

Comment:

Group 1 thought that if monitoring is carried out for the purpose of compliance, there need to be short-term models in place to predict the future behaviour of the waste. Performance criteria would be needed against which to analyse the results. Nirex may need to take a step back and look at other options for the storage of waste. Other topics should be open to dialogue as well, such as the packaging of the waste.

Monitoring will always be required, as society requires it, regardless of whether or not retrievability is written in. There needs to be a periodic review with set decision points looking at the social, technical and economic issues. There also needs to be a continuous review and a system should be set up to deal with this.

Group 1 was asked as to why monitoring would be needed if retrievability was not written into the design. The reply was that retrievability was not the only action which could be taken. There are other remediation techniques which could be used.

Group 2 concluded that within a monitoring regime there needs to be action levels set, and for this to be effective, people must know what action to take if readings are out of the ordinary.

Group 3 thought that there is a potential role for an international body to be responsible for all international monitoring activities. This could be the International Atomic Energy Association or a similar organisation.

Group 4 said there is a need to monitor the parameters which the public feel are important and inspect these at regular intervals. The package behaviour should also be watched continuously to confirm that nothing dramatic was occurring.

Group 5 thought that the timescale of the project was seen to be another problem, as the group didn't have an idea of the timescales involved. It was asked whether monitoring would only be carried out in the short term or whether it would carry on indefinitely. The group didn't know to what extent the waste would be monitored, whether it would be in the near field or the far field. It should be made clear what would be monitored and what would happen if the results were unexpected.

The group asked if responsibility was being avoided by not taking action immediately. A technological solution should not be confined to the deep disposal concept, as all options need to be kept open at this stage.

Response:

We would agree that monitoring results would have to be compared against predictions and that models will be needed to do this.

In terms of other topics for dialogue Nirex has the Nirex involvement programme which co-ordinates dialogue on all aspects of the Nirex work programme.

Nirex would agree that monitoring would be required regardless of whether retrievability is included or not. However retrievability provides the option to reverse the process (possibly in response to undesirable monitoring results – although other remedial action may be possible). We would agree that a system will need to be developed for reviewing monitoring results and feeding the information into the decision-making process.

As part of a monitoring strategy it will be necessary to establish what actions can be taken in response to 'out of specification' results from monitoring. For example if temperature measurements are higher than predicted it may be necessary to increase ventilation flow. This is being addressed as part of the Thematic Network referred to earlier.

The potential role for an international body, such as IAEA, to oversee all monitoring activities will be considered further in future work. Such a body could help to ensure that consistent standards are applied and continue to be applied.

The approach to developing a monitoring strategy is based on satisfying a number of objectives as identified earlier. Those objectives would include parameters that the public feel are important. Package monitoring would be required to provide information for a number of the objectives e.g. long-term safety and operational safety.

In terms of the timescales – monitoring would certainly be required up to the point at which the facility was sealed and closed. Following closure it is a regulatory requirement that safety of the system must not rely on monitoring. However, we envisage that some monitoring activities will still be undertaken to confirm that the system is evolving as expected. Decisions about the duration and nature of monitoring at this post-closure stage would be decided by society at that time. Nirex is actively investigating the options for monitoring in the post-closure period and will publish the outcome of its investigations in 2004/05.

Nirex agrees that all options need to be kept open at this stage and is fully supportive of the Defra and DA consultation process that will look at options in Stage 2.

Nirex is also undertaking work on other waste management options for a range of radioactive wastes and materials. We believe that work on options will need to continue even after the UK has made a decision about which option(s) to implement. The research on other options will need to be kept up to date in order to ensure that previous decisions are still robust at the point of implementation. This may only involve keeping a watching brief on options.

Further Actions:	Responsibility:
Publish report of Thematic Network on role of monitoring within a phased approach to disposal.	Nirex
Publish work on options for monitoring in the post-closure period.	Nirex

REFERENCES

[1] House of Lords Select Committee on Science and Technology / Management of Nuclear Waste. Session 1998-99 3rd Report, March 1999.

[2] UK National Consensus Conference. Radioactive Waste Management - Citizens' Panel Report. The UK Centre for Economic and Environmental Development / UKCEED, May 1999.

[3] UKCEED in association with CSEC Lancaster University. Workshop on the Monitoring and Retrievability of Radioactive Waste, December 2000.

[4] UKCEED in association with Sextant Consulting. Workshop on Monitoring and Retrievability of Radioactive Waste, March 2001.

[5] Nirex. Responses to Feedback on Monitoring and Retrievability. Nirex Report N/033, July 2001

[6] Nirex, The Proposed Nirex Forward Programme, Nirex Report N/015, March 2001.

[7] UKCEED in association with Forth Road Limited and CSEL Lancaster University workshops on the Monitoring and Retrievability of Radioactive Waste, February 2002.

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Rough "Strategy"

(*a draft presented by Andy Blowers to the Meriden meeting on 19 April and reflecting discussion at the meeting*)

1. At the present time and with our present knowledge, CoRWM considers deep geological disposal to be the best approach for the long-term management of the UK's higher activity wastes.

2. Therefore, we recommend that the Government and devolved administrations now start a process of staged implementation which will lead ultimately to the deep disposal of higher activity wastes.

3. However, we also recognise the significant role of storage, and that there are social and ethical concerns surrounding deep disposal which may be sufficient to prevent implementation at a suitable site.

4. We also recognise that the process of implementation of deep disposal will inevitably take a long time, possibly one or two generations before emplacement of wastes can begin.

5. Therefore, we recommend a staged process of implementation, consisting of the following elements:

    a. a commitment to ensuring the safe and secure storage of wastes during the interim period before emplacement in a repository, in a robust process, also taking account of the risk of delays in the repository programme

    b. a continuation of research into geological disposal, long term interim storage, and alternative methods for the long term management of radioactive wastes

    c. a continuing public and stakeholder engagement process aimed at building trust and confidence in the proposed long-term management approach

    d. a set of decision points providing for a review of progress with an opportunity for re-evaluation before proceeding further.

6. CoRWM considers that an essential precondition to successful implementation will be the achievement of societal consensus, that is, sufficient agreement to proceed.

Review of Nirex Report: 'The Viability of a Phased Geological Repository Concept for the Long-term Management of the UK's Radioactive Waste'

Version 3.1

NWAT/Nirex/05/003 November 2005

Version 3.1

Copies of this report can be obtained from:

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Document history This document has been prepared by Andy Baker, Paul Abraitis and David Brazier. Informal comments were provided to Nirex on an earlier draft version of the 'Viability Report' and Nirex took account of these comments in producing the final version of the report.		
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Principal authors	**Signature**	**Date**
Dr. A J Baker Dr. P K Abraitis Mr. D I Brazier		28th November 2005
Checked by	**Signature**	**Date**
Dr. W M Tearle		28th November 2005
Approved by	**Signature**	**Date**
Dr. A J Baker		28th November 2005
Distribution	Open	

Version 3.1

PREFACE

Any future authorisation to dispose of solid radioactive waste at a specialised disposal facility will be granted by the environment agencies, the Environment Agency (EA) in England and Wales and the Scottish Environment Protection Agency (SEPA) in Scotland, subject to the production of an acceptable post-closure safety case. Guidance on the development of such safety cases and the expectations of the environment agencies is outlined in RSA 1993, Disposal Facilities on Land for Low and Intermediate Level Radioactive Wastes: Guidance on Requirements for Authorisation (GRA).

In order to accomplish their mission "*to provide the UK with safe, environmentally sound and publicly acceptable options for the long-term management of radioactive materials*", United Kingdom Nirex Limited (Nirex) has developed the Phased Geological Repository Concept (PGRC), which is described as a staged approach to long-term waste management. Nirex considers the PGRC as a "*…benchmark against which to judge the adequacy of radioactive waste packaging proposals developed by waste producer organisations"*. The PGRC 'Generic Documents' produced by Nirex in support of this concept include a suite of safety assessments that are not specific to a particular site. An agreement between Nirex and the Environment Agency is in place to permit regulatory scrutiny of the work of Nirex. This involves an examination of Nirex's PGRC, its application to intermediate-level waste (ILW) conditioning proposals including associated Letters of Compliance/Letters of Advice (LoC/LoA) and the development of an environmental safety case for any future phased disposal facility. A similar agreement has been established between Nirex and SEPA.

The comments provided here represent the Agency's current views. Provision of these comments by the Environment Agency does not place the Agency under any obligation to approve any future Post-Closure Safety Case, submitted by Nirex (or any other organisation), in support of any subsequent authorisation, nor does it bind the Agency in any way to grant an authorisation for any future disposals.

Environment Agency of England & Wales

Version 3.1

EXECUTIVE SUMMARY

This is a review of Nirex's Report (N/122) entitled: "The Viability of a Phased Geological Concept for the Long-term Management of the UK's Radioactive Waste" (the Viability Report).

We agree with Nirex that deep geological disposal is viable, in the sense that, in the medium term, it is feasible that a safety case could be generated that would meet regulatory requirements, provided a publicly and technically suitable site were available. We agree with Nirex that early availability of a disposal facility is important in that it would enable radioactive wastes to be managed in a manner that would minimise the overall environmental impacts that might arise. However, it would have been helpful if Nirex could have provided a clearer explanation of the criteria that it believes are appropriate to judge viability.

We are concerned that plans for a long period of storage, which is envisaged as part of the Phased Geological Repository Concept, are not sufficiently underpinned technically. In particular, we are concerned that there appears to be insufficient justification for assuming that packages will last for a target period of 500 years. It is a cause for concern that previous research within the Nirex programme has not yet been developed or updated to provide the basis for a confident view on the longevity of wasteforms containing reactive metals, if they were to be managed under Nirex's Phased Geological Repository Concept.

We agree that no major issues have been identified that make deep geological disposal non viable. However, the report has not provided a good technical overview of many remaining key technical challenges and how they will be resolved.

In reporting the current technical position, we consider that Nirex present an overly optimistic view. Similarly, in presenting the arguments in favour of their proposed concept, the positive arguments are given prominence, and corresponding negative arguments are not examined. A more even-handed exposition of the arguments would be beneficial.

In all, whilst we have reservations about certain aspects of the report, we agree that it provides satisfactory support to the conclusion that deep geological disposal is a viable solution.

CONTENTS

1. CONTEXT

In this document, a review is provided of Nirex's Report (N/122) entitled: "The Viability of a Phased Geological Repository Concept for the Long-term Management of the UK's Radioactive Waste" (the Viability Report). Nirex's report sets out '*…why Nirex believes that the UK's long-lived radioactive waste should be placed in a Phased Geological Repository located between 300m and 1000m deep…'*.

Nirex's Viability report is underpinned by a number of Context Notes. We have offered comments on draft Context Notes over the past six months and Nirex has considered our comments when they revised the Context Notes. The Environment Agency was subsequently provided with a draft of the Viability Report and provided informal comments on this. A final version of the Viability Report was issued to the Agency in November and is the subject of the review provided here.

The comments that we provide correspond to our regulatory remit to consider the post-closure safety of any disposal facility. We do not comment, for example, on matters of transport or operational safety, which lie outside our regulatory remit. The Environment Agency has a current agreement with Nirex to review its work programme on the disposal of LLW and ILW. Some of our comments are informed by work undertaken under this agreement. The agreement does not cover Nirex's work on HLW, Spent Fuel or co-disposal, which are not currently subject to regulatory review. The Scottish Environment Protection Agency has a similar agreement with Nirex to that of the Environment Agency.

The Environment Agency makes no warranty in respect of the adequacy of the comments provided in this report. In particular, they may not provide a complete and comprehensive review of every aspect of the report, nor do they bind us to follow any particular course of action. The absence of comment should not be taken as an endorsement by the Environment Agency of the views expressed.

This is an independent review provided by the Environment Agency. However, it is appropriate to declare the work that two of the authors have undertaken in the past while working for organisations under contract to Nirex. Andy Baker has managed and/or undertaken a number of Nirex assessment and research projects, prior to joining the Environment Agency in 2004. He has contributed to or co-authored some of the documents cited in the reference list of the Viability Report. David Brazier has undertaken review work on many assumptions in Nirex's generic concept, prior to joining the Environment Agency in 2003. In undertaking this review, we have ensured that individuals are not primarily responsible for the review of any technical work that they were involved in directly.

2. VIABILITY

2.1 Overview

The objective of the Nirex report is to demonstrate that the Nirex Phased Geological Repository Concept (PGRC) is a viable option. In this context, it would have been helpful to provide a more explicit explanation as to how Nirex consider that viability should be demonstrated or evaluated. Criteria might include, for example, confidence that a geological disposal facility can be constructed, establishing that legal and regulatory requirements can be met and showing that adequate stakeholder confidence and acceptance is feasible.

Our view on deep disposal has been outlined in our responses to the CoRWM consultation [1, 2]:

" *In our view, the only sustainable solution to the long-term management of these wastes entails a clear commitment to developing a deep geological disposal facility"*[2].

We agree with Nirex that early availability of a disposal facility is important in that it would enable radioactive wastes to be managed and stored in a manner that would minimise the overall environmental impacts that might arise.

However, we believe that certain further research is needed to build confidence in the understanding of a number of key technical issues and processes that would affect the long-term safety of a deep disposal facility. The statement in the Viability Report (page 104):

'*…that enough fundamental research has been done and that the emphasis should now be on technology demonstration*',

is an overstatement of the position, in our view. We agree that technology demonstration should be a major future focus, but not that enough fundamental research has been done.

It is judged that a safety case that would meet the test of regulatory acceptability is possible on a timescale of a decade or so for a suitable site with appropriate design and waste acceptance measures. We agree in broad terms with Nirex that deep disposal is a viable strategy in this sense. Of course we are not in a position to prejudge the acceptability of any proposal that might be submitted. The claim that '*…the results show that all relevant regulatory criteria can be met'* (page 5 of the Viability Report) would need to be established for a specific, well-characterised site.

2.2 Status of the Technology

Nirex state the concept is viable in that "*the repository system is entirely based on tried and tested technology routinely used in the mining, construction and nuclear industries*, " (Page 5 of the Viability Report). We agree that in many respects this is correct. However, there are important exceptions in terms of the use of the relatively unique Nirex Reference Vault

Backfill and the plans to maintain and refurbish caverns and facilities of the size that Nirex are proposing, potentially over a period of several hundred years.

2.3 Underpinning Arguments

A range of arguments are potentially available to support a conclusion that a concept is viable and that sufficient confidence in that concept has been built. These include evidence that:

- regulatory principles and requirements can be met;
- international consensus has been achieved concerning the long-term management of waste;
- data from natural analogues supports the safety case;
- long term experiments, particularly in URLs have been used to confirm the behaviour of the system as far as reasonable and practicable;
- key models used to assess safety are underpinned by adequately validated models or are themselves validated;
- a multiple barrier design and a multiple factor safety case are provided;
- the concept is underpinned by high quality science and engineering and an appropriate research programme is underway.

Taking these in turn:

Regulatory principles and requirements

As noted above, we believe that it is feasible for a safety case to be prepared in the medium term that would meet regulatory requirements. In the Viability Report, Nirex present evidence that the regulatory risk target could be met. This is based on previous Sellafield specific assessments and on the Generic post-closure Performance Assessment (which illustrates performance for a generic set of assumptions and parameters).

There are a range of other regulatory requirements set out in the environment agencies' Guidance [3]. Many of these are discussed in the Viability Report. However, in many cases, Nirex is at an earlier stage in building confidence in compliance for requirements other than the regulatory risk target. The requirements include:

- demonstration of a multiple factor safety case (discussed below);
- optimisation of the design;
- demonstration that levels of radioactivity coming from the facility will not lead to significant increases in the levels of radioactivity in the accessible environment;
- compliance with a dose constraint for releases from the facility during the operational period.

Nirex has not yet demonstrated optimisation of a design, though this should be feasible given

sufficient resources in future. It could only be fully achieved when site specific information is available. Our comments in Section 3 also relate to this requirement.

A comparison between repository-derived radioactivity and natural levels of radioactivity is not fully explored in the report. However, the doses arising from a variant groundwater pathway calculation are compared with natural doses in part of Cornwall, and the regulatory risk target is compared with risks arising in general from natural radioactivity.
The focus of the report is on compliance with the regulatory risk target that applies after repository closure, rather than with the dose constraint that applies prior to closure. Nevertheless we consider that, in a properly managed facility, it should be feasible to ensure that compliance with the dose constraint is obtained.

Inevitably, the safety case has yet to be demonstrated for a specific site.

International consensus
As Nirex notes, geological disposal (phased or otherwise) is the preferred option of all countries that have made a decision for the long-term management of such wastes.

Natural analogues
Nirex refers to natural analogues as support for the viability of the concept (e.g. page 101 of the Viability Report). Care is needed in citing support for the concept based on natural analogue data. For example, the persistence in one case of a particular material or feature over geological timescales may not preclude many other cases in which the material or feature has disappeared. We recognise the value of natural analogues in providing confidence in the understanding of particular processes, and in helping to communicate aspects of a repository safety case. The way in which they can be used has not been adequately discussed in the report.

Long-term experiments
Long-term experiments, whether laboratory or field based, can be of great importance in underpinning aspects of a safety case and demonstrating the performance of certain repository components, at least over short timescales (i.e. up to tens of years). Nirex highlights the need for demonstration experiments, but could have highlighted more the potential benefits that such experiments may provide in terms of confidence building.

Validation
A key measure for building confidence in assessment results is the validation (as far as this can reasonably be accomplished) of the underlying models of physical, chemical and biological processes. Nirex refers to the fact that the assessment models are "well established" (page 5 of the Viability Report). However, these models are largely non-empirical and it would be appropriate to describe the work that Nirex has done (and presumably proposes to do) to evaluate the reliability of the detailed models that underlie the total performance assessment models.

Multiple barrier design and a multiple factor safety case
Nirex has designed a multiple barrier concept. However, Nirex's current safety case arguments involve considerable reliance on the geosphere barrier in order to provide the required performance. In our view, there has only been a limited demonstration so far of a multiple factor safety case. We recommend that Nirex considers this issue further, in terms of the degree of resilience of the safety case for the current design, and any design enhancements that provide additional resilience. We have made a related recommendation to Nirex as part of our review of the LoC assessment process [4].

Quality of science and technology
We would concur that scientific and technological excellence is demonstrated in the Nirex programme. This has been confirmed by certain peer reviews, which are referenced in the report. We would encourage Nirex to ensure that key components of its programme continue to be evaluated by peer review (in addition to the review provided by the current programme of regulatory scrutiny).

3. CHOICE OF DEEP DISPOSAL CONCEPT

Nirex prefers a particular ILW disposal concept involving the disposal in vaults of stainless steel and concrete containers, containing a cementitious wasteform, and the use of a cementitious grout as a backfill around the containers. The reasons why this concept is preferred over alternative designs (e.g. use of bentonite or disposal in silos) is not made clear in the report (or in other material that we have reviewed to date). We recommend that Nirex develop and present an analysis that enables the preferred concept design for the geological disposal of ILW to be judged against alternative designs, taking account of a range of issues including safety, environmental impact, practicability, social issues and cost. We consider that, where appropriate, the developer of a geological repository should examine variants to the design and their effects on radiological and other impacts. Nirex should be in a position to explain why they have adopted this particular design variant over any other.

A similar comment applies to the design that Nirex prefers for High Level Waste and Spent Fuel disposal.

Nirex's safety case arguments in relation to the HLW/SF concept includes credit for the long-term physical containment afforded by the container and the hydraulic barrier afforded by bentonite backfill, in addition to that afforded by the geosphere. The risk estimates in relation to the HLW/SF concept (a peak of 10^{-11} per year from the groundwater pathway) raise the important question as to whether (a portion of) the ILW inventory could be treated to yield waste packages that are suitable for such a concept, rather than the cementitious ILW concept. This would likely require pretreatments of raw ILW to remove significant gas-generating components that may challenge the bentonite buffer and the use of alternative encapsulants to cement. We note that many of the concerns in relation to waste package longevity, for example concerns relating to gas generation, could be mitigated if such waste pretreatments were adopted, with due consideration of operational discharges during waste

treatment and other relevant factors (cost, operational safety etc). Clearly such considerations would need to be made on a waste stream per waste stream basis through a suitable options assessment process. We would encourage Nirex to consider any challenging waste streams in this context.

Nirex makes the assertion that 30% of the UK deep geosphere is potentially suitable for a deep geological disposal facility. We have not reviewed the justification for this assertion. However, no clear outline is provided in terms of what the siting requirements are for the PGRC, or how this 30% assumption is founded or underpinned. Nirex has indicated that this assumption is being re-appraised. The report acknowledges that any future site will need to be technically suitable and publicly acceptable. However, the required geological characteristics have not been communicated other than in very broad terms (e.g. low groundwater flow rates, travel times, 300 to 1000 m depths). There are various discussions of the assumptions regarding site characteristics that are inherent in the Nirex GPA within the report (e.g. the discussion of the "Q, T & F" parameters on p. 52 of the Viability Report). The report does recognise the need for detailed site specific research and discusses some of the issues that will need consideration.

The discussion of suitable rock mass types in Section 4.4.2 of the Viability Report indicates that the concept may not be truly generic, in the sense that compatibility with all potential host rocks has not been established to the same extent as for fractured hard rock. Nirex has considered these issues in the past, but evidence is not presented in this Report to establish compatibility.

4. PHASED ASPECTS OF THE CONCEPT

Nirex talks in terms of the considerations in relation to closure, *"being societal not scientific or engineering",* (p. 37 of the Viability Report). It is true that decisions in relation to the timing of closure are socio-political in nature. However, we believe that there are some important scientific and engineering considerations that need to be addressed.

It is recognised that the Nirex Phased Geological Repository Concept includes flexibility in terms of the timescales for closure and that immediate closure following waste emplacement is not ruled out. However, the discussion of an extended period of monitoring and retrievability (Section 4.2) presents a view that could be considered biased, as it does not present any consideration of the negative aspects of this approach, for example:

- leaving the closure decision to future generations is a burden to them;
- the costs of an extended period of retrievable storage is a burden;
- worker dose and multiple package handling operations represent a risk burden;
- package degradation under extended storage in an open vault is inevitable - the extent depending on the quality of the initial wasteform and containers and the extent to which conditions are controlled in the vaults;

- any loss of package integrity prior to closure may not be consistent with optimised post-closure performance of the disposal system. Immediate backfilling might mitigate package degradation during storage as the hyperalkalinity afforded by the backfill would tend to minimise the corrosion rates of stainless steel packaging in a wet environment;
- should widespread reworking of packages be required (e.g. as a result of the loss of package integrity) during an extended storage period, this would be a burden (cost, worker dose etc) [5];
- the possibility of cavern failure (e.g. rockfalls, flooding etc) is likely to depend broadly on the size of the caverns and the timescales over which the facility remains open. Should the worst happen, post-accident recovery may prove difficult and may prevent optimised closure of the facility.

Adequate technical substantiation has not been presented (in this report or in any other Nirex material that we have reviewed to date) in relation to the lifetime of ILW packages during long-term underground storage. In this respect, the report may provide an overly optimistic picture of a trouble-free, extended operational period. Nirex has in the past undertaken work within its research programme to assess the lifetime of ILW packages. Although this work indicated that early package failure might be a problem, the work has not yet, to our understanding, been developed in any way or updated for Phased Disposal. In the absence of such an update, we do not believe that there is a well founded case that waste packages containing reactive metals will last for a period of hundreds of years. If a significant proportion of packages need reworking during storage over periods of hundreds of years (and this is quite possible on the basis of data that we have reviewed to date), then consideration should be given at this stage to an appropriate mitigation strategy. It may be appropriate to produce enhanced wasteforms for certain waste streams in order to reduce the need for waste reworking. If reworking were deemed to be a significant risk, and without a defined end point for closure it cannot be ruled out as a requirement, it may also be appropriate to make provision for this both financially and in terms of making appropriate design modifications to any repository. The Environment Agency is very concerned by this apparent gap in the technical underpinning of Nirex's concept, although at our prompting, Nirex has recently put work in hand to address it. However, we consider that the issues should not be seen as viability threatening, as steps could be taken to improve the quality of wasteforms and improve confidence in longevity.

We suggest that further focus is needed on possible scenarios in which the facility is abandoned without backfilling or proper sealing or closure. Following resaturation of such an abandoned facility, it would be expected that the roadways and access shafts would provide a route for the return of radioactive contamination to the environment.

In Section 4.1 (p29 of the Viability Report) it is noted that of a range of foreign countries *"only Germany has not adopted retrievability"*. In order to provide balance, it would have been helpful to explain why this is so. The German Akend Report on the Site Selection Procedure for Repository Sites [6] from 2002 states:

"*If facilitated retrievability of the waste is considered to be possible, the passive safe*

condition will be reached considerably later...active safety measures require stable social and economic conditions, which likewise cannot be guaranteed for the long periods of retrievability...Therefore, the Committee sees no reason to consider retrievability of waste from the repository in the development of the site selection procedure and rather pursues a consequent safety-related approach by concentrating on a repository system which exclusively features passive safety with emphasis on long-term safety regarding the site selection."

It would be helpful if Nirex could explain why they disagree with this position.

5. ILW PACKAGING

The discussion in Section 4.7.1 of the Viability Report discusses the output of a RWPG meeting that addressed the compatibility of wastes packaged according to the Nirex Specifications with concepts other than deep geological disposal [7]. We agree with Nirex that cementitious wasteforms are compatible in the broadest sense with a number of different management options. However, they may not be appropriately optimised for some options. We would also note the recommendation, made at the RWPG meeting, that:

"*...in light of the work that had been undertaken, and on the balance of probabilities, that waste should continue to be packaged under the LoC arrangements",* but also that *"...the arrangements needed to be kept under revie*w" [7].

As noted above, it may be desirable to produce enhanced packages for certain waste streams where there is any significant risk of reworking being required during a long period of storage.

6. MAJOR TECHNICAL ISSUES

In Section 9.2 of the Viability Report, Nirex identifies a number of 'viability threatening issues'. It is not clear from the text as to whether Nirex really considers these issues to be viability threatening.

In the case of Carbon-14 (C-14), two issues are not mentioned in Section 9.2, although they are covered briefly earlier in the report. These include the need to build confidence in estimates of the release rates of C-14 labelled gases, particularly where these estimates depend on models of microbiological processes. Further, 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. For example, if gases flow along partially sealed cracks, it might be difficult for the gas to access unreacted backfill. These issues are all important to developing a better understanding of the radiological consequences

that might arise from the gas pathway. We agree with Nirex that there may be scope for managing any residual issues by appropriate measures.

Overall, Section 9.2 focuses on a small number of possible 'viability threatening' issues; there is no comparable discussion of some of the other key technical challenges that remain. These may not be viability threatening in Nirex's terminology, but they are areas where further work is needed before an acceptable repository safety case could be generated. Some of these issues are identified as the subject of research in Section 6 of the Viability Report, but this largely gives a flavour for areas of research rather than highlighting the technical challenge to which a solution is required.

In our view the following are some of the other key technical challenges that remain:

- The need to better understand package longevity and corresponding degradation mechanisms over a long period of storage and hence any requirement to produce improved packages for certain waste streams or to make provision for reworking;
- Developing a good understanding of groundwater flow and radionuclide transport at a specific site, including the representation of flow and transport in fractured rocks;
- A fuller understanding of the impact of organic complexants and colloids as well as Non-Aqueous Phase Liquids (NAPLs – which are addressed in Section 9.2);
- Understanding the potential coupling between gas and groundwater flow;
- Developing a better understanding of the evolution of the 'near field' and its role in limiting radionuclide release, which should be closely linked to the consideration of possible design optimisation;
- The need for long-term experiments to demonstrate the behaviour of near-field components;
- Building more confidence in the safety case for criticality;
- Developing a clear strategy for repository sealing that is demonstrated to function adequately in the long term;
- Building an understanding of time dependent effects and their consideration in a justifiable way in assessment models;
- Demonstrating an adequate understanding of the values of key parameters.

It would have been helpful if the report contained a brief account of these key challenges and how Nirex proposes to resolve them. Some of the issues are addressed or listed in earlier parts of the report, but a more comprehensive overview of the nature of the challenges and the route to a solution has not been provided.

7. UNCERTAINTY

Nirex recognises the need to manage and treat uncertainty (see pages 59-60 of the Viability Report). We agree that this is a key requirement of a safety case.

Because of the uncertainties inherent in a performance assessment for a geological repository, undue reliance on numerical measures of performance may not be sufficient. Nirex describe the intention to develop an environmental safety case and allude to the need to address regulatory criteria other than annual risk and radiation dose. The need to address a number of regulatory requirements, for example, a comparison between levels of radioactivity from the facility and naturally occurring levels of radioactivity, might be considered to provide additional confidence. Nirex's work to address different performance indicators was discussed above in Section 2.

It is important that Nirex considers how to integrate technical analyses of uncertainty with work on the social dimension of uncertainty that Nirex has also sponsored. For example, in a report commissioned by Nirex, Hunt and Wynne [8] advise:

"...claiming too little uncertainty causes mistrust among a public increasingly exposed to the inherent lack of certainty of many scientific claims"

It is important that the uncertainties are explicitly acknowledged and communicated rather than subsumed into a statistical analysis with one numerical output (e.g. the expectation value of annual individual risk). It is good that Nirex highlight the uncertainties that exist in the assessment. However, in presenting aspects of their safety case we consider that Nirex sometimes fail to highlight the uncertainties sufficiently. Examples include:

- Uncertainties in the lifetime of packages during long-term storage and in the lifetime of the mechanical and electrical repository systems;
- Uncertainties in future societal and economic stability (sufficient to maintain and support safe repository closure);
- Uncertainties (despite everyone's best efforts and intentions) that no 'publicly acceptable' site will be found;
- Uncertainty in some of the processes that control the release of C-14 labelled gases including estimates of generation rates and assurance that carbonation will progress to completely immobilise carbon dioxide in the repository (as solid carbonate);
- The reliance of calculated results on certain assumptions concerning the biosphere and the characteristics of potentially exposed groups.

8. CONCLUSIONS

We agree in broad terms with Nirex that deep disposal is a viable strategy in that it is feasible in the medium term that a safety case could be generated that would meet regulatory requirements, provided a publicly and technically suitable site were available. We also agree with Nirex that early availability of a disposal facility is important in that it would enable radioactive wastes to be managed in a manner that would minimise the overall environmental impacts that might arise.

We are concerned that proposals for a long period of underground storage, which is envisaged as part of the Phased Geological Repository Concept, are not sufficiently underpinned technically. In particular, we are concerned that there appears to be insufficient justification for assuming that packages will last for a target period of 500 years.

We agree that no major technical issues have been identified that make deep geological disposal non viable. However, the report has not provided a good technical overview of the key technical challenges remaining and how they will be addressed.

Nirex present a fairly optimistic view of the current technical position. Similarly, in presenting the arguments in favour of their proposed concept, the positive arguments are given prominence, and corresponding negative arguments are not examined. A more even-handed exposition of the arguments would be beneficial.

Despite these reservations concerning certain aspects of the report, we agree that the report provides satisfactory support to the conclusion that deep geological disposal is a viable solution.

9. REFERENCES

1. Environment Agency, *Response to a Consultation by the Committee on Radioactive Waste Management,* 2005.

2. Environment Agency, *Response to 2nd Consultation by the Committee on Radioactive Waste Management,* 2005.

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4. Abraitis, P.K., Baker, A.J., Brazier, D.I., Ilett D.J., Duerden, S.L. and Tearle, W.M., *Review of Nirex's Letter of Compliance Process,* Environment Agency, 2005.

5. Environment Agency (RM Consultants Ltd), *Feasibility And Implications of Reworking of Intermediate Level Radioactive Waste Packages*, SCH040067, ISBN:

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6. *Site Selection Procedure for Repository Sites, Recommendations of the Akend – Committee on a Site Selection Procedure for Repository Sites,* W & S Druck GmbH, Köln, 2002.

7. Defra, *Report on RWPG Sponsored Compatibility Workshop*, DEFRA/RAS/04.007, 2004.

8. Hunt, J., and Wynne, B., *Forums for Dialogue: Developing Legitimate Authority through Communication and Consultation,* Report for Nirex, 2000.

PRESENTATION BY NIREX TO CoRWM, 20 FEBRUARY 2004, LONDON - SUMMARY

1. **In brief**:

This was the second event in Members' learning programme. It was not a formal meeting involving decision making. The next learning event would be a presentation by NGOs on 5 March.

2. **Present**:

CoRWM: Gordon MacKerron (Chair), Fred Barker, Mark Dutton, Lynda Warren, Pete Wilkinson. Secretariat: Steve Mansfield, Adam Scott. Nirex: Chris Murray, Ann McCall, Samantha King, Elizabeth Atherton.

3. **Nirex presentation:**

Nirex gave a presentation ***Nirex update - February 2004*** (document 232, copy attached) setting out the history of radioactive waste management in the UK, the role of Nirex, the lessons it had learned, and its hopes for the future including its working relationship with CoRWM.

Nirex handed over a series of reports:

- ***Concepts that could aid a site selection process***, 2000 (document 226)

- ***Technical note by Burges Salmon for Nirex on legal issues relating to veto, volunteerism and community benefits***, 2002 (document 229)

- ***Compensation in radioactive waste management: ethical issues in the treatment of host communities***, May 2002 (document 230)

- ***Nirex response to the Defra and Devolved Administrations' consultation paper***, March 2002 (document 231)

- ***Ethical issues in the disposal of radioactive waste***, 2000 (document 235)

They listed other areas which they had researched, including radioactive waste management and social science issues, on which they could send reports to CoRWM.

4. **Questions:**

Individual CoRWM Members put questions to Nirex on points raised in its presentation, so that they could better understand issues relevant to radioactive waste management.

5. Conclusion:

The Chair thanked Nirex for its presentation and for a useful meeting. This was not a decision making meeting and CoRWM was not at present making any specific requests of Nirex. Nirex were, however, a vital resource which CoRWM would draw on, for example through its waste inventory working group. He would consider how to ensure that other Members were aware of the information they had imparted. He welcomed the assurance that Nirex would not engage with stakeholders in areas where CoRWM was in the lead. CoRWM would be transparent about all information received from Nirex.

CoRWM would not consider potential sites. It would consider generic siting issues, but probably not in the early stages of its programme.

Secretariat February 2004

Document 2146

Committee on Radioactive Waste Management

Implementing a partnership approach to radioactive waste management - Report to Government, April 2007

Implementing a partnership approach to radioactive waste management - report to Government, April 2007

Chapter 1
Introduction by the Chair

1. This report is in response to a request from CoRWM's sponsors - the UK Government and devolved administrations for Scotland, Wales and Northern Ireland - for advice,.on two major issues in the management of the UK's radioactive waste in the long term: communities and volunteering, and a partnership-based approach. We were also asked to look at the nature of a staged decision process up to the point at which agreement on the availability of a potential site is confirmed.

2. This report differs from the July 2006 CoRWM report in that then, we were making firm recommendations, which the Government broadly accepted, on how to manage the waste. Now, we are giving advice to assist Government in drafting its consultation on how to implement our recommendations, and in particular in identifying a suitable site or sites for managing wastes. It follows that we do not have to, and have not, set out a recommended way forward but have attempted to provide advice on as broad a basis as possible. Nevertheless, where we are prefer a particular course of action, we have said so.

3. The Committee's advice is one of several inputs to the Government consultation which will start later this year. We set out, first, why CoRWM's further advice was sought; how it was developed; key issues and findings; and finally, detailed advice in each of the areas specified by Government.

Gordon MacKerron

Chapter 2
Background and context: Government's request for advice

4. On 28 July 2006 the Committee presented its recommendations to Government for the long-term management of the UK's higher activity radioactive waste. [1] This followed a three year review of options and recommended geological disposal as the end state, the vital role of robust interim storage, and a new approach to implementation, based on the willingness of local communities to participate, partnership and enhanced well-being.

5. On 25 October 2006 the Government announced that it accepted CoRWM's main recommendations. [2] In particular, it said that it would consult in 2007 on a proposed framework for implementing them, including a proposed "volunteerism" / partnership approach. This consultation is expected to start at the end of June.

6. The Committee's July 2006 recommendations included a detailed report on communities and willingness to participate, partnerships and a staged decision-making process. [3] It discussed these issues further in late 2006, and produced a series of short papers [4] on these topics. The Government then asked CoRWM to offer further advice on these topics by the end of April 2007 to contribute to the development of the consultation proposals. Government's questions to CoRWM [5] are attached at Annex A.

7. The Government's 25 October 2006 announcement also indicated that CoRWM would be re-constituted and required to scrutinise the implementation process and offer independent advice. The Committee would be appointed with revised Terms of Reference. In the meantime, existing Members were invited to accept an extension of their term of office until 11 August 2007. Some Members had other commitments and left the Committee during 2006; Annex B lists those still in office in April 2007.

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[1] ***Managing our radioactive waste safely - CoRWM's recommendations to Government***, July 2006, CoRWM doc. 700, p.3. (In this report, all document references are to CoRWM numbered documents unless otherwise indicated.)
[2] A copy of the announcement is on the website of the Department for Environment, Food and Rural Affairs at http://www.defra.gov.uk/environment/radioactivity/waste/index.htm
[3] ***Moving forward - CoRWM's proposals for implementation***, July 2006, CoRWM document 1703
[4] doc.s 2009, 2010, 2013-2015, 2020, 2021, 2025 and 2042-2044
[5] These were presented to our December 2006 plenary meeting - see doc. 2094, Appendix 1

Chapter 3
How the report was developed

8. The process was relatively simple compared with the detailed options assessment that the Committee carried out in 2003-6.

9. The period from August to 14 December 2006 was mainly taken up in anticipating and preparing for the task, as described in paragraphs xx. Highlights of this period included:

   - the Committee's 25 September and 9 November plenary meetings, held in public [6]; and

   - meetings with Government to identify what further advice CoRWM could provide. As part of this, CoRWM was represented at a Defra workshop held on 23 November, in the Government's ***Managing radioactive waste safely*** programme, to help frame the work required for its consultation. This helped identify some areas where CoRWM could offer further advice, and so helped Government to draw up the questions (Annex A) on which the Committee is now advising.[7]

10. The period from 14 December 2006 to end-January 2007 was mainly spent on planning the work programme, reviewing information we had already gathered and recorded in CoRWM documents, and discussing the substantive issues of communities, willingness to participate, partnerships, packages and staged decision making.

11. Highlights of this period included the Committee's 14 December and 19 January plenary meeting, held in public [8], which discussed the initial papers (referred to in paragraph [3]) and identified some of the key issues involved in developing a successful volunteerism - and partnership-based process.

12. The period from February to the end of March 2007 was mainly spent on gathering information and meeting UK and overseas specialists, stakeholders and citizens to seek their views on the issues. Highlights of this period included:

   - the Committee's 26 February plenary meeting, held in public [9];

   - a workshop on 27-28 February with experts from Belgium, Canada, France, Sweden and Switzerland, to discuss

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[6] Minutes of meetings: docs. 1881 and 2085
[7] Report of Defra meeting, doc. xxxx
[8] Minutes of meetings: docs. 2096 and 2119
[9] Minutes of meeting: doc. 2142

overseas experience of communities' willingness to participate, partnerships and staged decision making processes [10];

- meetings of members of CoRWM's Citizens' Panels, held on 17 and 24 March in Glasgow and London, who gave their views and suggestions on these issues [11];

- comments from local discussion groups and others who had responded to CoRWM's 2006 Discussion Guide and of whom we asked some new questions in a further Discussion Guide [12];

- meetings with the Local Government Association's Nuclear Legacy Advisory Forum (NuLeAF); the Community Development Foundation; the Scottish Councils' Committee on Radioactive Waste Management; academics from the Universities of Lancaster and East Anglia [13]; Cumbria and West Cumbria Strategic Partnerships and the Caithness Partnership; the Macauley Institute; the Nuclear Decommissioning Authority [14]; the Environment Agency, Scottish Environment Protection Agency and Department for Communities and Local Government [15]; members of Highland Regional Council and Copeland Borough Council; Dounreay and Sizewell Site Stakeholder Groups; Greenpeace; NGOs in Cumbria;and the Norfolk Environmental Protection Group [16]. These meetings were designed mainly to collect information about communities and how they can be effectively represented, issues relating to the demonstration or otherwise of a community's willingness to participate, effective partnerships, and staged decision making including planning and regulatory issues.

13. During April 2007, the Committee reviewed its findings and drafted this report to Government. Highlights of this period included:

- the Committee's 2 April plenary meeting, held in public: this identified the extent of agreement among Members on substantive issues, outstanding issues to address, and the extent to which Government questions could be answered; [17]

[10] Meeting record, doc. 2172
[11] Citizens Panels reports, doc. 2173
[12] Summary of discussion guide responses, docs. 2153
[13] Meeting records, docs. 2130, 2152, 2156, 2163, 2164 and 2177
[14] Meeting records, docs. 2125, 2147, 2150 and 2168
[15] Meeting records, docs. 2151 and 2165
[16] Meeting records, docs. 2148, 2149, 2167, 2166, 2169, 2170 and 2171
[17] Minutes of 2 April plenary meeting, doc. 2176

- further discussion and drafting in April, including working meetings on 13 and 23 April, held in private, to draw up CoRWM's detailed advice; and

- the Committee's 27 April plenary which [discussed some remaining issues and agreed a process for completing the report and passing it to Government]. [18]

14. Annex C lists CoRWM's meetings with people and groups over this period.

[18] Minutes of 27 April plenary meeting, doc. xxxx

Chapter 4
Implementation: some key issues

Introduction

15. The move from MRWS Phase 2 to 3 involves fundamental change in the emphasis of policy making which has implications for each of the three areas of implementation on which CoRWM has been asked to provide advice to government. The first, and obvious change is the move from option selection to implementation. This requires a careful setting out of a staged process which establishes key decision points as implementation proceeds. The second change is the increasing emphasis on the local scale. There is a need to understand what this implies in terms of the nature and size of communities and how the idea of a willingness to participate might work in practice. In order to achieve a successful process of community participation it will be necessary to ensure public acceptance and political support. This leads to the third area of change, the integration of technical and social issues through partnerships supported by packages at the local level.

16. Each of these three areas (staged process, communities and volunteering, partnerships and packages) is dealt with separately in the following chapters (5,6,7). The three areas are closely interlinked and some of the the interactions are noted in this chapter.There are also some overarching issues which, we consider, need to be identified at the outset and which form part of CoRWM's advice on the government's consultation. These issues relate mainly to aspects of governance which are fundamental to the successful outcome of the whole implementation process.

Guiding Principles

17. CoRWM set out some Guiding Principles at the outset of its work and these underpinned its recommendations both in its main report and in *Moving Forward: CoRWM's Proposals for Implementation.* For ease of reference these Principles are restated here together with brief commentary on their implications for the implementation process.

1. To be open and transparent

18. Here the aim is to earn public trust by securing confidence in actions. Openness requires that those responsible operate in public and are accessible both in person and through documentation. Transparency requires an organisation to make as clear as possible how, and why, any recommendations are

formulated. This principle is reflected in CoRWM's Publication Scheme and Transparency Policy.

19. Openness and transparency are essential components of any implementation process that may be adopted. All those taking part must have access to all information and discussion so far as security restrictions allow, or trust in the process and institutions will be lost, and the process will almost certainly fail.

2. To uphold the public interest by taking full account of public and stakeholder views in our decision-making

20. This Principle will be achieved through encouraging discussion and deliberation with the public, local political representatives and a wide range of stakeholders.

21. Successful and publicly acceptable implementation of CoRWM's recommendations cannot proceed without the full involvement of all interested parties. The participation and communication processes developed as part of CoRWM's successful PSE Programme offers good precedents for achieving this goal.

3. To achieve fairness with respect to procedures, communities and future generations

22. Fairness (equity) is fundamental to the inspiration of public confidence. It is necessary to ensure that anyone who wishes to express a view on matters associated with the process has the opportunity to do so. There should be no favouring particular groups, stakeholders, communities, or regions. But, it must also be recognised that some may have a greater interest in the process and its outcomes than others, for example, those living close to sites where waste is currently managed. It is important that non-nuclear communities are provided with the information necessary to ensure that, if they wish to do so, they are able to participate on equal terms with nuclear communities Fairness also involves recognising the rights of future generations.

23. Fairness would indicate that any community that wants to participate in the process of implementation should have an opportunity to do so, and any screening process to identify potential siting areas should strive to involve on an equitable basis as many interested stakeholders as possible and not favour or discriminate against particular areas or sites.

4. To aim for a safe and sustainable environment both now and in the future

24. This principle applies to present and future generations and embraces the natural, as well as the human, environment. In seeking to fulfil this principle, CoRWM recognises the need to apply the best available sound science together with social science and other specialist input and acknowledges that achieving a safe and sustainable environment requires an interdisciplinary approach. Proposals for the long-term management of radioactive wastes should seek to avoid placing undue burdens on the environment, both now and for future generations.

25. Whatever implementation process is developed it should clearly seek to take account of developing best practice in both technical and social sciences. It should also take account of the needs of present and future generations. The aim should be to achieve solutions that provide a level of environmental protection that complies with the requirements of sustainable development.

5. To ensure an efficient, cost-effective and conclusive process

26. During implementation it is important to ensure sufficient time to achieve acceptability for proposals. A staged decision making process provides a coherent framework for a conclusive process. Implementation must operate within resource and time constraints but should aim to have broad support and provide a lasting solution to the problem.

27. In addition CoRWM advises that two further Principles with specific relevance to governance and the needs of future generations should be considered. They are:

6. To uphold the principles and practice of representative democracy at appropriate levels of government throughout the implementation process

28. In order to achieve public acceptability and fairness it is necessary that decisions are endorsed through a democratic process that reflects and expresses the will of those affected by decisions. Representative government based on the principle of election provides a basis for establishing support for proposals, consent for their adoption and a right of recall that ensures a community's interests are safeguarded.

29. However, the management of radioactive wastes is a contentious issue and poses problems for representative democracy. One is the problem of ensuring that the issues are properly understood and fairly represented. To achieve public acceptability it is important that representatives are fully informed about the values, aspirations, anxieties and requirements of their electorate. This may be achieved through a variety of means

designed to inform representatives, including deliberative processes and testing of opinion through polls, referendums or other measures of opinion. Key decisions will require approval by the appropriate level of representative authority.

30. Another problem is the time-span of decision making which extends beyond normal electoral cycles. Decisions taken in the present may affect communities far into the future. It is, therefore, important that decisions are based on the ethical implications of intergenerational equity. Democratic decision making requires that, where possible, decisions should be left to those most affected by the consequences or, at least, irreversible decisions should be avoided. However, it must also be recognised that in the interests of safety and sustainability it may be necessary to take decisions now that are not capable of being reversed in future.

7. To enhance well-being in both the short and longer term

31. A key reason for the failure to find acceptable sites in the past is the negative image and stigma that has been associated with the management of radioactive wastes. It is axiomatic that a willingness to participate in a future process of siting is predicated on a host community deriving both material benefits and a positive image. Enhanced well-being is the key to an acceptable siting process. By well-being is meant those aspects of living which contribute to the community's sense of identity, development and positive self-image. Community well-being may be realised in a variety of ways through economic development, through greater control over its affairs and through an ability to define and realise its own vision for its future. Well-being is a broad concept and not narrowly defined in terms of financial incentives or community facilities designed as compensation for accommodating a national waste facility. The principle must be that any community hosting a long-term facility should enjoy a perceptible improvement in its quality of life becoming thereby a better place in which to live.

32. This principle should also apply to those communities beyond the host community which are affected by proposals. It needs also to be emphasised that enhanced well-being must be sustained through the generations.

33. There are, of course, other statutory and regulatory principles that must also be observed during implementation. However, the Guiding Principles set out above have been developed by CoRWM specifically for the MRWS process and relate to both substance and process of implementation. The list of Principles is not conclusive and there may be others, for example, a Principle of Partnership, that could be considered.

34. CoRWM recommends that these Guiding Principles should be affirmed in the forthcoming consultation and that government should invite comments as to their suitability and applicability during the implementation process. Comments on whether to endorse the two additional principles 6 and 7 should particularly be invited. Suggestions for additional principles should also be welcomed.

The Democratic Framework

35. Although CoRWM's consultations revealed considerable disaffection, in some cases amounting to a lack of confidence, with the representative democratic process, it was generally considered to be the only practical and legitimate basis for decision making. It is recognised that representative democracy, through the exercise of the vote, provides society's guarantee of legitimate decision making and institutional accountability. Moreover, the institutions of democratic government, both national and local, are long established, well resourced, capable and experienced at handling complex issues. Government has emphasised the leadership role that Councils perform. [19] They are able to speak for the wider community and the much larger number of people likely to be affected by proposals for a repository or waste stores, for example, by the impact on local industries such as tourism, agriculture and fishing or by the transport of waste.

36. CoRWM has recognised and affirmed the role of representative government in proposing a new Guiding Principle (see above). Indeed, it may be argued that the new approach to implementation especially if applied in other areas will help to strengthen local democracy. Nonetheless, it must also be accepted that simple endorsement of proposals put forward by implementing bodies is insufficient – public acceptability requires far more than that. From our considerations and consultations we have identified four aspects of the democratic process which require attention in developing an acceptable democratic framework for the management of radioactive wastes. These may be defined as: participation; subsidiarity; approval; and the right of withdrawal.

37. *Participative Democracy.* CoRWM's PSE work and consultation responses have demonstrated the importance of engaging and involving those likely to be most affected by decisions. Communities hosting a facility (and to a lesser degree those affected by it) need ways of expressing their views,

[19] reference needed

demonstrating acceptance (or dissent) and influencing its development. There are various channels for participation including through partnerships, through town and parish councils and through various deliberative processes. Deliberation provides some in-depth appreciation of community values and viewpoints as CoRWM's Report on Deliberative Democracy has shown. [20] At a wider level, views may be conveyed through a poll or referendum. The problems of assessing citizens' views are discussed in chapter 6. The point to stress is that participative processes should be an integral element in the democratic framework in order to ensure that representative decision making is fully informed. Participation and representation are seen as complementary, not alternative approaches. However, the balance between them in the sense of the relative importance to be attributed to each is a matter for debate.

38. **Government should consult on how, and how far the outputs of participative processes should be taken into account by representative decision makers.**

39. *Subsidiarity.* The relationship between participative and representative democracy leads in to questions of which decisions should be taken at what level of authority.

40. In its Report on Implementation CoRWM states that 'Decisions that affect the community should be taken at the lowest appropriate level'. Later the Report argues that key decisions should be ratified, 'by the appropriate elected representative authority'. These statements raise the question of subsidiarity, namely what is the lowest level of authority capable of taking effective and democratic decisions on specific aspects of radioactive waste management. Clearly, for some decisions such as screening out unsuitable areas or defining the scope of partnerships and packages, the national level is appropriate. For others, such as the decision to participate or to withdraw from the process, decisions should be made at the local level. This comprises two levels, the level of local government where local authorities represent broad urban and rural areas and the subsidiary level where smaller elected councils represent local communities. At the level of local government, Scotland, Wales and Northern Ireland have only one tier whereas much of England is covered by two tiers (county and district/borough) with the most urbanised areas comprising unitary authorities (though the arrangements are under review in several areas). Below the level of the local authorities there are elected parish, town and community councils.

[20] ***Deliberative Democracy and Decision Making for Radioactive Waste***, 2005, doc. 1346

41. The subsidiarity principle suggests there may be some decisions which should be taken at the lowest possible level. Therefore, town, parish or community councils might have a decision making role, for instance in deciding whether or not to respond to the invitation to participate in the first place. However, these lowest level councils have limited powers although these might conceivably be enhanced. At the very least such councils would need to be consulted and they should have a part to play in participative processes. Among the roles they could fulfil might be: rights of nomination to local siting partnerships; representing local views to the local authority; organising polls, referendums or other processes to express local views.

42. In order to encourage subsidiarity, the principle of delegation of powers might be considered. For instance, some authority to take decisions on behalf of local communities might be delegated to the parish/community councils or to appropriate elected district or county councilors or both. The partnerships, once established, might also be empowered to take decisions (on the distribution of benefits for instance). However, these powers would be within a democratic framework where ultimate authority rests with representative national and local government.

43. Government should consult on what is the appropriate level of decision making, on the role of parish and community councils and other bodies and on the delegation of functions and powers.

44. *Approval.* This relates to the question of what are the decisions that must be approved by the appropriate authority. In CoRWM's view this will be the local authority. These decisions will be those (we may call them 'key' decisions) affecting the long-term well-being of the community which require formal approval to achieve legitimacy. In its Report on Implementation CoRWM envisaged key decisions marking stages in the process whereby, 'there needs to be an agreement to proceed between the relevant parties ratified by the elected decision making body(ies) before proceeding to the next stage.' The staged process is described in chapter 5.

45. A related issue is whether approval should be seen as a formal endorsement, with or without debate. The German AkEnd process identified key stages where ratification of proposals put forward by a community would be automatic to ensure legitimation. [21] However, in Germany there is close correspondence in scale between the local community and the locally elected representative body. In the UK the situation is very different and a local authority might comprise and represent many

[21] reference needed

local communities whose interests may differ. Therefore, while it is presumed that lower level decisions will normally be endorsed by the local authority, it is not envisaged that this will be automatic; rather the decision should be informed by participative processes and seek to reflect, as far as possible, the expressed wish of the host community. At the same time the decision will also need to take into account the views of the community at large.

46. It may be that there is no common interest; rather a conflict between a community wishing to participate in siting and a wider surrounding community which is opposed to such a proposal. Local (and national) interests who recognise the putative benefits in hosting a facility may be opposed by those beyond the local community but within the wider elected body who fear they will be adversely affected by the proposal. In such cases, where interests diverge and neither consensus nor compromise proves possible the interests of the majority in the authority as a whole should not necessarily triumph over those of an individual community within the authority. There may need to be special arrangements to resolve the issue. This matter is further discussed below and in Chapter 6.

47. Government should consult on what constitutes effective democratic approval of a decision and on how conflicts between a community and the body that approves a decision should be resolved.

48. *Right to Withdraw.* The Right to Withdraw from the process was proposed as an integral component of a voluntary process and the principle was fully endorsed during CoRWM's most recent consultations. [22] It was recognised that there would come a point when the right would cease and this matter is discussed in Chapter 7. The Right to Withdraw raises two related issues. The first is that a community, though engaged in the process and willing to continue, learns that it is not chosen to go forward as the host community. In short, it does not withdraw but is withdrawn from the process. The question arises as to whether it should be compensated. The second issue is the situation that might occur if the implementing body, for whatever reason, decides not to proceed with implementation. Again, some form of compensation might be in order.

49. The consultation should invite comments on the principle and practice of the Right to Withdraw.

Community – Role and Relationships

[22] reference needed

50. The implementation process is predicated on the willingness of communities to participate. A critical issue, therefore, is what constitutes a community? The 'community studies' literature is vast and sociologists, human geographers and others have expended much effort in identifying and defining communities. Basically, it is possible to distinguish between 'communities of interest', that is communities whose members are drawn together by common concerns, activities or values and 'geographical (or spatial) communities' which include all those living within a defined shared territory. Communities of interest may be spatially extensive, comprising economic, political or socio-cultural interests. By contrast geographical communities are spatially bounded but may include within their territory a range of interests.

51. There are four aspects of community which are discussed below. They are: self-defining communities; host and affected communities; nuclear and non-nuclear communities; and host communities and local authorities. Some of the key issues relevant to governance are identified here with more detailed analysis being presented in chapters 5, 6 and 7.

52. *Self-defining communities.* As suggested earlier, in the UK context most local authorities cover areas much larger than those which are likely to constitute the host community. Conversely, a single parish or community council is likely to be too small either in area or population or both. The footprint of a repository may well extend across the boundaries of several parishes. In its Report on Implementation CoRWM recommended that 'there should be scope for communities to be self-defining in terms of an initial willingness to participate'. Self-defining communities may be revealed when a threat or opportunity is perceived. Thus, in the past, proposals for radioactive waste facilities have often aroused hitherto latent anxieties and mobilised communities of protest. It is CoRWM's expectation that its proposals may motivate communities to participate in the expectation of enhanced well-being. In terms of self-definition there needs to be some coincidence of interest and location. Potential host communities must be bounded and be able to express their interest in hosting the facility. Local administrative (local authority, parish, town or community) boundaries are well established and will prove suitable to demarcate the territory of a host community. It has also been put to CoRWM that travel to work areas are also clearly defined and might provide a basis for defining a host community (Copeland, Caithness).

53. Government should consult on what constitutes a community and whether the idea of self-defining communities is appropriate for the management of radioactive waste.

54. *Nuclear and Non-nuclear Communities.* The proposals for implementation are based on the premise that all communities have an equal opportunity to participate in the process. This is enshrined in Guiding Principle 3. However, that principle recognises that 'some may have a greater interest in the process and its outcomes than others, for example, people living close to sites where waste is currently managed'. In former times these so-called 'nuclear communities' may have been regarded as disadvantaged in the sense that they were already hosting radioactive waste with the negative image that implied. On the other hand, they have benefited from the jobs and economic development associated with nuclear investment. In terms of CoRWM's proposals, they may be at a considerable advantage in that they have knowledge and experience of hosting wastes and are able, if they wish, to seize the opportunity offered to enhance their well-being. It is certainly the case that, in other countries, communities which have volunteered to become hosts have usually been associated with the nuclear industry or have been in relatively remote and economically disadvantaged locations (Overseas Workshop). In order to enable non-nuclear communities to participate on a broadly equal basis with nuclear communities it will be necessary to provide detailed information and knowledge of what is involved and time to reach a considered decision. Effort will be needed to ensure that negative perceptions are dispelled or at least diminished and that the positive image arising from partnership and benefits is presented. A national process of framing and providing pre-involvement packages will be vital if fairness among communities is to be achieved (see Chapter 6).

55. The consultation should invite comments on what measures will be necessary to ensure a process that is fair for both nuclear and non-nuclear communities.

56. *Host and Affected Communities.* It is unlikely that a host community will correspond to a single parish, rather it is likely to comprise several neighbouring parish /community council areas. Beyond the areas defined as the host community will be a wider surrounding area which may be affected by the proposal. The question arises as to how the interests of affected areas will be recognised and articulated. Among the possibilities are through participation in the siting process, through benefits arising from the Community Package and through representation on the siting partnership. An obvious question is who should determine the number and interests of the representation. The local authority or an independent body are possibilities. These matters are discussed in more detail in Chapters 6 and 7.

57. The consultation should seek views on how affected communities, however defined, should be involved in the process.

58. *Host Communities and Local Authorities.* The potential conflict between a host community and the local authority within which it is situated has been referred to earlier and the need for special measures in the face of irreconcilable conflict has been recognised. There are several possible dimensions to the problem. The most likely is conflict between a willing host and an unwilling local authority reflecting the decline of support and the increase in opposition with distance from the proposed facility (the so-called 'doughnut' effect). One way of dealing with this is to provide mitigation for the affected areas to compensate them for the perceived and actual harm created by transport or other impacts. Indeed, it has been put to CoRWM that political acceptability may require the benefits from a facility to be widely dispersed in order to placate hostility from those parts of the local authority outside the host community. The danger here is that the benefits for the host may become so diluted that there is a diminishing willingness to participate (Copeland BC). It will be obvious that the more dispersed the benefits, the more disadvantaged will the host community perceive itself to be. This situation may be more likely to occur where the host community is a relatively small part of a much larger authority. The possible move towards large unitary authorities (some of which may be on the scale of county councils) is liable to exacerbate this problem.

59. Another possibility is that a potential host community may contain a core area that is reluctant surrounded by an area that is willing to participate. This could occur where the site for a repository or store is in a remote, rural area with a traditional population surrounded by a more populated area with a substantial nuclear workforce. Such a situation may well arise once detailed site investigation begins within an area which has declared a willingness to participate. Again, some form of compensation (in contrast to benefits) may be necessary though it must be recognised that the willingness to participate will not be universal. These issues are discussed in Chapter 6.

60. The consultation should invite comments on how potential conflicts between host communities and the wider surrounding communities may be mitigated or resolved.

The Institutional Framework

61. In its Report on Implementation CoRWM recommended that the staged decision making process should be overseen by, 'an independent body with overall responsibility for overseeing the research and development programme and the

siting strategy'. Part of its remit would be to ensure engagement with the public and stakeholders. These recommendations received overwhelming support during the PSE programme conducted by CoRWM and from those consulted in recent months. CoRWM's proposals were in line with those previously put forward by the House of Lords for an independent Commission and by the RWMAC for an Overseeing Body (refs.). All three proposals stress the need for a body with responsibility for overseeing policy and the ability to ensure national consultation. There was common agreement that the overseeing role must be clearly distinguished from the implementation role. In CoRWM's view a separate waste management body should be responsible for 'the construction and operation of any necessary facilities, and related research and development'. CoRWM's PSE gathered a range of views on the distinctive and detailed roles of the two bodies (Report Section 5.2).

62. In the event, CoRWM's recommendations on the institutional arrangements for managing radioactive waste did not fully prevail and, instead, an independent body with a more limited advisory and scrutiny role is being established. CoRWM has published its concerns on the matter (ref.). In view of the concerns expressed about the institutional arrangements, CoRWM considers it likely that the issue will be raised in any event by some stakeholders during the forthcoming consultation.

63. A key reason for reconsideration is the imbalance in power relations created by the new arrangements. On the one hand, the role of the independent body has been downgraded from that envisaged in CoRWM's recommendation. On the other hand, Government itself is taking the lead in the early stages and the role of the implementing body has been enhanced. With the absorption of Nirex the NDA now has the added responsibility for the long-term management of radioactive wastes together with its existing storage, decommissioning, clean up and production functions. The potential conflicts of interest this arouses has been commented on by several observers (UEA, Lancaster, Greenpeace etc.). In its role as implementer of long term radioactive waste management policy it is likely that the NDA will be responsible for R and D work and the organisation of public consultation as well as for the construction of facilities. Although the independent body will be able to scrutinise the plans of both Government and the NDA, major doubts have been expressed in CoRWM's recent consultation by members of the public and some stakeholders (CPs., Lancaster etc) on how effective the new body can be in influencing the implementation process. Although both the NDA and the independent body will be accountable to government, the NDA will have an executive role while the independent body's role is purely advisory.

64. This imbalance in powers also has implications for relationships with local communities and local government. Under the new institutional arrangements it will be a major challenge for the NDA's role to be effectively counterbalanced by a body whose role is merely advisory. In the view of some respondents to CoRWM's recent consultation the power of the NDA together with its potentially conflicting roles is likely to disadvantage any community and act as a deterrent to volunteerism (Greenpeace, Lancaster). While this may overstate the likely situation there can be little doubt that the lack of a genuine overseeing body weakens the position of potential volunteer communities.

65. Lack of trust in institutions was a major finding in CoRWM's recent PSE work. We have already noted suspicion concerning local authorities although their role as elected representative bodies is fully accepted. A major reason for CoRWM's recommendations for an overseeing body is the need to engender confidence in the process on the part of potential volunteer communities. The need for an effective overseeing role was put forcibly at one of CoRWM's Citizens' Panels,

66. However, it was considered necessary that the processes should be guided, integrated and overseen by an independent, nationally constituted body, which could also serve to provide information and assistance to the local community…It was suggested that this "body of expertise" should be similar to CoRWM. It was argued that it would be necessary to have such a body to "police" the situation, for instance to ensure that the process continues to move forward' (Report, 7.1)

67. Other respondents to CoRWM's consultation stressed that there was a need for institutions that are trusted (CoRWM's Overseas Workshop), an overseeing body 'with teeth' (UEA) and a body that would provide support to the community side of a partnership (Lancaster).

68. A number of roles were suggested for an independent overseeing body. Respondents felt it should have a key role in the national preparatory phase in identifying screening criteria, handling information needs, setting the ground rules for the invitation to participate and establishing the framework for partnerships. Once partnerships had been set up the body would provide support for communities and also oversee the evaluation of site selection.

69. In CoRWM's view, for the existing arrangement to be effective and to inspire confidence in the overall process, there should be a commitment by Government that the implementation framework should contain the provision that, before moving from one phase to the next, the programme includes a step whereby

the new Overseeing Body reports on the work of the current stage and the plans for the next, makes a recommendation on proceeding or not and Government makes a public response including any requirements it has placed on the NDA. During the stages when the process moves to the local level, CoRWM should have a role in monitoring the response to the Government's invitation, the establishment and working of partnerships, possibly attending the latter as an observer, and being available as an independent source of advice to the communities. Any occasion when the Guiding Principles are not being followed should be reported to Government with a recommendation for action.

70. CoRWM suggests that the status and role of the independent overseeing body be put out to consultation to enable comments to be made on the institutional arrangements for the long term management of radioactive wastes

Other Issues

71. This chapter has highlighted three components of fundamental importance to successful governance. First, the process must be based on Guiding Principles which set the standards on which the whole process must be based. Second, implementation must be set within a democratic and participative framework which ensures that the process is ultimately based on societal consent. Third, a successful process relies on institutional arrangement which inspire confidence among all participants.

72. These three components are relevant to each of the three areas on which CoRWM is offering advice and which comprise the following three chapters. They bring together the ethical, political and practical dimensions of policy. They are concerned with setting the framework within which the various actors in the implementation process – government, local authorities, implementers, communities, stakeholders and the general public – are able to interact to produce a successful outcome.

73. There are four other issues which may act as constraints on successful implementation and which should be considered in the consultation. They are: storage; new build; continuing engagement; and commitment by government.

74. *Storage.* CoRWM's recommendations on options were carefully qualified. They foresaw a long period of interim storage prior to deep disposal as the end point. There was emphasis on the need for a review of security aspects and research and development into storage as well as geological

disposal and a watching brief to be maintained on alternative methods of management. In order to sustain the favourable consensus for CoRWM's approach it is important that Government sets out and discusses at an early stage its proposals for carrying forward the security review and the R and D programme. There is the danger that enthusiasm in some quarters for the end point will result in the possibility of alternative methods for the long-term management including robust storage being downplayed or altogether neglected**.** *It needs to be made clear in the consultation that CoRWM has proposed a package of interrelated measures which should not be subject to 'cherry picking'***.** The proposals carried strong and widespread support which might fade if the importance of robust interim storage is not maintained during implementation.

75. In discussing the application of the voluntary approach to storage four cases are possible. These are: new stores at new sites; new stores at existing sites, involving receipt of wastes from other sites; new stores at existing sites without receipt of wastes from other sites; existing stores.

76. **CoRWM considers the government's consultation should invite comments on the scope of the security review and R and D programme on robust storage and on the extent to which the proposed implementation process should apply to different options for storage**.

77. *New Build.* CoRWM's proposals are vulnerable to misinterpretation on the issue of new build. The Committee was unambiguous in stating that its proposals for managing wastes relate only to legacy wastes. Even though the technical issues are largely common, CoRWM made clear that new build wastes raised different ethical and social dimensions. Yet, CoRWM's comments were used selectively in the Government's Consultation process on energy in 2006 to the extent that the subsequent judicial review found that statements on waste were 'seriously misleading'.

78. It is important that the consultation makes clear that wastes arising from any new build programme would require a separate process of assessment, including public and stakeholder engagement.

79. *Continuing Engagement.* Throughout CoRWM's work on options assessment and implementation an intensive and extensive programme of PSE has been sustained. Government has expressed its confidence that CoRWM's recommendations have inspired public confidence and that it has achieved public trust. For this reason **the consultation should confirm the**

requirement for continuing PSE throughout all stages of the implementation process.

80. *Commitment by Government.* It is widely recognised that past efforts to solve the problem of long-term management of radioactive waste foundered because of the negative impacts that were perceived. CoRWM's proposals offer an entirely different approach which emphasises the positive benefits to community well-being over the long term. They reflect the need for a radical change in attitudes and approach to the governance of radioactive waste which is now the experience in many other countries. Achieving a commitment to this approach will require considerable initial effort to encourage willing participation in the process. In particular there is a need for a pre-involvement period led by government which raises awareness and sets out the conditions and aspirations for the long programme ahead.

81. CoRWM considers the consultation should underline the importance of commitment by government to the early phase of a national process that emphasises and delivers a positive start to the programme and sets out the positive benefits to community well-being over the long-term.

Chapter 5
Staged decision making

Introduction

82. CoRWM has recommended that implementation should be a staged decision making process, which includes a set of decision points providing for a review of progress, with an opportunity for re-evaluation before proceeding to the next stage. [23]

83. This chapter offers advice to Government on a possible implementation programme up to the point at which the availability of a potential site is confirmed and detailed characterisation can begin. It address the following three issues on which Government has sought CoRWM's advice:
    - *the key stages and decision points for a voluntarism/partnership approach;*
    - *the decisions to be taken, and the nature of commitment and financial implications associated with each decision; and*
    - *potential timescales, balancing the needs of local communities with the need to progress the MRWS programme.*

84. The chapter outlines a possible programme based on an approach in which local communities decide whether or not they want to participate in the process and partnerships are established to determine the conditions that would make the repository acceptable to the local community. It focuses on the stages that affect the decision by local communities to participate or not and the work of partnerships and identifies some key decision points in the process. The issues that need to be addressed within each stage are discussed in the following two chapters.

85. The staged decision making process will not be a simple step by step process. Within each stage there are likely to be several different activities taking place on different timescales. Some of these will be dependent on activities taking place outside of the communities and partnership. This chapter does not attempt to outline a programme for these other activities, such as planning, because other consultees are providing advice on these aspects of the staged decision making process. It does, however, raise some questions that will need to be addressed because of the impact on the community/partnership process.

86. The programme outlined here is not the only one that could be implemented. As is discussed in the next two chapters, there is no single model for a host community or a partnership so it is

[23] document 700, Chapter 14, recommendation 3

impossible to be definitive about their modes of working. Nevertheless, the stages presented here indicate the broad direction for the process of site selection. Neither is it possible to be precise about the time that each stage will take because the process will largely be dictated by the needs of the community working through the partnerships. It is impossible to predict these in advance. Other uncertainties include the planning and regulatory regimes and the complexity of the engineering at the chosen site. It should also be recognised that there may not be a simple progression through the stages. There may be occasions when it is necessary to go back to an earlier stage.

87. It will be important to allow enough time for communities and partnerships to reach their decisions. Imposing a fixed timetable at the outset in an attempt to prevent procrastination will probably be counterproductive. Once a partnership is established, it will generate its own momentum and determining timescales may be easier. In the early stages, however, it will be important for the volunteer approach that communities find their own way, assisted by the provision of information, and are not hurried into a decision. CoRWM's approach to its PSE work in the early stages of its work on options, demonstrates the benefits or allowing people to draw their own conclusions. CoRWM was criticised in some quarters for not ruling out unacceptable options at the outset but believes that its approach was fundamental to its success in building and maintaining public confidence in the process. CoRWM has therefore recommended that the programme be determined in terms of outcomes and not fixed dates [24] and confirms that recommendation here.

88. However, on the basis of previous experience in the UK and overseas, CoRWM has developed some approximate times for the early stages [25] and Nirex has done the same for the later ones. [26] These are reproduced below to provide an indication of timescales.

The impact of devolution

89. CoRWM's report indicated that it should be possible, given a suitable site, to codispose of all the higher activity legacy waste in a single repository. However, this conclusion did not take account of devolution and the possibility that communities, especially existing nuclear communities where waste is already stored, might take a different approach to their 'own' waste. Furthermore, it is already the case that there are differences in planning law and procedure, especially between Scotland and England. The impact of these differences has not been considered in drafting this

[24] ***Moving forward - CoRWM's proposals for implementation***, July 2006, doc. 1703
[25] ***Bases of the indicative timelines***, 2006, doc. 1800
[26] Nirex information on timelines, TN507350, June 2006, doc. 1784

chapter but will need to be taken into account at an early stage of the process.

Planning and Regulatory Controls

90. The staged decision making process described in this chapter takes the process to the point at which the availability of a potential site has been confirmed. Many of the planning decisions, and all of the regulatory controls will be made after this event. Nevertheless, planning and regulatory processes will be carried out in parallel to the staged decision making process within communities and partnerships. It will be essential, for the smooth running of the programme that the processes are integrated as far as possible. It is too early, at this stage, to know whether the regulatory and planning processes employed in Scotland and England will diverge further in the future or, indeed, whether existing procedures may be superseded by new ones such as the use of a Planning Commission. For this reason, planning and regulatory aspects of the staged decision making process are not included in this chapter.

91. However, CoRWM considers that it will be important to address the following questions:

1. What planning regime will apply?

- what assumptions, if any, can be made about the likely planning regimes in place at the time when permission is first required?
- is the development of repository likely to be included in a broader category of major infrastructure development or is it sufficiently distinctive – not least because of the partnership approach – to be regarded as *sui generis*[27]?
- how will the identification of a suitable site for a repository relate to the development plan process?

92. These questions are of relevance to the staged decision making process because the need for planning permission will influence the work undertaken within the partnership and its relationship with the local planning authority.

2. When, if at all, will a Strategic Environmental Assessment (SEA) be carried out?

- will there be an SEA of the policy of opting for a geological repository?
- will an SEA be required once the candidate sites have been selected?
- if so, will the SEA examine the alternative of interim storage?
- will an SEA be required if there is only one candidate site?

[27] *Sui generis* means 'of its own kind'.

- will any SEA be conducted on a UK or country basis?

93. These questions are of relevance to the staged decision making process because the need for an SEA and the opportunities it provides may assist partnerships in their understanding of the implications of a facility for their area.

3. What regulatory regime will apply?

- will RSA [in full] 93 apply or will there be changes to the authorisation process?
- will the NDA, in its Nirex context, continue to provide advice to the regulators through a section 37 agreement [can we explain what this is?]?

94. These questions are of relevance to the staged decision making process because of the role of the regulators as possible partners in the partnership and as ultimate decision-makers in terms of authorisations. Given the long term nature of site selection and repository development, there will be a need to provide regulatory advice before the point of authorisation.

The Stages in Implementing a Repository

Stage 1 The pre-invitation period

95. Government has endorsed CoRWM's recommendation that site selection should be based on the willingness of communities to participate in the process and have made it clear that they do not wish to impose a repository on an unwilling community. However, before communities consider the process, they will need to be aware of what the process and the siting of a facility within their community entails and associated potential benefits and detriments. While some nuclear communities are familiar with the MRWS programme, the vast majority of the country is not in this position and there will be a need for a period of awareness-raising and providing information before the invitations to participate are issued. [28] Even in the nuclear communities where nuclear power is a major activity, there is a need to increase awareness within the non-nuclear sectors of the community. [29]

96. This stage of the process will be concerned with raising public awareness of the MRWS process and its relevance to them and preparing the framework for the implementation process in order to inform the invitation process. There will be two stages of public engagement revolving around the consultation and the decision

[28] Norfolk meeting report, doc. 2170

[29] ***Developing the implementation framework: Initial invitations and local decision making about participation***, Nuclear Legacy Advisory Forum (NuLEAF), February 2007; and ***Implementing radioactive waste management – Siting and Planning in Partnership, an assessment for NuLEAF***, Hetherington Nuclear Consulting, April 2007

arising in response to it. These are briefly outlined below, followed by a description of the preparatory activities that will need to be undertaken prior to the issue of the invitation.

Stage 1.1 The Government's Consultation

97. The publication of the Government's consultation document provides an opportunity to inform or remind local authorities and parish/community councils of the MRWS process and emphasise the fact that the long term management of radioactive waste is something that everyone should be concerned with – to the extent that they will, in due course, be asked to consider the possibility of hosting a facility in their area.

98. CoRWM recommends that notice of the consultation is promulgated as widely as possible and not restricted to the 'usual suspects' , i.e. those already identified as stakeholders in the radioactive waste debate.

Stage 1.2 Raising awareness of the implementation process

99. The input from the consultation exercise will enable Government to develop its plans for taking implementation forward. It is presumed that Government will issue its response to the consultation in the form of a white paper or some other statement. As with the consultation document, the response should be promulgated as widely as possible and an opportunity given for people to seek answers to questions. Information should be sent out so that local authorities are aware that an invitation will be coming. Working through local government associations and associations of local government environment officers; ensuring that community and parish clerks are made aware of what is happening; and working with regional government offices where appropriate would also raise awareness. Before any communities agree to become involved in the process, they will want to know exactly what they are becoming involved in. It will not be sufficient just to repeat the statement that an expression of willingness to participate will not in itself lead to any commitment to host a facility. There are bound to be some people who will be suspicious of the whole process. If a clear framework for decision making is set out at the outset, this should help to allay some of these suspicions. The framework set out in the response should state the key features of the Government's programme, including a reiteration of the principle of seeking a willing community. It should also contain details of how the invitation process is to be conducted and set out 'rules of engagement' where these are considered necessary.

Preparatory Work for Stage 1
(a) Developing a framework for site selection

100. The responses to CoRWM's PSE process show that the clarity and completeness of the initial framework are essential ingredients to establishing confidence in the on-going process. Thus, the framework should address all the issues associated with:
    - the over-riding principles and governance of the process – see Chapter 4,
    - the staged decision-making process including the issues addressed in this chapter and those associated with the planning process and regulatory approval,
    - the process for communities expressing a willingness to participate – See Chapter 6,
    - the process for working in local partnerships – see Chapter 7,
    - the process for site selection should more than one community express a willingness to host a repository.

101. it is suggested that information on the following items should be included. This list is not intended to be exclusive but simply to provide an example of the type of information that might be included:
    - how the Government will ensure that the whole of the country is made aware of the invitation and how communities will be able to inform themselves so that they can make an informed decision on whether to accept the invitation
    - a clear statement of what the invitation is for – stating that there will be an unconditional right to withdraw and specifying the point at which that right will come to an end
    - details of any assistance, financial or otherwise, that might be provided for communities to assist them in deciding how to respond to the invitation
    - what the sub-surface criteria are and how a community can find out how their locality scores against them
    - details of the Involvement Package – how extensive it might be, what it can be used for including whether it will provide support for independent research, a salaried secretariat, etc.
    - the Community Package – a broad indication of what it might contain and how and when it is to be decided.
    - details of the role of the partnership
    - what will happen if no communities come forward or if no partnerships are successful
    - how the selection between sites is to be made should this prove necessary
    - how decisions outside the partnership will be made – ie regulatory decisions, planning decisions, contractual arrangements for site development etc. This might include the publication of a Radioactive Waste Facility Guide for Local Authorities and/or a Planning Policy Statement.

Preparatory Work for Stage 1
(b) The site selection process

102. Although the initial baseline plan that is being prepared by the NDA assumes one repository for the UK,[30] there may be a decision that some or all of Scottish wastes will be managed separately from waste in England and Wales, which would require two separate processes. **Government should be clear how this issue will be decided.**

103. Regardless of devolution issue, it is possible that the approach adopted will result in more than one potential host community coming forward. Nirex [31] has indicated that it would be impracticable to carry out borehole investigations simultaneously at more than two sites. Thus, if more than two communities confirm a willingness to proceed to this phase, it will be necessary to select only two for the next stage. Similarly, if borehole investigations are carried out at two sites, it will be necessary subsequently to select which site, if any, should be taken forward to the next stage of seeking planning permission for an underground laboratory and repository.

104. As part of its work on options for long term radioactive waste management, CoRWM drew up a set of criteria as a basis for comparing options. While these criteria are not necessarily readily transferable to a comparison between sites, the process by which CoRWM drew them up, which included extensive public and stakeholder engagement, did help to inspire public confidence in the outcome. For communities to have confidence in the ongoing process, it will be necessary to be as clear as possible at the outset on how such a selection between communities will be made. One option would be to consult on the selection criteria as part of the consultation exercise so that selection criteria can be agreed before the invitations are issued.

105. In addition to generic criteria, others might include :
- the degree of local support for the project (an important factor in Belgium)
- locality with respect to the current location of the waste
- locality in relation to human populations and distance from features such as national parks, other industrial developments etc,
- cost and ease of construction,
- likely implications for local socio-economics.

[30] reference needed from Mark i.e. WIG note or other reference cleared with NDA
[31] Nirex information on timelines, 2006, doc. 1779 [Mark: do we mean 1784?]

106. It is recommended that Government should invite views on when the basis for choosing sites should be made and on what criteria.

107. It will also be necessary for communities to have confidence in the body that makes the selection. In Belgium, the Government made the selection of the site for the national repository for short-lived waste on the basis of advice from the implementer. In Sweden, the implementer will make the choice of site for the repository for spent nuclear fuel. However, the Belgian experience shows that there are difficulties in the implementer being both a member of the partnership and having a decisive influence in site selection. An alternative is for advice on the selection to be made by the Government's independent advisory body.

108. It is recommended that Government should invite views on which body should make the choice of site(s) that should go forward to the next stage.

Preparatory Work for Stage 1
(c) ***Initial Screening on subsurface criteria***

109. CoRWM has recommended that invitations should not be sent to parts of the country that, with present knowledge, do not have suitable geologies. [32] The consultation document should be clear in how the subsurface criteria have been derived and peer reviewed and by whom. If it does not clearly identify areas of the country that have been excluded, it should also say how communities can find out how their area performs against the these subsurface criteria. **Views on the subsurface criteria should be invited** and assessed before the areas that do not have suitable geologies are identified**.**

Preparatory Work for Stage 1
(d) Technical preparations

110. The response to CoRWM's PSE process [33] and previous experience in both the UK and overseas [34] has shown that developing an understanding of the design features that are expected to limit the amount of radioactivity that would migrate from the repository back to the biosphere and having the opportunity to influence key aspects of the design that could mitigate local concerns, such as monitoring and retrievability, are key aspects of achieving acceptance by a community. It is expected that the NDA will prepare information on the concept

[32] document 1703, paragraph 64
[33] reference from author needed
[34] reference from author needed

design for a repository, explaining how it will be developed and who will be involved. Clearly, the development of the repository design will be an ongoing activity throughout the staged decision making process but sufficient information must be given at the outset to enable communities to appreciate what a repository might look like and to formulate questions.

111. Another important ingredient of establishing local acceptance is confidence that the main uncertainties associated with the long-term performance of the repository have been identified and that they will be addressed and resolved by a comprehensive research and development (R&D) programme Communities and partnerships will have their own priorities for research and development to address their concerns and are unlikely to be convinced by research results presented to them as a fait accompli. Nevertheless, it is expected that the NDA will prepare itself by reviewing past work in both the UK and abroad to identify the main uncertainties and develop an R&D programme that will address them. Chapter 18 of CoRWM's report identifies key uncertainties which it believes should form the basis of that R and D programme.

112. **Key Decisions and Timetable**The key decisions to be made at the pre-invitation stage are the extent of the awareness raising process and the amount of information that will be made available at this stage. The latter may be informed by the responses to the consultation. It will be necessary to provide sufficient information to prepare people for the invitation without being too prescriptive.

113. The timescale will be dictated by the time taken for the consultation and the Government's response to it but is likely to be in the order of about 1 year.

114. The pre-invitation period will be culminate in the decision to issue the invitation.

Stage 2 Issuing and responding to the Invitation

Stage 2.1 Issuing the invitation

115. Issuing the invitation is the event that triggers the next stage in the decision making process. It is essential that the invitation reaches its intended audience and that they are given sufficient information to enable them to respond. If the invitation is sent only to local authorities (i.e. district, county and unitary authorities), there is a danger that Chief Executives or Council Leaders will not act on the invitation. Only those local authorities that have already given the matter favourable consideration are likely to come forward. Others may have a 'non-nuclear' stance and reject the invitation straight away without giving it consideration or may

simply not give it proper consideration because it does not seem relevant to their area.

116. It is in the interests of finding a willing community that government identifies a way in which this response can be discouraged. The following are suggestions for doing this:
- The awareness raising undertaken in Stage 1 will ensure that the invitation is not unexpected 'cold calling'; this could be done, for example, by
- issuing the invitation to all elected local councils, i.e. including parish, community and town councils as well as district, county, regional councils and unitary authorities
- requiring an acknowledgement of receipt so that non respondees can be followed up if necessary
- requiring local authorities to make a justified response to the invitation so that they will have to, at least, debate it and encourage them to seek the initials views of the electorate.

117. The invitation will have to include a deadline for responses or else there is every likelihood of procrastination. This should be set sufficiently far in the future to ensure that local authorities have an opportunity to make a considered response.

118. The invitation will also have to state who will be eligible to accept an invitation and on what basis. The bottom line here will be that the government will wish to be assured that the respondees are competent to form a partnership which will be representative of a defined community.

119. The next chapter discusses these issues in greater detail.

Stage 2.2 Responding to the Invitation

120. Very few communities will be in a position to know how to respond to the invitation without seeking further information. It is certain that some communities will have a range of questions that they will need to have answered before reaching a decision to proceed. Obtaining the necessary information, disseminating this to the community, seeking answers to questions etc. will all take time and hence resources. The fact that these costs are likely to occur needs to be acknowledged at the outset. The next chapter suggests several ways in which government could assist.

121. While the subsurface criteria can be applied at a generic level to exclude parts of the country, they will not ensure that the rest of the country is suitable. Before deciding whether to proceed, the subsurface criteria should be applied to the area under consideration. The potential host communities will need to be advised on how this might be done.

122. Accepting the invitation amounts to an expression of the willingness to participate in the process to determine whether a suitable site can be found on terms acceptable to the host community.. While it needs to be clear to all involved that it is no more than that and is definitely not a commitment to host a facility or even an expression of conditional willingness to do so, it must be more than just a 'nothing to lose' acceptance. Government will need to know that those responding to the invitation represent a definable 'community'.

123. The community will need to demonstrate that it will be able to make a long-term commitment to the partnership and be able to play an instrumental role in establishing it. It will need to demonstrate:
- how the community is defined both sectorally and geographically
- if the acceptance does not come from a local authority, how the community relates to local government boundaries
- if the community is not a local authority how it intends to work with the local authority and, most importantly, how it intends to inform and be informed by the local democratic process
- how it intends to form a partnership and who it would expect to be included
- how it expects to engage with 'affected' communities and the wider local authority community where this is necessary.

124. The next chapter identifies the following key stages in communities responding to the invitation:
- The initial expression of a willingness to participate
- Verifying that the community is willing
- Approval by the appropriate elected body,
- Registering the willingness with Government.

125. Resolution of differences between a community that is smaller than the area represented by the local authority and the local authority (ratifying body) has been addressed in Chapter 4.

Key Decision and Timescales

126. The key decision to be made at the end of Stage 2 is the decision by the potential host community to register its interest in proceeding to the next stage. Two factors will determine the length of time necessary for a community to complete this stage, the extent of existing knowledge of the issues and the process of obtaining the necessary evidence to demonstrate that the community is willing to proceed.

127. Experience overseas indicates this and the following stage has taken about two years in nuclear communities that are familiar with the issues, but it is possible that, even with the initiative to

increase awareness in the process at the start, other communities may take longer and it is important not to be over prescriptive. However, procrastination must be avoided. A possibility is for each community that is still deliberating to provide an annual progress report and for Government and the advisory body to make a judgement on whether sufficient progress is being made to justify continuing the decision making process.

128. **Views should be invited on the process for ensuring that sufficient time is allowed for communities to make a considered decision without the danger of procrastination.**

Stage 3 Reaching a decision on whether to proceed with boreholes

Stage 3.1 Establishing the Partnerships

129. As discussed in Chapter 7, the way in which the partnerships are established and the production of the partnership agreements are critical in ensuring their success. The Involvement Package, the broad details of which will have been decided during Stage 1, will be of importance here. The steps in this parts of the process include:
- exploratory interviews and research
- draft proposition of a partnership agreement including the purpose, composition, organisation and method of working
- engagement with potential partners on the content of the agreement including the development of roles, positions etc.
- production and signing of the agreement
- inaugural meeting to establish the partnership.

Stage 3.2 Addressing Community Concerns

130. Both the community and the NDA will need to know that the area has the potential to host a community. In this stage, there should be an evaluation of the suitability of the areas represented by the communities that have agreed to proceed, probably carried out by the NDA working alongside the partnership. At the same time,the partnerships will need to work to establish if conditions can be agreed that would make a repository acceptable to the local community.

131. The fact that a locality satisfies the sub-surface criteria does not guarantee that it will provide a suitable geology for hosting a repository. Even if it does appear to be suitable, surface conditions might make it impossible to carry out the necessary investigations (seismic surveys), and/or there might be other non-geological factors that might preclude some parts of the locality from consideration. The extent to which this should be defined at national level in advance remains open **and views should be invited on this issue**.

132. One suggestion would be for Government to set out a number of possible criteria just as it does in planning policy statements (see Stage 1). This would guide decisions but would not preclude areas. This stage would, therefore, involve the NDA and partnership in
- a more detailed site survey based on desktop studies
- discussions within the partnership of potentially suitable sites and potentially unsuitable sites
- discussion of what the construction and operational phases of the repository would mean for this locality – transport routes, number of lorries, noise etc., jobs
- discussion of repository design and how the safety case would be determined including the identification of areas of concern and, where possible, setting up mechanisms to address these
- setting out the R and D programme in detail, bringing results of work undertaken hitherto to the table and planning for peer review, planning for joint fact finding programmes on outstanding uncertainty issues and establishing a robust programme for future work as identified..

133. The community may have other concerns and, if so, the partnership would need to satisfy itself that these can be addressed and, if this involves future undertakings by the NDA or Government, such as health or environmental monitoring, what these should be.

134. In addition, the partnership would need to establish whether its well being could be enhanced in the short- and longer-term if it were host to a repository and under what conditions. However, a detailed Community Package need not be developed at this stage; only enough for the partnership to be convinced, in engagement with the local community, that there is sufficient incentive to proceed.

Key Decisions and Timescales

135. Asserting that the community is willing to proceed to the stage of surface-based investigations using boreholes is a key decision point and should only be made after verifying, through a demonstrably transparent method, that the views of the host community and the wider populace support the decision to proceed. If the level of support were less than had been anticipated, this might lead to a return to an earlier stage of the partnership process following a detailed investigation into the reasons for dissatisfaction or, in extreme circumstances might lead to a decision to withdraw from the process.

136. The decision to proceed must be supported by a number of other decisions including:

- a decision by the NDA, in consultation with the regulator and the partnership, that the area is suitable
- agreement by the partnership and the NDA, that the concerns of the community can be addressed
- the partnership and the NDA agree suitable areas within the community for surface-based investigations using boreholes,
- the partnership agrees that the well being of the community can be enhanced and recommends that the community proceed to the next stage.
- The appropriately elected body approves the recommendation of the partnership

137. In Belgium, which is the country that has implemented the closest equivalent to this stage, but only for short lived waste, the equivalent of the above decisions took four years. The inventory for the UK repository is long-lived and much more complex and includes heat generating waste. Thus two disposal concepts will be required if co-disposal is pursued. It may include nuclear materials such as spent nuclear fuel, plutonium and uranium. Thus, the timescale for resolving local concerns to the satisfaction of the community is likely to take longer than in the Belgian example.

Stage 3.3 Selecting host communities for Borehole Investigations

138. The discussion of Stage 1 indicated that, if more than two communities reached this stage of the process, it would only be practicable to carry out borehole investigations in two and a choice would have to be made.

139. The process of selection, should it prove necessary, must be transparent and as objective as possible using pre-determined criteria and a pre-determined process. If selection criteria have not been drawn up at this earlier stage, they will need to be drawn up now.

Key Decisions and Timescales

140. The key decisions will be the selection of the host communities for further exploration and the location of the borehole sites within these communities.

141. The time needed for this stage, should it prove necessary, will be determined by the process that is adopted for carrying it out. Communities that have reached this stage will have made a considerable commitment in terms of time and energy so the selection process must be transparent and robust. Even if the process and criteria have been decided in Stage 2, it may take a year or more to complete this stage in an acceptable manner.

Stage 4 Planning Application for Borehole Investigations

142. Drilling of boreholes will require planning permission. Planning policy guidance will be needed to enable the Local Planning Authority (LPA) to take appropriate account of the willingness expressed by the partnership; this should be a material consideration.

143. With the process suggested above, if the body that endorsing the recommendation to proceed is also the LPA, the latter is not likely to reject the planning application. If the two bodies are different and the LPA rejects the planning application, the reasons for this will need to be carefully assessed to determine the extent to which the refusal amounts to a rejection of the proposals for a repository. If it becomes clear that the LPA is not of the same view as the ratifying body, there will be the same need for the resolution of disagreements as discussed in Chapter 4.

Key Decision and Timescale

144. The granting of planning permission to undertake borehole investigations is a key stage in the implementation process. Earlier work by Nirex estimated three years for submitting a planning application, conducting an EIA and obtaining approval, but there is scope for this to be reduced as a result of close communication between the work of the partnership and the LPA.

Stage 5 From Boreholes to an underground laboratory

Stage 5.1 Determining the suitability of the site and reaching a decision within each community

145. The scientific data that will be a major input into deciding the site of the Underground Rock Laboratory (URL) and the potential site of the repository will be obtained in this stage.

146. The interests of the local community will include being satisfied that the analysis of the cores demonstrates that at least one of the areas within the community is suitable in terms of geology and other environmental factors. If it is feasible to develop more than one site within the community area, the partnership should have a prominent role in deciding which should be chosen.

147. The partnerships may wish to specify conditions for being selected for the repository. Issues for inclusion might include:
- agreement on how to address issues arising from the URL research including the need for the partnership to agree to changes in specification

- agreement to use joint fact finding to assess implications of URL results
- commitment on behalf of the partnership and the NDA to accept the outcomes of any arbitration/dispute resolution process
- agreement relating to the terms of Community Package should the development not proceed for whatever reason

148. If there are two communities at this stage, there are two options with respect to the level that the scope of the socio-economic benefits is developed before a specific site is selected. In the first, the view is taken that the commitment of resources by the partnership to developing the scope of an acceptable socio-economic package is so great that it should be left until the community that is the proposed host community is selected. This is the approach that is adopted by Oskarshamn and Osthammer in Sweden. The second is that further development and agreement of the socio-economic package is necessary for the partnership to recommend that the community should continue to be considered as a potential host. This is the approach that was adopted in Belgium, where scopes of socio-economic packages were developed by two communities.

149. The advantage of the former approach is that it avoids unnecessary work on the part of the host community that is ultimately unsuccessful. The advantage of the second approach is that both communities are ready to proceed so that, if the URL investigations lead to a rejection of the first site, it should be possible to proceed with the second without having to develop the package. However, there is a danger that this approach will lead to a direct competition between communities with the risk of a 'race to the bottom'.

150. Views should be sought as to whether this flexibility should be retained or whether the process should be more clearly defined in the initial framework.

Key Decisions and Timescales

151. If the partnership recommends that the implementation process should proceed to the next stage the key decision will be the formal approval by the host community that it is willing to proceed to the next stage, i.e. the planning application for the URL or URL/repository.

152. Constructing the URL will be a major commitment of public money and thus the completion of the implementation agreement is an obvious place for the right to withdraw to end provided that all the conditions in the agreement are fulfilled. **Views should be**

sought on when the unconditional right to withdraw should end.

153. The timescale for this stage will be determined by the speed with which the borehole investigations can be completed and the issues that are raised during the analysis of the borehole samples. As it is likely that the unconditional right to withdraw will be lost at this stage, communities will wish to be certain that any future concerns, such as those arising from the URL investigations, will be dealt with in a manner that is satisfactory to them.

Stage 5.2 Selecting the host community for the URL

154. If two potential host communities have indicated a willingness to proceed to the next stage, it will be necessary to select one to take forward. In essence, the process involved will be a repeat of Stage 3

Stage 5.3 Negotiating a Community Package

155. Once the proposed site is selected, negotiations can be completed for the totality of the Community Package including any commitments associated with ongoing engagement, the conditions for proceeding to a repository and commitments to provide data, carry out monitoring and the socio-economic package. The formal agreement of the outcome of these negotiations constitutes the basis for the acceptability of constructing the repository.

Key Decision and Timescale

156. The agreement of the Community Package and the conditions for the ongoing work will be key decisions to be made before proceeding to the next stage. There is no overseas experience on which to base a judgement on the time to agree a community package of this nature but there are non-nuclear precedents such as the agreement between Shetland Council and the Oil Industry, which is outlined in Chapter 7.

Stage 6 Planning Application for Development

157. There are two possible scenarios. The first is that there would be an application for planning permission for a URL and, assuming that the results of the underground investigations did not raise any insurmountable problems, a separate application for permission to construct the repository would be made. Alternatively, if the intention is for the URL to become part of the repository, there could be a single application covering both phases of the development. A further complication is that it is

likely that procedures for obtaining planning permission may be different by the time the application is made.

158. Issues that will need to be considered include:
- the matters that might be considered in reaching a decision on the planning application. There will need to be clarity on the extent to which the planning process should be concerned with the radiological safety of the repository, if the application is treated at central government level as a major infrastructure project, the extent to which local issues, relating to surface facilities, should be referred to the local planning authority
- if there is an application for planning permission to construct a URL and then a repository, the extent to which changes in the proposed development might be allowed before a new planning application is needed.

Key Decisions and Timescale

159. Obtaining planning permission is a significant point in the staged decision making process and the decision on whether to grant planning permission is a key decision, albeit one that is beyond the remit of the partnership process.

160. Previous estimates by Nirex have allowed 3 years for submitting the planning application, including the necessary environmental assessments, and obtaining planning permission.

The Remaining Stages

161. Based on earlier advice from Nirex [35], these are:

Stage 16 Underground Investigations and Writing the Safety Case (~ 6 years)

Stage 17 Regulatory Approval to Construct Repository *[timescale]*

Stage 18 Construction (~ 7 years)

Stage 19 Emplacement (~ 65 years for all CoRWM's inventory in one repository)

Stage 20 Closure (~10 years)

Key Decisions Involving the Partnership/Local Community

162. Based on CoRWM's PSE process acceptability of the overall project will depend on recognising that the local community must be involved in scrutinising the URL results, having full access to

[35] Nirex information on timelines, TN507350, June 2006, doc. 1784

the safety case and its regulatory approval, being involved in decisions on when to backfill the individual compartments, having access to the results of monitoring and ultimately being involved in the decision to close the repository.

Chapter 6
Communities and willingness to participate

Introduction

163. Some of the key issues concerning the nature of communities and the democratic basis of participation have been discussed in Chapter 4. Here, we focus on how the general principles and concepts already identified may be applied in the process of implementation itself. In particular, this chapter is concerned with the issues of communities – their identification and representation - and the means by which they can express their willingness to participate in a process which might ultimately result in their hosting radioactive waste stores or a repository.

164. It should be noted that our recommendations on siting are intended to apply to long term interim stores in new locations as well as to repositories although there will be some differences in application arising from the nature of the facility itself. In its Report on Implementation [Ref], CoRWM identified the extent to which its recommendations on implementation should apply to new and existing stores as a subject for further work. At CoRWM's National Stakeholder Forum in January, 2006 [Ref], new stores at new sites were identified as an obvious candidate but no further work has been done since then. This issue remains an area for further discussion.

165. This chapter is in three parts. The first concerns the process up to the issuing of the invitation to participate (we may call this the pre-invitation period and it covers the first six stages outlined in chapter 5). The second and third parts are concerned with stage 7, responding to the invitation; part 2 considers the basis on which communities might respond while part 3 discusses the means whereby a willingness to participate is confirmed and endorsed.

1. The Pre-invitation Period

166. The pre-invitation period involves a process of national screening, framing and establishing a framework for the subsequent voluntary process. Chapter 4 indicates that the success of the whole process depends on a positive start which provides clear information about what is proposed and how the process will be conducted. While this early national process must be led by government, in CoRWM's view the Independent Overseeing Body should should provide advice and indicate its approval. This should provide the process with the platform of public confidence and trust on which to proceed.

1.1 Initial Screening

167. In its Report on Implementation CoRWM stated that, 'Broad criteria should be applied to screen out those parts of the country where radioactive waste facilities would be unacceptable on scientific or other grounds'. This initial screening should take place before communities are invited to volunteer to prevent any impression that siting decisions had been made in advance and also to avoid encouraging abortive efforts on the part of communities in areas of unfavourable geology. The contrary view is that equity requires that any community wishing to participate should be allowed to do so even though subsequently it might be ruled out on technical grounds. It is not part of CoRWM's brief to comment on the criteria that should be used for initial screening save to say that the identification of criteria should be subject to an open and transparent process.

168. However, CoRWM has consulted on the question of whether initial screening should occur before or after the invitation to participate. The response was overwhelmingly in favour of prior screening and, accordingly, **CoRWM recommends that the government should consult on the basis that initial screening should be undertaken before the invitation to participate is issued and that within the remaining territory that has not been screened out all communities that wish to express a willingness to participate should have an opportunity to do so.**

169. It should be noted that initial siting criteria are necessary to identify broad areas where sites might be found. It should be noted that the screening process only excludes sites – it does not lead to any presumption that all non-excluded sites might be suitable. It will be necessary to develop another set of criteria (which may be called 'siting criteria') that will be used to choose suitable and acceptable sites for radioactive waste storage or disposal within potential host communities.

1.2 Information and Other Requirements

170. The need for comprehensive information about what the programme of implementation involves has been stressed to CoRWM by many respondents (refer). While some nuclear communities will be familiar with the MRWS programme, the vast majority of communities are not in this position. Various means of awareness raising should be used including media, involvement of local authority associations, national stakeholder groups and there should be direct communication with all local authorities and local communities.

171. **Therefore, CoRWM recommends the consultation should emphasise that there should be a period in which awareness is increased and information is provided to help communities**

decide if they wish to express an initial interest before invitations to express a willingness to participate in the programme are issued.

172. The information required will include the following:

- A brief explanation of government policy based on geological disposal as an expected end-point and a period of robust long-term interim storage

- Assurance that it is government policy not to impose a facility on an unwilling community. Rather, government will ensure that a package of benefits will be negotiated that will enhance the well-being of any host community in both the short and longer term.

- A description of the partnership arrangements that will be developed and what will determine that a repository is acceptable to the community. The partnerships will enable potential host communities to address areas of concern, finance research to obtain information and, if necessary, commission independent advice.

- Confirmation that the costs of setting up and operating the partnerships will be met from national resources and funds will be available for engaging with the community to establish whether or not it is willing to participate in the process.

- A declaration that any community expressing a willingness to participate in the process will have the right to withdraw up to a pre-defined point if it considers that acceptance of a facility by the local community cannot be achieved.

- Assurance that safety and security will be overseen by existing or any new regulatory processes in the UK

- A peer reviewed analysis of the volumes and radioactivity of the wastes to be stored/disposed together with basic facts about radioactivity, the expected size of the store/repository and the length of time over which the facility will be built.

- An indication of who to contact for further information.

1.3 The Invitation to Participate

173. Once the national framing and awareness raising is completed the invitation to participate can be issued. **The invitation should be accompanied by the information set out above together with a detailed description of what is required in the response.**

174. A key question is who issues the invitation? There appear to be three possibilities. First, is that the invitation comes directly from government (either from the responsible ministers or departments). Second the invitation is issued by the NDA as the Government's implementing agency, while a third option is that the invitation is sent out, on behalf of the government, through the independent overseeing body. CoRWM prefers either the first or third of these options but the government may wish to consult on the choices. Therefore, it is recommended that **Government consults on which body should issue the invitation to express a willingness to participate in the siting process.**

175. A second question is to whom should the invitation be directed? In line with the democratic principles outlined in Chapter 4, CoRWM considers there are three alternatives. One is to issue the invitation to local authorities (unitary, district/borough, county councils) giving them responsibility to ensure the invitation is widely publicised and promulgated within their territory. Local authorities do have a leading role in representing and supporting community interests. The question is whether, given very different standpoints on nuclear matters, they can be relied upon collectively to ensure that the opportunity to express a willingness to participate is offered on an equal basis across the UK. It may be advisable to require local authorities to respond to Government within a given time, explaining what they have done to publicise the invitation within their communities. Another possibility is to send the invitation to every parish, town and community council. An issue here is that these councils are too small in terms of resources to ensure an effective response. In some areas (and, from our consultations, Cumbria is an example) there may be groupings of parishes that could provide a joint response to an initiative of this kind. At present there is no consistent pattern of groupings below local authority but above parish/community level across the country. A third option is to send the invitation to both local authorities and to community/parish councils. There may also be other bodies to whom invitations might be directed.

176. Government should set out the arguments and consult on whether the invitation to express a willingness to participate in the siting process should be sent to local authorities in the first instance and/or to parish/community councils; and whether or not it should be sent to other bodies such as existing local partnerships.

2. Responding to the Invitation

2.1 Defining the Community

177. Who responds? Government asked CoRWM 'how communities might be identified and represented for the purposes of volunteering, and how community identification would relate to the

role of local authorities as democratically elected bodies and their statutory roles and responsibilities.' A prior question is how will the community itself be defined? In Chapter 4 it was suggested that a self-defining community must be bounded and able to express an interest in hosting a facility. In terms of appropriate size, the closest example of a local community is the Town, Parish or Community Council. These organisations are mainly consultative in practice. But they are elected bodies and are formally constituted and any decisions taken by them are consistent with the concept of subsidiarity, even if they have limited powers.

178. The principle of subsidiarity indicates that decisions should be taken at the lowest appropriate level. However, a single parish or community council is likely to be too small to constitute a host community and in practice, the smallest unit might comprise a number of contiguous parishes within which a facility is located. There may be several ways of defining such communities. For example, in Cumbria the County Council is considering establishing Community Boards which comprise a number of neighbouring parishes and small towns. In many parts of the UK, local partnerships define areas with common interests and purpose (for example Coastal Partnerships, ref.). For example, the Caithness Partnership is seen as influential and representative in its local area. It has also been suggested that journey to work areas might provide a basis for defining communities of appropriate size and common interest for the purpose of hosting a radioactive waste facility (Copeland BC).

179. CoRWM recommends that the government consult on what size and definition of community represents an appropriate basis for responding to the invitation to express a willingness to participate.

2.2 Who Responds?

180. Having defined the community, there remains the question of who should respond on its behalf. Clearly, in tune with the democratic principle, the response must come from those elected to represent a community and committed to testing their view of 'willingness' through a process which will demonstrate the level of support or antipathy towards the notion of volunteering which exists within the community.

181. The essential elements in answering this question, then, are the need to uphold the principle of local democracy and the need to ensure that the community is represented appropriately. Several possibilities exist. One is that the expression of a willingness to participate is a joint response of the parish/community councils comprising the self-defined community. In favour of this is the

commitment by Government (e.g., in the 2000 Rural White Paper) to strengthening the future role of parish/community councils. A second option, suggested by Copeland BC, might be that the councillors representing the community on the unitary local authority (or, in the case of two-tier authorities, the local councillors for both authorities) make the response. A third possibility is that the local authority itself responds on behalf of the local volunteering community.

182. In each case it will be necessary to deal with the problem noted in chapter 4, namely the lack of congruence between the size of a potential host community and that of the local authority which approves key decisions. Unitary authorities, county and district councils are relatively large geographical areas with a clearly defined democratic and representative political structure. Parishes, community councils or even local partnerships or other groupings represent only a small proportion of these geographical areas and yet can be identified as the units which will represent the most affected citizens.

183. Given that a local authority represents many different communities it cannot necessarily speak for any one of them. Many citizens at both panels held by CoRWM were adamant that elected councillors were not representative of their views and generally could not be trusted to reflect the views of the constituents. However, UK local government provides a well tested system of political representation and decision making and, ideally, should have a central role in siting decisions. Councils can speak for the wider community and the much larger number of people likely to be affected more indirectly by a long-term, interim storage or repository proposal, for example, by the impact of waste transport. The local authority would be competent both to express a willingness to participate on behalf of a community in its area and to approve a decision to participate.

184. Views on these options vary. Therefore, CoRWM suggests that **in its consultation government should seek views on the procedure for responding to an invitation to express a willingness to participate and also on which are the appropriate bodies to make the response.**

2.3 Resolving Conflicts

185. Whoever makes the response there is still a potential problem of conflict. This can be posed in the form of a question, Can a minority volunteer the majority or, conversely, can a minority deny the wishes of a majority? Clearly, some ground rules are necessary by which the legitimacy of a volunteer approach can be judged acceptable by the implementing body or Government.

186. A conflict can occur in two ways. On the one hand, a local authority might express a willingness to participate when among the group of people most affected there is no desire to do so. On the other hand, a community may wish to volunteer but the local authority is not willing to ratify that decision.

187. There will be a number of ways whereby such conflict can be mediated and resolved. Local government is well used to dealing with problems where local interests appear to be in conflict with the wider interests of the authority (school closures, road schemes, housing development schemes, waste management projects and so on). Sometimes these can be resolved through consultation and debate leading to mutually satisfactory agreements. In the case of a radioactive waste facility deliberative processes between local authority and community should be encouraged to achieve an acceptable consensus.

188. However, there is no single model for success and it may prove impossible to build consensus and agreement at local authority level. In that event, as we observed in Chapter 4, an unwilling majority should not necessarily triumph over a willing community. Conversely, it will not always be the case that the interests of the volunteer community should prevail; hence we do not advocate automatic ratification by the local authority of a community's expressed wish to participate. In the case of such an impasse, a means of dispute resolution will be needed, preferably binding on all concerned. This may be achieved through appeal to a higher authority to mediate and, if necessary, propose a solution. Or, endorsement could be required under certain clearly prescribed conditions. This is another area where the Independent Oversight Body might play a mediating role.

189. It is to be hoped that these issues of community identification, representation and ratification, while they appear from the perspective of 2007 to be problematic, will, in fact, be resolved with relative ease at the appropriate time as the issues relating to specific communities minded to volunteer are identified within their own specific social and democratic settings.

190. Government should consult on possible ways of ensuring that an expression of willingness to consent is able to proceed. Views should be sought on appropriate methods and conditions for resolving conflicts such as mediation or appeal to a higher authority. Comments should also be invited on how ratification may be achieved where conflicts arise.

2.4 Affected Communities

191. So far we have focused mainly on the issues pertinent to the identification of a host community. There are other communities, more remote from the actual facility, which could legitimately claim to be 'affected' and therefore involved in the decision to site a facility in a particular area.

192. These can be identified as those communities which might consider themselves to be disadvantaged by, perhaps, increased lorry movements over a long period, those which might consider themselves 'blighted' by association with radioactive waste, especially in areas which rely on tourism or those communities more remote from the actual site which feel they are at risk from discharges from the facility.

193. Some have suggested that the 'affected' communities should make a coherent case for being categorised thus and that the criteria for 'being affected' should be set at national level (need refs. to relevant consultation). Others (ref. Citizens' Panels here?) argue that the impact of the facility should be taken as a given and that concentric radii of units of a mile from the centre of the site should be used to graduate the area into those which, being closest and therefore 'hosting' the facility, should have the greatest say - and the greatest compensation in terms of 'wellbeing' benefits associated with the community package – while those further away have a reduced say or 'weight' given to their views and a consequent reduction in benefits.

194. It needs to be reiterated that while initial reactions may well be negative, the implementation process is founded on the expectation that a voluntary approach backed by packages to ensure well-being will provide a positive image in the longer term. How far this spreads will depend on the extent to which packages can benefit affected as well as host communities. **The consultation should seek views on, a. methods of representing the interests of affected communities, for example through local authorities and on partnerships and b. on how 'affected communities' might be defined and whether they might share in the benefits.**

2.4 Nuclear and Non-nuclear Communities

195. As indicated in chapter 4 the distinction between 'nuclear communities [36]' and 'non-nuclear communities' has implications

[36] The term 'nuclear community' is widely used, including in studies of the impact of the nuclear industry. Nuclear facilities tend to be located in coastal areas of relatively low population density and sometimes provide a high proportion of local employment. They are also the locations where the waste is stored. These factors probably account for the fact that the industry enjoys a higher than average level of acceptance and knowledge among people in such areas. Although CoRWM does not think that as part of initiation of the voluntarist approach, any distinction should be made in the way that nuclear and non-nuclear communities are treated, the European experience is that interest in hosting waste

for the application of the principle of fairness which is one of CoRWM's Guiding Principles

196. In the nuclear communities, most of the legacy waste subject to CoRWM's recommendations is already located and transporting it to another location is seen by many as creating an unacceptably high security risk (*refs. here?)*. For example, spent fuel is accumulating at Sizewell in Suffolk and by 2040 there will be 1000 tonnes in store involving an estimated 1000 separate transports if moved elsewhere.

197. Nuclear communities may be said to have enjoyed the benefits flowing into the local economy and are also familiar with the industry and with issues relating to waste management. They may, as a consequence, be more willing to accept new facilities. By contrast, non-nuclear communities are less informed and have not benefited directly and will possibly be more resistant to expressing a willingness to engage in a siting process as a consequence. However, the voluntary process does not make any assumptions that the waste will remain in its current locations. **The consultation should seek views on what measures are needed that will enable non-nuclear communities to have an equal opportunity to meet a national need while benefiting their community in doing so.** It was suggested earlier in this chapter that it is important to create national awareness of the siting process at the outset of the implementation process.

198. It is worth recording here that several of CoRWM's consultees expressed the view that communities attracted by a 'benefits package' are likely to be those which are economically disadvantaged and therefore in need of any regenerative spin-offs such a development might bring. But it might also bring long-term blight to such areas.. While there is an ethical argument that rightly argues against targetting a poor and vulnerable community to be a repository site, once again, it needs to be emphasised that the proposals foresee long-term benefits to the well-being of communities that host facilities. Provided the host community is part of an equal partnership and its decision to participate, or agree to host a facility, is not the result of pressure, there is an opposite ethical argument which suggests that it would be wrong for people outside the community to pressure it into expressing unwillingness to participate.

3.Expressing a Willingness to Participate

3.1 Methods of Measuring Support

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management facilities has mostly (although not universally) been shown by nuclear communities at some point – sometimes downstream – of the process. Experience and "real politik" both suggest that the dynamics at work of the process will be different for nuclear communities compared with others.

199. When a community signifies its willingness to participate it is assumed that the decision is supported by the community at large.

200. Establishing and demonstrating of the level of support – positively or negatively - is critical to a process based on collaboration and co-operation between a community and the implementer. It is imperative that the methods employed to demonstrate the level of support are genuine, transparent, legitimate and as far removed from misinterpretation as possible.

201. In order to achieve this, any body overseeing the process by which the level of support is gauged must be manifestly independent of the community and the implementer. Once again, there is a potential role for the independent oversight body here.

202. In addition the process of demonstrating support must be properly and independently funded. CoRWM considers the funds should be administered by the appropriate local authority.

203. There has been considerable discussion both within CoRWM and with stakeholders about the methods used to gauge support, and how the results might be interpreted. There seems to be general agreement that a variety of methods should be used. These include polling, and opinion surveys, deliberative methods and voting. The methods used during CoRWM's PSE programme were felt to be a good guide and in line with CoRWM's Guiding Principle 2 (See Chapter 4).

204. Most discussion focused around whether referendums might have a part to play in the process of deciding whether an initial expression of interest is sufficiently supported in the community to lead into a willingness to participate.

205. In favour of holding a referendum were the following arguments:

- as an instrument of the popular will it provides a clear expression of the views of the community at large

- the long-term management of nuclear waste is of such community-altering and lasting significance to an area that it is anticipated that the overwhelming majority of people would demand a say. The ability for ordinary members of the public to grasp complicated issues should not be underestimated.

- a referendum can help to inform or confirm a specific decision, such as the decision to participate (or, later in the process, a decision to withdraw). To educate a constituency over a potentially long period of time and then not to ask it to give its verdict through a popular vote may appear perverse,

especially if the locally elected representatives, as seems inevitable, will, in any case, make their decision on the basis of their appreciation of the views of the community.

- a referendum can be used in different ways. It can be used in conjunction with other methods of reflecting community views. A referendum may help to inform a decision that will ultimately be ratified by the appropriate elected body. Or the result could mandate ratification. Either way it may be seen as an integral part of the legitimation process.

206. Arguments against holding referenda were:

- concern about low turn out failing to reflect the views of the whole community or to give a biased result influenced by propaganda

- the complexity of the issue which makes it inappropriate for the simple question and answer format of a referendum

- the problem that other community issues not necessarily connected to the point in question may influence voters' responses

- the vote is a snapshot of views taken at a particular time rather than a measured response considered over a period of time

207. Views are invited on the methods that should be used to understand and verify the level of community support for a willingness to participate. In particular, what role, if any, could referendums play in establishing support for the willingness to participate.

3.2 Information Requirements

208. Earlier we indicated the need for information provision for awareness raising during the pre-notification phase. Information will also accompany the invitation to express willingness to participate. And, once communities have expressed an interest, their decision to go forward must be a fully informed one. The comprehensive involvement of a community in the issue is predicated of course on the belief that the MRWS process – particularly this stage of moving from the theory to the practice – is fragile and vulnerable. For it to move forward successfully requires time, patience and nurture in order to maximise the level of confidence and trust communities put into the process.

209. Thus the process itself must inevitably be comparatively slow and patient and allow a community access to a detailed range of data upon which it can base its decision.

210. In CoRWM's view this information should include the following elements. These would be of three types: information that is mainly factual; potentially negative consequences; and potential benefits.

211. Factual information would include:
- the volume of waste to be stored/disposed of
- the type and properties of radioactivity associated with this volume of waste
- the generic type of store/repository planned including, when available, details of packaging, backfill, access and vault lining and robustness against attack.
- information about the expected performance of the store or repository over time (in terms of the acceptance criteria that would have to be met)
- the approximate size (and, if a repository, the depth) of the facility and the length of time it will take to construct

212. Negative factors would include:
- the potential disruption that will occur, and the possibility of at least short-term blight
- information about the impact of the 'maximum credible accident' in the case of a store or, in the case of a repository, the impact of a badly characterised repository which fails to contain the radioactivity as it was designed to do

213. Positive factors would include:
- the job opportunities the facility is likely to generate
- information relating to the proposed, generic benefits which will accrue over time to the community and which are intended to enhance its well-being both in the short and longer term.

Chapter 7
Partnerships

Introduction

214. This chapter addresses the ongoing process after a short-list of communities have been identified that have expressed a willingness to participate in the siting process for a repository. It is assumed that, by this stage, parts of the country that are technically unsuitable for a repository have been identified and that none of the communities on the short-list are located within this area.

215. In accordance with CoRWM's recommendations, the next stage is to establish a partnership approach, which is based on establishing an open and equal relationship between the implementing body and the potential host communities. [37] CoRWM recommended that a framework for the process should be agreed in conjunction with stakeholders at the national level before detailed work starts at the local level. Those aspects of the framework (Stage x in Chapter 5) that relate to partnerships and Involvement and Community Packages are the subject of the current chapter.

216. This chapter addresses:

- The purpose, nature, role and method of working of partnerships
- Establishing partnerships
- The scope of Involvement and Community Packages and their sources.

217. Note that while the waste management facility discussed in this chapter is a repository, the same arguments would in most cases apply if the facility were to be a new store in a new location (see Chapter 4 for a discussion of the extent to which CoRWM's recommendations on willingness to participate might apply to a range of other stores.)

Purpose

218. The intention of a partnership approach is to create an environment in which host communities can engage with the implementing body without feeling victimised by a national process over which they ultimately have little control. [38]

219. Thus, the main purposes of a partnership are to:

- address all the concerns that a potential host community and other affected areas may have associated with the construction, operation, closure and post-closure of the proposed repository,
- agree a Community Package that will include socio-economic benefits that have been developed to ensure that the well-being of the community would be enhanced in both the short and longer term and
- ensure that the process of selecting a site for the proposed repository is effective and conclusive.

220. The concerns that communities may have will vary from case to case but it is anticipated that they will include the uncertainties associated with the long term performance of the repository and the long-term impacts on human health. The ways in which these uncertainties may be addressed are discussed in paragraphs xx.

[37] ***Moving forward - CoRWM's proposals for implementation***, July 2006, doc. 1703, paragraph 42

[38] ***Managing our radioactive waste safely***, July 2006, doc. 700, page 138

221. Government should consult on whether the purpose of the work to be carried out in the partnerships (as outlined above) is adequate and comprehensive.

Nature of Partnerships

222. CoRWM has recommended that partnerships should be based on an open and equal relationship between the potential host community and the implementing body . [39] It has been suggested that an equal relationship between the NDA and the local community means that the aspiration of the local community to enhance its well being and the aspiration of the NDA to implement a repository are regarded as equally important by all members of the partnership . [40] The relationship should therefore be one of mutual respect and understanding and commitment to learn from each other.

223. However, the two partners will have different roles. The local community, as represented by the partnership, will need to be satisfied that its concerns are addressed satisfactorily and that, together with the negotiated Community Package, its well being will be enhanced in both the short and longer term. Ultimately, if it considers that these objectives can not be achieved, it can conclude that the community should withdraw from the process – see paragraphs xx. The NDA is responsible for ensuring that a repository is implemented and therefore must ensure that design features requested by the community can be included at reasonable cost and do not compromise safety. The role of the regulators in addressing safety issues during the work of the partnerships is addressed in paragraphs xx.

224. Who should represent the NDA in the Partnership will depend on the way the NDA is structured and on the funding arrangements. Thus, the possibilities include representation by:

- the main NDA body
- the NDA subsidiary implementing body or
- an implementing contractor.

225. It will be important for the successful working of the partnership that the NDA representation ensures that the agreements reached by the partnership can be delivered. This suggests that representation by an implementing contractor would not be appropriate. **The consultation must be clear on what NDA structure is being implemented, the responsibilities of each part of that structure and what alternatives there are for its representation.**

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[39] ***Moving forward - CoRWM's proposals for implementation***, July 2006, doc. 1703, paragraphs 53ff

[40] reference needed

226. To be successful, the partnerships must have the freedom to achieve their aspirations without interference. However, it is appropriate that the Independent Overseeing Body (IOB) monitors the work and provides advice where it or the partnership considers that it will be helpful. The issue of accountability is addressed in paragraphs xx and the method of working and decision making are addressed in paragraphs xx.

227. There are different views on whether implementation partnerships should be separate entities form existing strategic partnerships. Some existing strategic partnerships think they should, since their objectives and accountability will be very different [41] and CoRWM is inclined to this view. However, when developing the socio-economic aspects of the Community package, it will be necessary for the implementation partnership to work in close co-operation with the local strategic partnership. Other strategic partnerships think that because the overlap in membership between existing partnerships is so great and that the same will be true for the implementation partnership, the latter should be part of an existing strategic partnership. [42]

228. Government should consult on the nature of partnerships as outlined above and on the desirability of their being separate entities from existing strategic partnerships.

Responsibilities of Partnerships

229. In order to achieve their purpose in accordance with the guiding principles, the partnerships should have the following responsibilities:

1. Effectively engaging with the community to establish its concerns and aspirations, ensuring that the community is well informed about the work of the partnership and ensuring that the recommendations that the partnership makes have broad support.

2. Developing the knowledge and skills of the members so that they can perform their role effectively.

3. Ensuring that the concerns of the community are addressed to its satisfaction.

4. Developing a Community Package that will ensure that the well-being of the community is enhanced.

5. Engaging with the relevant elected authority to ensure that the latter is kept fully informed, that its concerns are taken into account and

[41] Cumbria Strategic Partnership meeting, 2007, doc. 2150
[42] West Cumbria Strategic Partnership meeting, 2007, doc. 2147; Caithness Partnership meeting, 2007, doc. 2168

that there are no surprises when the Community package is presented for approval.

6. Making recommendations to the elected authority either that the Community Package should be approved or that the community should withdraw from the process.

7. Scrutinising the work of the NDA and its Site Licensing Company to ensure that the process of developing the repository design and establishing the suitability of the site provides confidence in the safety and low environmental impact of the repository.

8. Ensuring that the concerns of affected communities are addressed.

230. In the partnership arrangements that have been established in Belgium, Canada, Finland and Sweden, the implementing body and the regulators have played a major role in providing information to address the concerns of the community but, in all cases, there has also been the ability to obtain independent analysis and advice. Based on this experience, the agreement that underpins the partnership should place a responsibility on the NDA and the regulators to fulfil this role and the resources that are provided should allow the partnership to obtain independent advice. [43]

231. CoRWM has also recognised that, in order for a repository to be acceptable to a community, it should have the opportunity to influence generic aspects of the design. [44] Thus, there should be scope for the Community Package to include technical aspects in addition to the socio-economic package.

232. **Government should consult on on whether the responsibilities of partnerships described above are adequate and comprehensive.**

Establishing the Partnership

233. Who establishes the partnership is an important issue because, to establish confidence in its work, it must be seen as properly representing the community and not unduly influenced by the local authority, the NDA or Government. For this reason, it is inappropriate for the partnerships to be established by the NDA or Government.

234. However, it is difficult to see an alternative to the local authority having the responsibility for ensuring that partnerships are established although there are advantages in the actual

[43] ***Moving forward - CoRWM's proposals for implementation***, July 2006, doc. 1703, paragraphs 124ff, 177ff

[44] ***Compilation report: opportunity to comment on CoRWM's draft recommendations, PSE4***, June 2006, doc. 1739

establishment being done by an independent body. Once the partnership is established, it could be managed and the discussions could be facilitated by an independent body Independent bodies have been used in existing partnerships. They have assisted with the training of the partners and the design of the framework. This has ensured that a common language is used, perceptions are not influenced by a major player and the method of working is designed from the outset. [45]

235. Government should consult on the responsibilities and methods for establishing partnerships and the use of independent bodies.

Representation

The Community

236. CoRWM has recommended that the representatives of the potential host communities should reflect the full range of interests in the community as far as practicable. [46] There is therefore a need to establish what is the range of interests and who can represent them. In Belgium, this was done by research carried out by the local university while, in Sweden, the representation on working groups that advised the municipal council was decided by the council itself. [47] NuLeAF supports the latter model. [48]

237. Three possible models for deciding on who represents the community are:
   1. an independent body on the basis of research carried out in the community,
   2. the local authority or
   3. a combination of the above i.e. the local authority commissions independent research and advice to identify who should be invited to be members.

238. CoRWM favours the third.

239. The procedures that are used to recruit and appoint members of the partnerships must be consistent and transparent. They should therefore be part of the national framework that is established before the invitations to express a willingness to participate are issued.

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[45] Meeting with Scottish Environment Protection Agency, 2007, doc. 2165
[46] ***Moving forward - CoRWM's proposals for implementation***, July 2006, doc. 1703, paragraphs 96ff
[47] reference needed
[48] ***Developing the implementation framework: proposals for siting partnerships***, NuLEAF briefing paper 3, 2007

240. The overall process and result should be scrutinised by the Government's independent overseeing body.

The Local Authority

241. CoRWM has also recommended that the proposals that are developed through partnership arrangements must be endorsed by the appropriate elected authority. [49] Thus, it is important to ensure that the partnerships develop proposals that will be regarded as acceptable by the elected authority. The failure to endorse one of the Community Packages developed in Belgium is attributed to the lack of appropriate representation of the elected authority in the partnership [CoRWM, 2006c]. [50] Thus, it is necessary to ensure that the level of representation allows the elected authority to be kept informed, allows its views to be expressed, allows the partnership to recognise local political realities and ensure that there are no surprises when the proposals are presented for endorsement.

242. There is more than one approach to deciding what the appropriate level of representation of the elected authority should be. In Belgium, proposals were made by the local university based on the research that was carried out in the community. An alternative is for a senior member of the elected authority to chair the decision making body of the partnership and be accountable for ensuring that there are 'no surprises' when the proposals developed by the partnership are presented for endorsement. CoRWM favours an approach in which independent research establishes the appropriate level of representation by the local authority having raised the issues with the community.

243. In so doing, it is important to recognise that, as in existing partnerships, there will be tensions between elected councillors and community members [National Audit Office, 2004]. In the citizens' panels convened by CoRWM, the view was expressed that the there must not be the potential for the views of the community to be overridden by the views of representatives from the local authority.

The NDA

244. In terms of the representation from the NDA and other national bodies, it is important that the number of representatives with a high degree of technical knowledge is sufficient for the purpose but low enough so that members without a technical background in radioactive waste do not feel intimidated and so that the discussions can proceed at a pace that allows each member to

[49] ***Moving forward - CoRWM's proposals for implementation***, July 2006, doc. 1703, paragraphs 86ff

[50] reference needed

fully take part. In the Belgian partnerships, the number of representatives from the implementing body was limited to one in each part of the partnership. The structure of partnerships is addressed in paragraph [x].

245. The number of NDA representatives in each part of the partnership should be agreed by deliberation between the members including the NDA.

Other National Bodies

246. CoRWM's Public and Stakeholder Engagement [51] has shown that one of the major community concerns is the long-term safety of the repository. Experience overseas has shown that an important element of acceptance by a local community is a sense of ownership in the generic aspects of the design. [52]

247. The NDA or its subcontractor will be responsible for developing the design of the repository and producing the safety cases that support its construction, operation and closure. The nuclear regulators have a statutory responsibility for assessing these safety cases and CoRWM has recommended that the safety and environmental regulators should be involved in the implementation process at a very early stage and continue to be closely involved throughout the process. [53]

248. During the work of the partnerships it will important for them to have access to advice and information from both the relevant environmental agency, the Environment Agency or the Scottish Environment Protection Agency, and the Nuclear Installations Inspectorate although care must be taken to ensure that this does not conflict with their regulatory discretion. [54] This could be achieved by the regulators nominating a representative to be seconded to each partnership as an observer to provide information and advice, possibly under Section 37 of the 1995 Environment Act. Another possibility is a discussion forum outside the formal partnership arrangements, but there is no apparent reason why informative discussion can not take place within the partnership working group that is addressing safety and the environment. The regulators would supply information on safety based on the best available science. [55]

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[51] see, for example, ***Basis of the indicative timelines***, doc. 1800, July 2006
[52] ***Moving forward - CoRWM's proposals for implementation***, July 2006, doc. 1703, paragraphs 91 & 94
[53] ***Moving forward***, July 2006, doc. 1703, paragraph 204
[54] Meeting with Scottish Environment Protection Agency, 2007, doc. 2165
[55] Meeting with Environment Agency & Department for Communities & Local Government, 2007, doc. 2151

249. An important role of the regulators will be to advise if proposals made by the community would compromise safety.

250. Other major concerns are security, which is regulated by the Office for Civil Nuclear Security (OCNS), and the effect of low-level radiation, a source of concern among some members of the public and stakeholders. The Health Protection Agency (HPA) is the body that advises the Government on such issues.

251. Thus, both the OCNS and the HPA will have an important role to play in the discussions that will take place within the partnerships. These bodies should attend meetings of the partnership, when it is considered to be necessary, to provide advice and clarification.

252. The partnership may wish to involve other national bodies in their discussions including scientific bodies and NGOs. This is discussed further in paragraphs xx.

253. **Government should consult on representation in the partnerships as outlined above.**

Accountability

254. It is essential that the work of the partnerships is efficient and conclusive, while ensuring that the needs of the local community to develop the capacity to meet its aspirations and ensure that its concerns are fully addressed are recognised.

255. There are similar models for establishing partnership arrangements for the long-term management of radioactive waste in Belgium and Canada. In Belgium, the partnerships were established as non-profit-making organisations under a national bylaw. The bylaw set out the terms and conditions under which the partnership would work and be funded. It was negotiated between each municipal council and the implementing body and each member of each partnership signed the appropriate bylaw. In Canada, a similar arrangement was established by a contract between the corporation of the local community and the implementing body. Essentially, both the working of the partnerships in Belgium and the working of the community groups in Canada are accountable to both local government and the implementing body.

256. However, CoRWM's view is that partnerships in the UK, should be accountable to both the local authority and national government. Partnerships should provide annual reports to both and these should be scrutinised by the independent overseeing body on behalf of Government. The local authority or the overseeing body could identify if a partnership was not acting in accordance with its mandate and advise accordingly.

257. The partnerships should also be accountable to the community that they represent. The responsibility to closely engage with the community is addressed below and should be incorporated into the partnership agreement.

258. Partnerships could also be accountable to themselves by being companies limited by guarantee. The directors would be responsible for ensuring that the partnership worked in accordance with its mandate and the partnership could employ its own staff. This would give it a measure of independence from the local authority without compromising its close engagement with both the community and the local authority. Some coastal partnerships have formed Limited Companies with charitable status [Scottish Coastal Forum, 2001].

259. Government should consult on the accountability of partnerships as outlined above.

Structure

260. Because the concerns and aspirations of each community will be different, there is a need for flexibility in the details of the structure and methods of working that are employed by each partnership, [56] which should be developed locally. However, fairness requires that the same capability should be provided to each partnership and, thus, there must be a common framework. However, the resources that are needed to effectively engage with the community will depend on its nature and population.

261. In the Belgian partnerships, a model that worked well consisted of:

- A Executive Committee
- A General Assembly
- Working groups for each of the main areas of concern in the community such as health, environmental impact, the generic design and the well-being of the community. They present their work initially to the Executive Committee and then to the General Assembly
- A secretariat that played a major role in drafting the papers produced by the partnership, including its recommendations, and carried out all the administrative duties. [57]

262. In this model, all the partners are represented on the General Assembly, which decided the main elements of the work that should be done and approved the Community Package that was recommended to the elected authority for endorsement. The Executive Committee was elected by the General Assembly to manage the day to day running of the partnership and was

[56] reference needed
[57] reference needed

chaired by the chair of the General Assembly. The working groups consisted of members of the partnership, other members of the community, members of national bodies and specialists as appropriate. The chair of each working group was on the Executive Committee.

263. It is important that the number of representatives in each part of the partnership is large enough to be sufficiently representative and yet small enough to be effective. In the Belgian partnerships the numbers were:

- Executive Committee: about 10
- General Assembly: about 30 to 35
- Working Groups: 10 to 20
- Secretariat: 2

264. However, the size of the Continental municipalities is much smaller than local authority areas in the UK and the inventory associated with the Belgian process was confined to short-lived low and intermediate-level waste. Thus, the UK context is much more complicated and will require greater secretarial support. Some local strategic partnerships are supported by a secretariat team of four. [58]

265. Otherwise, the above structure is similar to that of existing local strategic partnerships. [59]

266. Government should consult on generic issues of the structure of partnerships as outlined above.

Engagement with the Community

267. CoRWM has recognised that there is a danger that the participants become a club of experts [60] that is remote from the majority of people in the community. This danger not only destroys the intent of avoiding the experience of nuclear facilities being imposed on communities, it introduces a grave risk of failure. [61] Thus, it will be necessary for each partnership to engage effectively throughout its work with its local community, local strategic partnerships and the relevant regional bodies as well as those in affected areas. In nuclear areas, there will also be a need to liaise with the local Site Stakeholder Groups. The partnership must ensure that the recommendations it develops have reasonable support within the community and provide demonstration of this support.

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[58] West Cumbria Strategic Partnership meeting, 2007, doc. 2147

[59] Doc. 2147

[60] Webler, T, page 22 of ***Forum on Stakeholder Confidence; Belgian Workshop; November, 2003***, NEA/RWM/FSC(2004)4, OECD, Paris, 2004.

[61] reference needed

268. In the interests of openness and transparency, CoRWM recommends that the decision-making body (the General Assembly) of the partnership follows CoRWM's example and holds its meetings in public and that there is an opportunity for the public to question Members at some point in each meeting.

269. Government should consult on the responsibility of the partnerships to engage as outlined above.

Affected Areas

270. CoRWM has recognised that, in addition to the concerns of potential host communities, there will also be a need to take into account the concerns of neighbouring communities and those along transport routes. In programmes that are moving forward abroad, it has been the responsibilities of the partnerships (Belgium), the potential host municipalities (Finland and Sweden) and or the local community councils (Canada) to ensure that these concerns are properly addressed.

271. It is difficult to specify criteria for defining affected areas. Communities may genuinely regard themselves as affected because of concerns such as accidents or security threats during transport or because they perceive that the repository may affect their livelihood such as fishing or the tourist industry. Thus to some extent affected areas will be self defining.

272. Members of the public have expressed the view that any benefits that are included in the Community Package should be related to the distance communities are from the selected site, known as the contiguity principle. [62] Such a system has been employed in France. [63] The extent to which it should apply will depend on the size of the community that the partnership represents. If the community is defined as the area of the local authority, the partnership will determine the nature of the required benefits within the area and it will be the responsibility of the local authority to ensure that the concerns of its neighbours are adequately addressed. Government will need to address complaints by neighbours who consider that the host authority is not taking account of their concerns and advice should be provided by the independent overseeing body If the area is smaller than that of a local authority, it may be appropriate for representatives of affected areas to be associated members of the partnership to ensure that their concerns are addressed.

273. However, it will be important for the number of associate members to be limited to ensure that the work of the partnership is efficient and conclusive. It should be the responsibility of

[62] ***Citizens Panel (Fourth meeting) report***, April 2007, doc. 2173
[63] ***Overseas experience - developments in France***, February 2007, doc. 2129

Government, on advice from the independent overseeing body to determine the appropriate number of associate members in consultation with the representatives from the potential host community and the affected areas. Since the repository and the transport of waste to it will only be licenced if it is judged by the regulators to be safe, the purpose of associate membership should be limited to addressing the safety and security concerns of affected areas.

274. Government should consult on the how the following key issues associated with affected areas should be addressed as outlined above:

A what criteria should be used to establish what is an affected area?
B should affected areas receive any benefits?
C how should the concerns of affected areas be addressed?
D how should the legitimacy of affected areas be established

Method of Working and Decision Making

275. As with the structure, it will be necessary for each partnership to develop its own method of working to ensure that local concerns and aspirations are addressed. However, there will be some common elements. For example, the basis for decision-making must be by deliberation. This is fundamental to the concept of an equal partnership.

276. In addition, however, many local communities, including those in Belgium, Canada, Finland, France and Sweden have seen the need to commission independent advice.

277. CoRWM has also pointed out the advantages of joint fact-finding in obtaining a broad acceptability of proposals that are made by an implementing body. [64] This is a process that was developed and used successfully in the BNFL national nuclear dialogue. Essentially, both parties to a disputed issue agree a programme of work, the methodology and the consultants to carry out the work and jointly oversee the work's prosecution, agreeing it stage by stage. This allows both parties to accept the outcome of the study as opposed to critiquing the work – and inevitably disagreeing with it - carried out by one party in response to an issue raised by the other.

278. With the structure proposed above, the decision making body of the partnership is the General Assembly, where decisions could be put to the vote.

[64] ***Moving forward - CoRWM's proposals for implementation***, July 2006, doc. 1703, paragraph 102

279. There is more than one model of how the implementing body should participate in the decision-making process. In the Belgian model, it had a vote in the decision making body but chose to abstain from voting on all local issues. In the Canadian model, it played a full role in the discussions, the provision of information, expert advice and design development but played no part in the decision making process apart from design issues.

280. What is important is that the implementing body plays a full role in providing information, expertise, support, access to experts and works in full co-operation with the community representatives to develop the generic features of the repository concept. Thus, there is no requirement for the NDA to have a formal role in decision making on local issues but, as noted above, it should be party to decisions that have a significant impact on costs and on proposals that compromise safety based on regulatory advice.

281. Government should consult on methods of working and decision making as outlined above.

Resolution of Conflicts

282. There is an issue of whether there should be external arbitration if the local authority did not endorse a recommendation by the partnership, particularly if it did not endorse a recommendation to continue to participate in the process. This occurred in the case of Fleurus in Belgium and might occur in the UK, particularly in cases where the partnership represented a potential host community that was only part of the electorate of the local authority. This issue was addressed in paragraphs xx of Chapter 4 where Government was advised to consult on the merits or otherwise of establishing a procedure for arbitration.

Development of Working Practices and Skills

283. In its Evaluation of Local Strategic Partnerships [Office if the Deputy Prime Minister, 2006], the Office of the Deputy Prime Minister pointed out that "effective partnership working can take a considerable time to become embedded". In addition, there will be a need for members to become familiar with issues such as the nature of the waste, the nature of a repository and the means by which the isolation of the waste over the required timescale is achieved before the partnership can develop the means by which the repository can be acceptable and start to develop a Community Package. In existing partnerships, training and the provision of information is generally under resourced. [65]

284. In addition to technical issues, partnerships may need to develop skills such as leadership development, partnership

[65] Meeting with Scottish Environment Protection Agency, 2007, doc. 2165

working, effective listening, external communication and community engagement.

285. Sufficient time and resources must be allowed for these preliminary stages.

The Right to Withdraw

286. As noted in Chapters 4 CoRWM has recommended that potential host communities should have the right to withdraw from the process up to a pre-defined stage in the implementation process and that the points at which there is a right to withdraw should be clearly defined in advance. [66]

287. These points need to reflect a balance between a community withdrawing from the process after considerable sums of public money have been spent on the process on the one hand and ensuring that the concerns of the community have been satisfactorily addressed and that its well being will be enhanced on the other. As shown in Chapter 5, the latter will be established when the Community Package has been formally agreed and, thus, this should occur before planning permission for the Rock Characterisation Laboratory is sought.

288. However, at this stage, the suitability of the site still needs to be demonstrated by detailed research. Thus, it is not appropriate for the right to withdraw to cease completely, but it could be limited to allowing the community to withdraw only if it can not be satisfied that the suitability of the site has been demonstrated by the underground investigations.

289. Government should consult on when the right to withdraw should cease as outlined above.

Partnership Agreement

290. As noted in paragraphs xx, there is a need to encompass the above framework in an agreement or contract that will govern the work of the partnerships. In Belgium, the bylaw, which set out the terms of reference of the partnership, was signed by each member.

291. The agreement will need to place the project in context and address all the issues that have been discussed above. Thus it will need to include:

- Identifying the type of facility that is being proposed

[66] ***Moving forward - CoRWM's proposals for implementation***, July 2006, doc. 1703, paragraph 113

- The inventory of the waste that will be disposed
- The purpose and responsibilities of the partnership
- Accountability
- The principles under which it will work
- The key stages in its work and the stages to which the current agreement applies
- The representation and the roles of each type of member
- Associate members and their roles
- The role of the regulators and other experts
- The structure
- Engagement with the community and the ratifying body
- Method of working and decision making
- The right to withdraw
- Funding
- The framework for developing a Community Package

292. Government should consult on the nature of the partnership agreement as outlined above.

Key Information Needs

293. The information that a partnership will require so that its concerns are addressed and it can decide what mitigating measures are necessary, if any, will be a matter for each community. The issues on which information will be required will be very similar to those that were identified in paragraphs xx but, as the partnerships will address the issues and how they can be mitigated in much greater depth, more detail will be required.

294. During CoRWM's PSE process, the major issues of concern were safety and security.

295. Among the detailed safety issues on which the public and stakeholders wanted information and which formed part of CoRWM's deliberations are:

- rate at which containers corrode
- increase of gas pressure in containers
- microbial activity and its effect on radionuclide mobility
- effect of water ingress
- effectiveness of the backfill,
- the stability of the vaults,
- the extent to which the excavation of material to create the repository will alter the characterisation of the site
- the extent to which the backfilling of the shafts and drift will restore the isolation of the waste
- the predicted impact on health and the environment and its timing,
- the worst that could happen
- the uncertainties associated with predictions at long times into the future an how these are being addressed

- practicability and responsibilities for pre- and post-closure monitoring
- responsibilities for remediation
- the debate about the impact of low-level radiation
- how the security of nuclear materials will be secured during transport and when they are on site.

296. In addition to safety and security, experience overseas and CoRWM's PSE process indicates that partnerships will also want information on the following:

- the complete decision-making process up to the time that the repository will be closed, who will be responsible for making each decision and the approximate timescales for each stage.
- world-wide experience in implementing repositories including how community concerns are being addressed and how socio-economic well being is achieved,
- other UK communities involved in the process as potential host communities,
- communities that have identified themselves as affected communities
- world-wide experience in disposing of each category of waste and nuclear material and why the selected concept is being proposed,
- current knowledge of the geology and hydrogeology of the area, its suitability, how it compares with other geologies in the UK and the extent to which repositories in similar geologies have been researched abroad,
- the means of transporting the waste to the repository, the frequency of deliveries and any new infrastructure that will be required,
- the physical and other disruption that will occur including noise, dust, visual impact, transport, use of local materials, dumping of spoil etc.
- the long-term visual impact during repository operation and care and maintenance,
- the impact on the natural environment
- the employment benefits during construction and operation
- other potential developments such as encapsulation, material development etc.
- current development plans for the area
- current socio-economic conditions and how they would be affected by the proposed development.

297. Where there are significant uncertainties, it will be necessary for the partnership to have the opportunity to scrutinise the research and development that is being done in each area.

298. In all examples overseas, it has been the responsibility of the implementing body to provide the technical information required by the partnerships. However, as noted above, there is an important role to be provided by the NDA contractors, the

regulators and the HPA. Information on local and regional plans and conditions should be provided by the local and regional authorities. The need for other sources of information, such as obtaining independent expertise and joint fact finding, has been identified in paragraphs xx.

299. Government should consult on the information that the partnerships are likely to require as outlined above and on page [x].

Involvement Packages

300. The aspects discussed above will require significant resources and, as pointed out by CoRWM, [67] overseas experience shows that communities are unlikely to express a willingness to participate unless these resources are provided in an Involvement Package that is funded externally.

301. Examples include the case of Belgium where the implementing body funded:

i. general expenses such as the salaries of the two members of the secretariat,
ii. operational costs such as telephone, services, post etc,
iii. site visits and meetings outside the locality,
iv. conferences and
v. employment of independent expertise.

302. All three partnerships were provided with £170,000 per year for items i) to iv). In the case of Dessel, £50,000 was paid for an independent assessment of the socio-economic impact that the repository would have and a further £50,000 was paid for independent input on design issues. [68] In Sweden, municipalities are provided with £200,000 per year from the Nuclear Waste Fund to develop local competence in discussions with the implementing body and employing expert advisors.

303. However, the inventories being considered are more limited than that of the UK higher activity waste. It has been noted that the Belgian inventory considered by the initial partnerships was confined to short-lived waste and, in Sweden, the repository under current consideration is only intended for spent nuclear fuel. In the UK, there will be a need to consider a range of wastes that will involve two disposal concepts.

304. Thus, the Involvement Packages should cover,

- the salaries and other costs of the secretariat

[67] ***Moving forward - CoRWM's proposals for implementation***, July 2006, doc. 1703, paragraph 102
[68] ***Involvement and community packages***, draft 4, October 2006, doc. number

- operational costs,
- developing the capabilities of members
- engaging with the local community
- liaison with other bodies inside and outside the locality
- commissioning expert advise and research
- expert facilitation for aspects such as joint fact-finding and evaluation of options, and
- compensation for loss of earnings and child care.
- local authority cost such as additional officers and time to attend meetings

305. Although the framework for Involvement Packages must be established before invitations to participate in the process are issued, the details may need to vary between areas because of local factors such as population. Thus, each partnership will need to negotiate the resources it requires.

306. Government should consult on the nature of Involvement Packages as outlined above.

Funding of Involvement Packages

307. Government should cost the the items in Paragraph 19.5 to establish a suitable figure for the annual support of partnerships. Although support will be required before a willingness to participate is established, as discussed below, the above level of support should start as soon as the agreement is signed and continue throughout the development of the facility, but the level of support may change as the role of the partnership changes over time.

308. Nirex has suggested that it would be beneficial to establish a fund for the Involvement Package that is managed by an independent body [69] and NuLeAF [70] considers that this would contribute to the confidence and trust in partnerships on the part of local communities.

309. Whatever funding arrangements are established, confidence in the ongoing process requires that Government establishes a secure basis for funding the partnerships over the time for implementing the repository.

310. Government should consult on the funding issues raised above.

Pre-partnership Support (may put this in Chapter 5)

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[69] Nirex 2006 - reference needed

[70] ***Developing the implementation framework: proposals for siting partnerships***, NuLEAF briefing paper 3, 2007

311. Local communities will incur costs before partnerships are formed to:

- organise the dissemination of the necessary information to the community
- establish the level of willingness for participation,
- establish the appropriate membership
- draw up a draft partnership agreement and
- negotiate the agreement with members

312. Such support should be available to all local communities that express a willingness to participate. Government should cost such support and agree to provide it before the invitations are issues

313. Government should consult on what pre-partnership support shouls be provided.

Community Packages

314. Identifying the issues and conditions that will ensure that a repository is acceptable to a community is inevitably a matter for the community itself. Experience overseas indicates that these may include the general areas of [71]
   - Safety
   - Health
   - Environment
   - Generic technical issues
   - Communication
   - Socio – economic benefits
   - the process by which site investigations are carried out and evaluated
   - the development of associated facilities such as encapsulation plant
   - Other commitments such as limitations on the inventory and ongoing funding for the project.

315. Thus a community package may cover a very wide range of issues Financial input is not necessarily involved under all headings. Socio –economic aspects may take the form of establishing the right framework for regional economic developments such as granting the freedom of local authorities to create the necessary conditions for development, removal of restrictions to economic growth etc. However, financial input may be involved and this will need to be added to the budget for managing the UK's legacy waste.

[71] ***Citizens Panel (Fourth meeting) report***, April 2007, doc. 2173

316. Two of the design aspects of the repository that featured in CoRWM's PSE events were monitoring of the waste and the extent to which the repository should be designed to enable the waste to be retrieved and for how long this situation could be maintained. [72]

317. The key issues associated with monitoring were the extent to which it could enhance the confidence in the long-term safety case and its possible requirement to provide assurance to the public and stakeholders. These issues concern what is monitored and for how long. One aspect of monitoring is addressed in CoRWM's report. [73]

318. Retrieving the waste could be achieved by reversing the procedures that were employed to emplace it or removing the backfill as discussed in CoRWM's report. [74]

319. Other design aspects that are important to local stakeholders are those that affect the visual impact of the facility.

320. The socio-economic aspects of the package would be subject to European Community State Aid rules and any limitations associated with these would need to be clearly identified in advance.

321. Examples of community benefits in the UK are :

1. Landfill Tax Credit Scheme

322. This was a scheme that was introduced with the landfill tax in October, 1996 to help to mitigate the effects of landfill on local communities by providing funds that are used to improve local land. [75] It encourages partnerships between landfill operators, their local communities and the public and voluntary sectors and allows landfill site operators to donate up to 6% of their landfill tax liability to environmental projects in return for a 90% tax credit. A very wide range of organisations may register to receive the support. By June, 2006, the Landfill Tax Credit Scheme had funded about 2,000 organisations to the tune of about £600M.

2. Aggregates Levy Sustainability Fund (ALSF) Grant Scheme

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[72] see, for example, ***Moving forward - CoRWM's proposals for implementation***, July 2006, doc. 1703, paragraph 35; ***Citizens Panels third meeting summary report***, 2006, doc. 1750; and ***Report of the National Stakeholder Forum meeting, 9-10 May 2006***, doc. 1751

[73] ***Managing our radioactive waste safely***, July 2006, doc. 700, page 119

[74] ***Managing our radioactive waste safely***, doc. 700, pages 117-119; ***The nature of partnerships***, draft 5, October 2006, doc. 1850.1

[75] see website at http://www.ltcs.org.uk

323. The levy on aggregate extraction was introduced in April, 2002.[76] Part of the money raised by the levy finances the ALSF, whose aim is to address the environmental and social costs of aggregate extraction by delivering environmental improvements, minimising the demand for primary aggregates and reducing the local effects of aggregate extraction.

The ALSF Partnership Grant Scheme was formed by English Nature and the Countryside Agency in April, 2006 and had an allocation of £4.7M in the financial year 2006/7, which has been allocated.

3. Sullom Voe

324. In 1972, when it became clear that several oil companies wanted to bring oil ashore in the Shetland Isles, the County Council of Zetland, now the Shetlands Islands Council (SIC), decided that the local community should benefit. This aspiration was realised with the aid of a private members Bill that led to the Zetland Act, 10th April, 1074, which provided special powers to the council to compulsory purchase the land that was identified as the proposed oil terminal. It also allowed the council to become the harbour authority provided for the setting up of the Sullom Voe Associated Ltd (SVA), which was jointly owned by SIC and the Brent and Ninian pipeland system partners in the North Sea. The Act specified environmental safeguards that must be put in place and it specified that a disturbance allowance should be paid by the oil industry.

325. This legal basis allowed SIC to negotiate:

- receipt of 1p per tonne of oil brought ashore,
- rent for the terminal site
- rates (local taxes) for the terminal, until national legislation was changed,
- profits from the operation of the port,
- profits from the joint-venture tug operation,
- profits from the joint-venture construction of workers' villages during building of the terminal
- in addition to the benefit of wages spent in the Shetland economy.

4. Planning Gain

326. This is where local authorities can ask land developers to offer some benefits, e.g. in terms of infrastructure or finance, to compensate for new developments. Current UK examples are mechanisms to ensure that part of the profit of private profit-making organisations benefits the community. Radioactive waste is different in that most of it is Government responsibility.

[76] see Defra website at http://www.defra.gov.uk/environment/waste/aggregates/index.htm

327. Planning gain supplements are now available as a form of development tax, but it is unclear if raising revenue in this way can be applied to specific projects. [77]

328. **Government should consult on the nature of Community Packages as outlined above.**

Development of the Community Package

329. The success of each partnership will depend on the commitment and stability of the membership. Experience overseas has shown that it takes approximately four years to develop a Community Package successfully, [78] whereas a typical lifetime of a volunteer is about two years. Thus, it is important that the detail with which a Community Package is developed is limited and that details, such as the detailed financial arrangements, are left to separate negotiations after the initial package has been endorsed and the site(s) for detailed investigation are identified. This is the stage that has been reached in Belgium.

330. However, the Belgian process only addressed short-lived waste and, for the higher activity long-lived waste, it will be necessary for the siting process to include the three stages of feasibility studies, borehole investigations and underground research as outlined in the next chapter. If a decision is made to manage some or all of Scottish waste separately from waste from England and Wales, there may need to be two implementation programmes but, typically, in each one, borehole investigations would be limited to two sites and underground research limited to one. Thus, the development of the Community Package should by limited to what is required to confirm the willingness to participate in the next stage. The complete scope of the package can be left until the borehole phase and the detailed financial arrangements should only be negotiated with the community whose site is selected for underground research. There is always the risk, of course that these negotiations break down. In which case, it will be necessary to return to the other community where borehole investigations were carried out or return to an earlier stage in the process.

331. Government should consult on the development of the Community Package as outlined above.

Negotiated Community Package

332. In programmes that are proceeding overseas, the detailed Community Package is negotiated between the elected authority

[77] Meeting with Environment Agency & Department for Communities & Local Government, 2007, doc. 2151
[78] reference needed from Mark

and the implementing body. No alternative to this model is being proposed although, if the partnership were to be established as a company limited by guarantee, it could negotiate on its own behalf.

333. Once a detailed Community Package has been agreed, there will be a need to create a formal agreement that binds both parties.

334. Government should consult on the negotiation of the Community Package as outlined above.

Funding of the Community Package

335. Confidence that the Community Package will be delivered is fundamental to the success of the entire process. If an independent fund managed by an independent body is not established, it is essential that the funds are ring-fenced from any other expenditure and that the means by which these funds will be protected over the time that they have been committed is transparent.

336. Government should consult on the funding of the Community Package as outlined above.

Benefits to Communities that are not Selected

337. Participation in a partnership will require a considerable commitment from members of the community and it is inevitable that, as they become deeply involved in the issues and the ways in which concerns can be mitigated and the details of a socio-economic package, they will develop a deep sense of ownership of the potential package. Experience in Belgium has shown that communities that are not selected experience a sense of injustice if they receive no recognition for their efforts. The possibility of expending a major effort for no benefit could be a major obstacle to communities expressing a willingness to participate.

338. To avoid these situations, all communities that establish partnerships should have the opportunity to negotiate a limited benefit for their community.

339. Government should consult on providing benefits to communities that are not selected as outlined above.

Site Investigations

340. For a community to be satisfied that its site is scientifically suitable, it will need to monitor and scrutinise the results of the underground research. It may need to be convinced about the suitability of the site and ensure that the uncertainties are adequately addressed. Thus, a separate Involvement Package

will be necessary for this phase, which also includes the resources to commission independent evaluations of the results of the site investigations and joint-fact finding. Only when the safety of the site is resolved to the satisfaction of the partnership would the right to withdraw be completely ended.

341. At this point, the Community Package would become effective.

342. Government should consult on the role of the partnership during underground investigations and the time that the Community Package becomes effective as outlined above.

Construction, Operation and Closure

343. The community will continue to have a stake in the construction, operation and closure of the repository. This will include monitoring that all the conditions that are included in the Community Package for these phases are met.

Chapter 8
Conclusion

344. We do not repeat here the main conclusions reached in this report. Chapter 4 on Key Issues effectively summarises the most important points, and we have highlighted, in bold, the most important conclusions and questions for consultation in our more detailed Chapters 5, 6 and 7

345. Government has invited applications for a re-constituted Committee which will be appointed later this year. While existing appointments run until mid-August, this will probably be CoRWM's last detailed report to Government. We are discussing with sponsors what remaining work we can do, probably mainly in May and June.

346. Further information about the Committee and its work is available from
- CoRWM's website http://www.corwm.org.uk or
- the Committee secretariat, telephone 020 7082 8491, e-mail contact@corwm.org.uk.

Annex A Government questions to CoRWM

[extract from CoRWM document 2094, December 2006]

Secretariat note: Following discussion with sponsors, Government has provided this draft statement of additional advice sought from CoRWM following its July recommendations.

PROVISION OF SUPPLEMENTARY ADVICE BY CORWM

Outputs needed from CoRWM

1. CoRWM is asked to provide supplementary advice on the implementation of voluntarism/partnership arrangements as set out below consulting the public and stakeholders as appropriate.
2. Advice will be supplied by the end of April 2007. As early as possible beforehand, CoRWM will publish draft proposals or papers reflecting the direction of its thinking on the issues set out below.

Background

3. CoRWM's advice will contribute to the preparation of the UK and devolved administration governments' (hereafter Government's) 2007 consultation document proposing a framework for implementing the "Managing radioactive waste safely" programme. This will focus on the way in which voluntarism / partnership could be delivered in practice in the UK context.
4. Government will produce, through a parallel process, criteria for screening out scientifically unsuitable parts of the UK for use in conjunction with the voluntarism approach. These criteria will be produced in an open and transparent manner. CoRWM will be involved though it will not play the leading role in their production.

Advice required

5. CoRWM is asked for advice in the following areas:
   - 5.1. the process leading up to communities volunteering to participate, including:
     - 5.1.1. how communities might be identified, defined and represented for the purpose of volunteering;
     - 5.1.2. how community identification would relate to the role of local authorities, as local democratically elected bodies, and their statutory roles and responsibilities;
     - 5.1.3. what information local communities might require at the point of invitation to volunteer, bearing in mind the further detail that would need to be filled in as subsequent discussions / negotiations progressed;
     - 5.1.4. how communities might be enabled to secure the necessary resources to explore and evaluate potential interest;
     - 5.1.5. how the application of agreed criteria for the scientific screening of sites might feed in to this stage of the programme;
     - 5.1.6. how interest from local communities interested in volunteering could be mandated and registered;
   - 5.2. the nature of the partnership, assuming a short list of volunteer communities has been identified from expressions of interest, including:
     - 5.2.1. the key stages in which volunteer communities would develop and decide further their interest in participation;
     - 5.2.2. the key points at which further agreement with the implementing body, and Government as its sponsor, might be developed and solidified;
     - 5.2.3. key information needs, and their means of delivery, as negotiations proceed;
     - 5.2.4. the nature and potential stages of development of the necessary agreement and information documentation;
     - 5.2.5. in light of such analysis, the nature of any Involvement Package and the activities it might need to cover;
     - 5.2.6. bearing in mind that they would need to be the subject of specific discussions with volunteer communities, initial thoughts and options for inclusion in

Community Packages, commenting on timing, whether they are one-off or ongoing and, if the latter, potential duration: this should, in particular, draw on potentially comparable existing UK examples and schemes;

5.2.7. how Involvement and Community Packages might be managed and accounted for;

5.2.8. the nature of any repository design elements that might be the subject of specific, as opposed to general, consideration during the negotiation process; CoRWM is asked to advise on how such work might relate to the partnership programme, not on its detailed scientific or engineering content;

5.3. in light of (5.1) and (5.2), a possible programme for implementing a voluntarism/partnership approach, up to the point at which the availability of a potential site is confirmed and detailed characterisation can begin, including:

5.3.1. the key stages and decision points for a voluntarism/partnership approach;

5.3.2. the decisions to be taken, and the nature of commitment and financial implications associated with each decision;

5.3.3. potential timescales, balancing the needs of local communities with the need to progress the MRWS programme.

6. CoRWM may not have the resources - including time, and access to relevant expertise - to address all these issues to the same level of detail. If that is the case, items 5.2.6 and 5.2.7 have slightly lower priority in light of their "downstream" nature.
7. In providing advice, CoRWM should where possible advise where the consultation should set out specific proposals; or set out alternative options with comments on them; or just set out the issues and invite views. In the second case, CoRWM should where appropriate give its own view on the preferred option.
8. CoRWM's advice, or appropriate summaries of it, should be provided in a form that is concise and ready for public engagement. Government will prepare its own document; but where it accepts CoRWM advice, it does not wish to incur the risk of "loss in translation".

Annex B CoRWM's Members

Chair
Professor Gordon MacKerron, Brighton - economist and energy policy consultant, Director, Sussex Energy Group, SPRU, University of Sussex

Deputy Chair
Dr Wynne Davies, Buckinghamshire - former Vice President, Group Health, Safety and Environment, Amersham plc and former Lecturer in Physics and Radiation Biology, University of London,

Members

Mary Allan, Ross-shire - Lecturer, School of Business, The North Highland College,

Professor Andrew Blowers OBE, Bedfordshire - Professor of Social Sciences at the Open University, former county councillor, former Board Member of Nirex UK,

Professor Brian D Clark MBE, Aberdeen - Professor of Environmental Management & Planning and Board Member, Scottish Environment Protection Agency,

Dr Mark Dutton, Cheshire - physicist and radiological protection and radioactive waste management expert, independent consultant, formerly with NNC,

Professor Lynda Warren, Ceredigion - zoologist and Emeritus Professor of Environmental Law at the University of Wales, Board Member of the Environment Agency,

Pete Wilkinson, Suffolk - Director of Wilkinson Environmental Consultancy, former Chair of Greenpeace UK, Director of Greenpeace International and co-founder of Friends of the Earth.

Clicking on each name in the electronic version of this document will take you to the Member's details on our website.

Fred Barker, Fiona Walthall and Jenny Watson left the Committee after July 2006 due to other commitments.

Annex C People whom CoRWM met

CoRWM met with the following people and organisations to collect information and advice.
This is not an exhaustive list: for example, the Committee also held progress meetings with Government sponsors and attended a Government workshop on 23 November held to discuss plans for its consultation exercise.

The Committee met:

Organisation	Date	Report (doc.)
Caithness Partnership	15 Mar. 2007	2168
Citizens Panels - Glasgow	17 Mar. 2007	2173
- London	24 Mar. 2007	2173
Community Development Foundation	9 Feb. 2007	2130
Copeland Borough Council	20 Feb. 2007	2148
Cumbrian NGOs	19 Feb. 2007	2149
Cumbria Strategic Partnership	19 Feb. 2007	2150
Department for Communities & Local Govt.	15 Feb. 2007	2151
Dounreay Stakeholder Group	14 Mar. 2007	2167
Environment Agency	15 Feb. 2007	2151
Greenpeace	20 Mar. 2007	2169
Highland Regional Council - Caithness councillors	14 Mar. 2007	2166
Lancaster University	9 Mar. 2007	2163
Norfolk Environmental Protection Group	21 Mar. 2007	2170
Nuclear Decommissioning Authority	7 Feb. 2007	2125
Nuclear Legacy Advisory Forum (NuLEAF)	14 Feb. 2007	2152
" "	28 Mar. 2007	2177
Overseas experts - Canada & Europe	27-28 Feb. 2007	2142
Scottish Councils' Cttee on Rad. Waste Management	12 Mar. 2007	2164
Scottish Environment Protection Agency	13 Mar. 2007	2165
Sizewell Site Stakeholder group	30 Mar. 2007	2171
University of East Anglia	5 Mar. 2007	2156
West Cumbria Strategic Partnership	20 Feb. 2007	2147

Committee on Radioactive Waste Management

Final: 21.02.07

CoRWM Document Number: 2169
Meeting summary

Please could one CoRWM Member complete this for each meeting attended and e-mail it to Sam Bains who will give it a document number.

1. Date, place and title of meeting attended:

20th March 2007, Greenpeace offices at Canonbury Villas, London N1, bilateral to discuss implementation issues requested by HMG in the form of supplementary advice from CoRWM

2. Who attended for CoRWM:

Andy Blowers
Brian Clark
Pete Wilkinson

3. Others present:

Jean McSorley	Senior Consultant
Nathan Argent	Climate and Energy Campaigner

4. Purpose of attending meeting:

To deepen CoRWM's understanding of the views of Greenpeace on the issues in question.

5. Main points discussed / information acquired:

The meeting focused initially on the proposed institutional arrangements. Greenpeace were pleased with their successful judicial review which had declared that CoRWM's recommendations had been misused in the consultation on future energy policy. Thus far, Greenpeace had refrained from responding to the government's consultation due to a potential conflict of interest with the judicial review procedure. Greenpeace were especially concerned about the oversight issue and believed that, without effective and independent oversight, the proposed staged decision making process would not work.

Greenpeace were also concerned about the potentially conflicting roles of the NDA. Greenpeace also strongly expressed the view that the absorption

of Nirex by the NDA would have implications for the implementation process: a Nirex legal opinion indicated that the NDA move was illegal. In addition, the NDA would be in charge of the timing, funding and strategy associated with the construction of the repository but would also appoint the site licensee company (SLC) which will be responsible for construction. While it could be argued that there is a separation of functions, the reality is that the public will see no practical separation between the NDA and the SLC.

The NDA also has conflicting roles in terms of the current and proposed funding intentions of many aspects of the decommissioning and waste management programme. It partly funds, for instance, NuLeAF, it will fund the SLC and the overall management programme and will also fund the partnerships if and when they are established. This results in a programme in which all the powers reside with the government or its agencies and not with any body perceived to be independent from government in the role of overseeing body. The degree of power invested in the NDA as a result of the above will disadvantage any community and act as a deterrent to volunteerism. Greenpeace reiterated its view that there should be an independent oversight body that manifestly was not the NDA.

Given these concerns which would make the process extremely fragile and vulnerable, Greenpeace consider the issues of community identification, willingness to participate etc pale into insignificance by comparison.

On the question of membership, Greenpeace considered appointments should be made *ad hominemI* rather than on the basis of a predetermined template. Greenpeace would be raising its concerns about political and public confidence in the process in a letter.

Greenpeace felt that the programme is being largely driven by the need to demonstrate that new build waste can be dealt with and pointed to the recent IAEA report which claims that the UK must catch up in terms of its waste management programme.

Communities:

Nuclear communities, Greenpeace felt, are likely to have different concerns to non-nuclear communities. Unitary authority plans will also have a significant impact on the identification of communities and the way in which they express a willingness or otherwise to participate. Both host and affected communities should be consulted as the areas in which this work is potentially taking place is so large. Greenpeace pointed out that a large turn out for an expression of a view in a travel to work (TTW) area might only be 40% of the electorate.

Greenpeace pointed out that the issue of identifying communities related to the storage issue as well as the repository. Storage was going to be required for a further 40 years or so and conditions applicable to a repository must also be applied to the potential storage sites.

Essentially, Greenpeace's view is that any potential community needs to have a barrier between it and the NDA and the current arrangements do not provide for this.

Volunteerism:

Greenpeace questioned whether local authorities (LAs) can be effective in reaching all citizens in respect of information provision. People need to know what is being proposed and active participation in the process is necessary. It was pointed out that, in some cases, communities surrounding the potential host site might be more willing to participate (an inverse of the 'doughnut' theory where willingness declines with distance from the facility).

While Greenpeace felt that LAs might be seen as more trustworthy than the NDA, they also felt that it was impossible at this stage to see what sort of information provision might be required and what level of success might be achieved in promulgating this information.

The invitation to express a willingness to participate could only come from the government. LAs would receive the invitation and then promulgate within their territory. The information needed and the steps to be taken should be agreed at national level as should an agreement on the obligation to promulgate the information. It would also be necessary to devise a mechanism to settle a situation in which local interest was in favour but the wider LA was against or vice versa. LAs do not have the requisite powers to act as a mediating body but European planning concepts (based on the Aarhus Convention) might help as might a review of the planning process. The energy White Paper in May will discuss planning as does the Barker Report which examines the conflict between the need for deliberation versus the speeding up of the process with less public participation (although the review applies to planning in general and not to nuclear in particular). It was felt that the simultaneous publication of the government's consultation paper on planning and the White Paper on Energy was unusual and could be unfortunate.

Partnerships and packages:

This was discussed only briefly. The partnership must be open and equal in which the interests of the community and the NDA must be equally represented and given equal weight in a balanced relationship. Funding was the key to allowing affected communities a voice. Any package agreed must, in the negotiation, accept that, for some time, there will be an on-going loss to the community. A repository or even a store would result in a long period of blight and amenity loss before any 'benefits' were evident. At Sellafield, for example, a loss of jobs being experienced now is a detriment, a repository will be a detriment and the blight and disruption the community will experience over decades will also result in long term disruption and an initial downturn rather than an increase in wellbeing.

Finally, Greenpeace expressed the view that the 'debate is getting ahead of itself' and the issues being discussed now could easily be postponed for 'a few years' and could be seen quite legitimately as part of a measured 'staged decision making process.'

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6. Actions for CoRWM (what, when, whom):

To take these views into account when providing advice to Government

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7. This note written by:

Pete Wilkinson/Andy Blowers/Brian Clark

Committee on Radioactive Waste Management

Final: 21.02.07

CoRWM Document Number: 2170
Meeting summary

Please could one CoRWM Member complete this for each meeting attended and e-mail it to Sam Bains who will give it a document number.

1. Date, place and title of meeting attended:

21st March 2007, Norfolk County Hall, Norwich, bilateral meeting with the Norfolk Environmental Protection Group

2. Who attended for CoRWM:

Brian Clark
Pete Wilkinson

3. Others present:

Teresa Cannon, Chief Emergency Planning Officer for Norfolk
Glen Buck
Zandra Waterford
Mark Grant, Defra (Rimnet)
Plus other Norfolk District Council emergency planning officers

4. Purpose of attending meeting:

To establish the views of the Norfolk Environmental Protection Group in respect of the implementation issues on which CoRWM has been asked by government to give supplementary advice.

5. Main points discussed / information acquired:

We arrived at the meeting at a point at which Mark Grant (Defra), was about to begin his presentation on Rimnet. This report spares members the details of that hour-long presentation. It was interesting but not germane to our business. There was little time left for a detailed discussion on the issues we brought to their attention. The report below is therefore of necessity brief and presented in bullet points as the discussion was unavoidably rather unstructured since the participants had limited knowledge of the issues.

- The difficulty they saw in the initial debate and which would be important to defining and then seeking participation of a community was –what are the issues and how are they framed and presented in a coherent manner?

- The involvement stage must be based on the provision of information: who determines what information is needed and presented?

- The 'R' word (radioactive) always prompts an emotional response which will militate against rational debate.

- The parish/community council is too small an entity to be considered as potential host communities and in any case they can be over-ruled by the District or County. By the same token, it is worth remembering that a decision at District level can be overturned at County level.

- The first priority for any potential community will be safety and the first question proposers will have to answer is 'Is it safe?' the answer to which will immediately draw challenges.

- Other key issues are the credibility of third party expertise and the perceived independence or otherwise of government. These have been tested on issues such as the 'super-casino' project and incinerators which have featured in the regional political agenda recently.

- How can the debate be 'defused'? It needs to be 're-branded' to convey a climate of even-handed information upon which a rational decision can be made.

- The terms of the community package are critical to success: the benefits must accrue over decades.

- The idea of 'two tier' volunteerism was mooted in which different communities might be able to negotiate different packages based on different waste types they were prepared to host – i.e. HLW, ILW, spent fuel, plutonium etc.

- An exploration of the 'worst case scenario' would be important in that under normal operational circumstances, benefits would accrue but there should be provision for another process to take over which would ensure compensation packages in the event of things going wrong.

- Another idea emerged which was that should the URL prove that local conditions were not suitable for a repository for radioactive waste, the site might be considered suitable for another type of

facility – perhaps for non-nuclear waste. This would avoid having to invest finance and resources to no avail.

- Examples of local partnerships were examined (such as the Great Yarmouth Partnership and the liaison groups established around chemical plant and animal feed companies) and generally found to be operating well, carrying weight and being generally respected although good and equitable representation is always a problem. No solution to guard against self-interest has been found, however, and this is a recurring problem in that it tends to undermine the ability of the groups to operate as openly and as transparently as they might wish.

- In the Great Yarmouth Partnerhsip example, parishes, business interests and local voluntary groups co-operate under the banner of a local authority-run local strategic partnership arrangement.

- Issues of appointment of the members and accountability of the partnership were not explored fully.

- On the right to withdraw from a partnership, those present felt that the partnership should be based on a contract to ensure the goalposts were not shifted and that the 'get involved for the cash' tendency could be guarded against: why get involved in order to withdraw?

- Those present felt that the learning process for a potential community should take place before the community was able to exercise its right to withdraw but also at the point of site specific investigations should conditions arise which were not acceptable to the community.

- Two other useful suggestions were made: the idea of a pilot study to take place without obligation on either side but to explore what a contract (partnership) might look like and what steps would be taken, how information would be provided, ensuring that all issues of concern to the local community might be explored fully without commitment. The second was the possibility of a cooling off period immediately after the agreement to form a partnership to allow reflection before full commitment.

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6. Actions for CoRWM (what, when, whom):

To take these views into account when providing advice to Government

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7. This note written by:

Pete Wilkinson, Brian Clark

nirex

TECHNICAL NOTE

Concepts That Could Aid a Site Selection Process

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PROVISONAL or INTERIM status means this Technical Note is 'work in progress' and has been prepared to facilitate Nirex's work programme and does not necessarily reflect the company's final position.

This Technical Note is part of an ongoing programme of research conducted by Nirex and its contractors. It is a component of the research into options for the long-term management of radioactive waste in the UK.

Nirex want to develop the thinking outlined in this Technical Note through discussions with others. Therefore, this Technical Note should be viewed as 'work in progress' (i.e. interim or provisional status) and Nirex would be grateful for any comments on the ideas put forward. Nirex recognises that the Technical Note only outlines our view and that others may have different views on the issues.

Conditions

Bibliography

A complete bibliography of Nirex publications is available at the Nirex website, www.nirex.co.uk, or from Nirex Corporate Communications at the address below or e-mail: info@nirex.co.uk.

Feedback

We welcome feedback on our reports. Readers are invited to provide comments to Nirex on this Technical Note.

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CONTENTS

Concepts That Could Aid a Site Selection Process

1 Introduction

In the UK the history of inadequate public involvement in decision making in radioactive waste management has contributed to the overall failure to implement government policy. A key feature of any analysis is the nature of the 'contract', implicit or explicit, between a host community, the developing agency and UK plc in general. One perspective on the UK experience is that the implicit 'contract' between UK plc and Cumbria 'required' a repository in return for the continued prosperity of the nuclear industry in West Cumbria. This was not acknowledged openly and certainly not generally accepted by the local population. In future we believe the process within which issues surrounding the location of a radioactive waste management facility are discussed will need to involve open and transparent discussion of the terms of the 'contract' between society in general and any host community. Any such 'contract' must based on the absolute need to meet appropriate safety requirements.

The process itself of how a site selection methodology is established, communicated and implemented will be a strong determinant of how legitimate final decisions are perceived to be. It may be the case that features of processes used elsewhere would be helpful in creating a framework for future public involvement in the UK. Two of the most common concepts in site selection processes are 'volunteerism' and 'veto'; however, even these need to be set within the overall framework of public involvement and government commitment to the process. A wider commitment to financial or structural support for potential future host communities may well have to be a feature of any future site selection process **whether or not communities 'volunteer', or have a veto**.

This note outlines certain features of the site selection processes used in a number of national programmes for the management of solid radioactive waste. Some programmes have encompassed aspects of 'volunteerism' in selecting potential sites for radioactive waste facilities.

By 'volunteerism' we refer here to a community expressing an interest in participating in a process to determine the suitability of siting a radioactive waste management facility in its location. Such an expression of interest must be seen as independent, but may be in response to an invitation by those authorities responsible for carrying out a site selection exercise or it may be an unsolicited offer. It should also be recognised that some countries (notably France and the US) actively encourage volunteerism through cash or social incentives.

With some national programmes, the additional concept of a local community veto has been applied. The term 'veto' perhaps also needs expansion and should be seen in the context of the decision-making hierarchy between the local and the national government levels. In some examples overseas, communities may have a *de facto* veto whereby the implementor may agree to abide by the voting of the community (as in Sweden) although there is no legal requirement to do so. There are also examples of where a formal veto may be overridden by a higher decision making authority. Moreover, in other examples, while a definitive veto does not exist, the community may exert a high degree of influence on the development of a programme.

Authors: E. Atherton, A. Hooper & J. Mathieson

The long-term management of radioactive waste involves issues of intra- and inter-generational equity. We define intra-generational as meaning 'between members of the same generation', and inter-generational as meaning 'between members of different generations'. The current generation has benefited from the electricity, medical treatment and other processes that have led to the creation of the wastes. It could therefore be argued that there is a duty to find a solution to the waste problem on behalf of future generations and to ensure that they do not suffer a detriment at the expense of the present generation's activities.

Finding a solution to radioactive waste could also entail one community 'hosting' the waste. This could be viewed as intra-generational inequity, as one group is agreeing to 'host' the waste for the rest of the population. The issues of intra- and inter-generational equity need to be addressed and any inequity towards the 'host' community or future generations must be dealt with.

Table 1 provides an overview of volunteer siting experiences and the use of a local veto in site selection for radioactive waste facilities around the world; while Appendix One provides more expansive comment on:

- the legal framework that applies to the process;
- the role of Government and / or the legislature in the decision-making process;
- the role and nature of local decision making, including voluntary involvement and rights of veto;
- the benefits on offer for local communities and related issues.

2 Legislative Considerations

In some countries, wide public involvement is part of the history and culture of their democratic process. The degree of legislative basis for interaction with the public in the site selection process, whether volunteerism and/ or use of the veto is part of the process, varies between countries, for example:

- in France, specific legislation (the so called 'Law of 1991') specifies the process in some detail, either directly or through secondary legislation;
- in both Sweden and Finland, more general Environmental Impact Assessment legislation is used to formalise the interactions between the developer and the public;
- in Belgium, the interaction arrangements have been established through initiatives of the waste management organisation, supplemented by signed contracts between the parties.

It is recognised that in the UK context, consideration may have to be given in the consultation exercise to introducing measures, which may or may not require special legislation, to enable formal interactions to take place between the siting authority and the hosting community. In particular, consideration may need to be given to integration with planning law and environmental impact assessment legislation.

3 Technical and Socio-political Requirements

There is a general consensus that, as with any controversial project, the future consideration of siting options for whichever option is chosen for the long-term management of radioactive waste, will comprise both technical and socio-political aspects. While technical aspects of site selection may be seen to follow internationally accepted methods (such as the guidelines published by the IAEA), socio-political processes do vary quite considerably between nations. In particular, the extent and manner of local community engagement with the site selection process is worthy of careful review. What should not be overlooked, however, is that the technical requirements themselves encompass both socio-political and socio-cultural choices and can become highly contested and controversial. Thus, it should not be taken for granted that there is a clear division between technical and social issues; the technical aspects of site selection need to be open to deliberative consultation, and a common understanding of their interpretation established as part of the site selection methodology.

However, it should also be recognised that in countries such as Canada, Finland and Sweden, (and to a certain extent France), the nature of relatively large areas of uniform potentially suitable geology, makes volunteerism in respect of a deep geological facility, less of a technical challenge to the investigating organisation. Within the UK, greater consideration would need to be given to the variance in geology across the country and the relatively small continuous areas of potential suitability.

It needs to be made clear that 'volunteering' is against a background of *openly discussed and agreed conditions*. The 'volunteer sites' are not given any technical dispensation to favour them on such requirements over other sites – they have to satisfy the same technical, safety and environmental requirements as any other site. However, volunteering may be linked to anticipated social and economic benefits. For example, France historically has provided such benefits for nuclear power station sites as a normal part of the development process; and the US has offered financial benefits to States hosting the monitorable retrievable store, and to the State of Nevada for hosting the Yucca Mountain HLW facility (although in return for relinquishing its right to object to the facility).

Site selection processes therefore have to be seen in the context of a comprehensive package of measures, specifically tailored to meet the socio-political and cultural needs and expectations of the communities involved. Volunteer processes and the use of a local veto are potentially important concepts in developing an effective process, but they must be seen to be part of a wider package of procedural measures.

4 Levels of Decision Making and Representation

Decisions to slow down or opt out of the process have not tended always to be made by those directly engaged in the dialogue, but often at higher levels of Government (Regional, Federal, or Cantonal) where wider socio-political issues appear to have contradicted local decisions. Related considerations are:

- recognition by all affected parties as to who is deemed to represent local communities;
- how the views of a wide range of members of those communities are elicited and encompassed; that is, who has the right to volunteer; and

- the extent to which this commands support from all those within the community.

Taking these considerations, when looking at overseas examples, one must be clear as to what the 'entity' is that is taking the decisions on participation in the procedures, what level that represents in government hierarchy, and whom such an entity represents. Again this varies between countries, for example:

- in Sweden, it is the Municipality (the administrative unit below county level) that takes the decisions, based on referenda, on accepting the waste management organisation into its area;
- in France, it was at Départment level that decisions on the question of expressing an interest in the volunteer site selection exercise were made. However, it was at the town council level that local public inquiries were heard and at Ministerial level that the final directions on investigations were made. In some cases local Mayors arranged for referenda to be carried out, but these are regarded as non-constitutional and carried no legal weight;
- in Switzerland, the Wellenberg site, in the community of Wolfenschiessen, proposed by the waste management company NAGRA, was accepted through a referendum by that community but rejected in a further referendum at the higher Cantonal level; and
- in Canada, there has been some dispute over representation and the meaning of local acceptance. Given the dispersed and diverse nature of the populations in some areas, there was not always agreement between various interested groups on representation.

Moreover, it should be recognised that site selection is progressively definitive. The Swedish example is quite instructive in this sense. Siting studies range from countrywide studies, through to 'county specific general studies', then to feasibility studies at municipality level. This has the aim of identifying 'areas of interest' and ultimately prioritising these for further investigation, before deciding on a more exact location.

5 Features of Volunteerism and the Veto

Based on observations of other programmes, the features of allowing or encouraging communities to put themselves forward for consideration as a potential host site, include the following:

- the early establishment of open dialogue at the local level;
- communities do not feel that selection has been imposed upon them by some unknown entity applying only technical criteria without due consideration of their involvement in decision making;
- local representatives, including Members of Parliament, are fully aware of the commitments and are not embarrassed by an unanticipated announcement;
- an early understanding by all parties that meeting the technical selection requirements is essential, but not sufficient, for the establishment of a facility;

- clear commitments from all stakeholders to engage in open discussions;
- increased accountability between the facility development organisation and the local community;
- the volunteering community has to recognise its responsibilities with respect to the long-term nature of its decisions. A local government representative is elected typically for four years but may be participating in a decision, which will last well beyond that timescale and span generations. Further, the siting organisation needs to receive some comfort that such a decision will not be revisited within the timescales suggested by its degree of commitment to the stage it has reached within that community. Feasibility studies may take place within an election period, underground investigations within several, and if the site is ultimately chosen, operations may last well over one or two generations;
- related to the last point, a risk that, assuming veto powers to 'walk away' from the process are established, they may be exercised at some point, thereby resulting in wasted expenditure. Experience suggests that this risk is primarily related to those who are not directly engaged in the dialogue process from the outset. Those who are so involved are less likely to exercise the veto. This emphasises the need to encourage opponents and critics to participate in dialogue;
- the potential misinterpretation of the arrangement – for example that relaxed safety principles may be applied to a site that has 'volunteered'. Effective communication and dialogue should overcome this; and
- the need to make clear that any social and/ or economic investments in a volunteer community are entered into within a transparent and agreed framework. Any future processes will need to establish the range of appropriate measures or agreements that can legitimately be entered into.

6 Equity and Community Benefits

The equity issue may need to be addressed in the form of benefits to the local community; these might be, for example, in the form of enabling them to participate in the dialogue surrounding the siting and development of the waste management facility, and/or the provision of community facilities. Providing community benefits has to be handled carefully to avoid the criticism that the local community is being 'bribed' to accept a facility, and the benefits must be appropriate to the facility and of the right order of magnitude.

In the case of future generations, it may be necessary to set up a trust fund (as has been considered in Switzerland), to help them to deal with any issues identified as being passed to them by the present generation (e.g. evaluation of long-term monitoring results to inform consideration of eventual repository closure).

Issues to be considered include:

- are the community benefits defined before the community volunteers to host a facility, or do they develop over time?
- at what stage should benefits be provided? e.g. when a community volunteers, when the investigations start, when the site is identified as technically feasible, when construction begins or when the facility is operational;
- who controls the community benefits funds and how they are spent?
- who should be involved in negotiation about the community benefits: can the community influence what is paid and where the money is spent? and
- should the community benefits be defined by law?

Table 2 indicates where community benefits measures have been used in other countries. Several types of benefits have been made available to local communities and most of these are to enable a community to engage in the debate surrounding the siting of a facility or to help to alleviate the increased pressure put on infrastructure due to the development. Thus there is a timing issue of when benefits are first paid, which can date from the initial approach to carry out initial investigations, all the way through to construction and operation of a facility. Moreover, in the examples shown it can be seen that the contributions associated with the various phases escalate by orders of magnitude.

The benefits can be categorised as follows:

Community Empowerment Measures: Such measures are designed to enable the community to participate and influence the debate surrounding the development of the site:

- provision of information about the development;
- establishment of local groups to monitor the facility and engage in debate with the development organisation;
- funding for the community to hire their own experts to check the investigations carried out by the development organisation; and
- funding for the community to hire advocates to present their case in formal proceedings.

Social Benefits: These are designed to offset the potential stigma attached to volunteering to host a facility.

- payment of local taxes;
- guarantees of employment for local people;
- local training, so people in the area can be recruited for jobs;
- support of local service industries;
- investment in public services (e.g. new roads, hospitals, recreation facilities); and
- guaranteed property prices.

Economic Benefits (or Recompense): These benefits could include a variety of mechanisms for economic regeneration at a local and regional level. Infrastructure projects and ongoing business incentives could be partly tied to the project. The ideas for exact form(s) of assistance would have to be worked up with representatives of key stakeholder groups.

Under the existing legal regime in the UK the possible range of benefits to a local community include:

Planning benefits, often referred to as 'planning gain'. The Department of the Environment Circular 1/97 sets out guidelines for the types of benefits which can be accepted by the local planning authority in connection with the grant of a planning permission. The benefits are usually proportional to the size of the development and its perceived impacts on the local community.

Provision of an assistance scheme for property owners indirectly affected by the development. Under present UK law compensation for 'planning blight' is only available where the developer has powers of compulsory purchase and is further restricted to those owners whose property is required for the development or will be physically affected by the development. It is possible for a developer to establish a voluntary system of assistance which goes beyond the requirements of the law, which may assist in meeting public concerns with regard to the perceived impact of proposals on property prices. There are precedents for such schemes in the UK.

Payments of consultants fees for the planning department and local community. A fee has to be paid when a planning application is made that in part reflects the amount of time and resources that the planning department will have to incur to review the plans. There are also precedents where the developer has voluntarily reimbursed the fees of consultants hired by the local planning authority. This could be extended to pay for consultants hired by the local community.

The land use planning system in countries providing host fees is very different to the system in the UK. The UK system is founded on the principle that planning permission should be neither bought nor sold. Therefore, current UK law would not allow the payment of host fees.

The consideration of community benefits should not be dependent on a community volunteering, all communities should qualify, independent of how their area had been chosen.

At another level consideration could be given to a change in policy, whereby a particular community was seen to be taking the waste on behalf of the rest of the UK. In this situation ethical issues would be key, safety must be sacrosanct and recompense could be substantial and geared at meeting the key requirements of the community. The requirements of surrounding, associated communities would also need to be considered, but to a lesser degree. This approach would allow the community itself to define the need for benefits.

7 Conclusions

To conclude, experiences in other countries indicate that while 'volunteer sites' have been encouraged, they have not always necessarily proved to be successful in terms of ultimately establishing a facility at that site. However, they have been successful in establishing a process of open dialogue between the facility developer, regulators, and other stakeholders at the local level. Taking account of these experiences, and recognising that there are historical and cultural differences, consideration of a contract between society and a local community and within that context volunteerism, the use of the veto and benefits for a community should be an integral part of the forthcoming DETR consultation exercise. Several other issues are also worth debating at the beginning of the process:

- the establishment of mechanisms to promote open dialogue with all stakeholders at all levels;
- consideration of communities involvement in decision making about siting and facility development;
- early understanding by all parties that meeting the technical selection requirements is essential, but not sufficient, for the establishment of a facility;
- increased accountability between the facility development organisation and the local community; and
- the range of and control of community, social and economic benefits that could be made available during the siting, development and operation of a facility.

Summary Table 1

Country	Experience of Site Selection including aspects of 'volunteerism'	Application of local Veto powers	Comment
Belgium	Yes, ongoing now for L/ILW disposal. HLW programme under consideration.	Yes, partnership community can 'walk away' at any time.	Several communities have agreed to enter into 'partnerships' with no irrevocable commitment to establishing a facility
Canada	Some, for LLW and historic wastes, but now in abeyance for these and HLW.	Yes.	LLW siting seen as good example of volunteerism, despite failures.
Finland	Yes. Potential sites selected through mixture of volunteer and geological screening process.	Yes, law requires local community to give a positive indication.	Volunteer sites have been actively engaged by the EIA consultation.
France	Yes, for URLs, under 1991 French Law a Mediator was appointed to guide the process.	Public Inquiry process results in Govt. decrees directing ANDRA to investigate.	Volunteer URL site under investigation. Volunteer sites are common in France for a wide range of industrial activities including NPPs in return for economic and social benefits.
Germany	No.	Historically no.	Since new German Government elected, site selection process under review through 'consensus talks'.
The Netherlands	Site selection by Govt. committee in 1984 identified 3 'willing' sites. Borsele storage site chosen by COVRA.	No.	Dutch policy is above ground storage for 100 years at an industrial site.
Spain	No. HLW programme in abeyance. El Cabril L/ILW facility was an existing storage facility.	In effect for El Cabril, through planning process.	Site selection for HLW in abeyance. El Cabril L/ILW facility in operation since 1992.
Sweden	Yes. Since 1992 SKB have invited participation of communes.	SKB have agreed to abide by community decision. But Govt can override local veto.	A total of 8 sites have volunteered for feasibility studies, 3 have nuclear traditions, and 2 have withdrawn.
Switzerland	No.	Yes through referenda at various local levels but which can be overridden by higher Cantonal and Federal Govt.	Role of referenda important and question can be re-put at later dates.
USA	Yes for LLW and the temporary fuel store (MRS), but not for the operating TRU deep disposal facility (WIPP) in New Mexico or the HLW programme at Yucca Mountain, Nevada.	Yes, but Congress can override State's decision.	Historically proactive and innovative processes but limited success away from established nuclear sites. Siting of the MRS failed despite financial compensation and use of special Negotiator.

Table 2 Overseas Examples of Community Benefits

Country	Community benefits offered*
Belgium	ONDRAF/NIRAS finance the costs of the local partnerships within budgetary limits. Other economic benefits are not prescribed.
Canada	In the LLW siting programme, property values and employment were 'guaranteed' for a potential host community. Pure financial recompense had been proposed for a particular site, but the programme is now in abeyance. Finance was made available for community liaison groups, 'open houses', publicity materials and visits to other management facilities.
Finland	No incentives or compensation required to be paid directly by the Government. However, nuclear facilities pay a local property tax at the highest rate of 2.2% while the average rate is 0.5-1.0%. This property tax is seen as the most obvious benefit for the local community. As reported in the 1999 EIA report, the direct effect of such increases in tax revenue from the siting a facility (income, property, and corporation) may be partially offset by 'national tax revenue equalisation'.
France	In the URL programme, financial aid to contribute to local development and improving the natural environment is required to be paid under the 1991 Law. FF5 million / year (~£0.5M) is payable to a local authority during the borehole drilling phase to compensate for loss of business tax due to the peripatetic nature of process. Up to FF60 million (~£5.6M), as a 'economic supporting measure' for the Départment hosting the URL (both Meuse and Haute Marne receive this payment as the URL is located near the border of the two). FF60 million (~£5.6M) is equivalent to twice the 'host fees' payable to a Départment hosting a single reactor 900 MW(e) PWR. Moreover, this package is in addition to the normal finance received from the Central Government for local government purposes. For the near-surface repository at Centre de l'Aube, which commenced operation in 1992, ANDRA (with the Ministry of Industry) set up a 'matching' fund of FF35 million (~£3.3M) which has to be targeted at specific projects attracting equal funding from the local community. ANDRA also pays an additional FFr1.5 million (~£0.1M) in local taxes each year and guarantees to fill specified proportions of construction and operational jobs with local labour.
Germany	Notwithstanding the new site selection process, no incentive requirements are currently explicitly stated in the Law. However, the Government of Lower Saxony was offered an annual grant of several million DEM (DEM 1 million ≈ £0.3M) from the Federal Government in respect of Gorleben, but the payments were refused and the arrangement remains suspended.
The Netherlands	No specific incentive requirements regarding the interim storage site at Vlissingen are specified.
Spain	Allocation of monies from the Waste Management Fund for guaranteeing minimum incomes to hosting communities is prescribed by Ministerial Order and is dependent on the type of facility under consideration (nuclear site spent fuel storage, central fuel storage, NPP undergoing decommissioning, L/ILW storage / disposal facility) population density, and distance from the facility. No compensation order yet exists for a deep disposal facility for HLW / spent fuel. Low and short-lived intermediate-level waste is disposed of at El Cabril near Cordoba, which came into operation in 1992. About Ptas 3,000 million (~£1.1M) is paid each year to the town councils located near to El Cabril.

* Note: Currency conversions are as at October 2000 so should be treated with some caution when referring to historical figures.

Country	Community benefits offered*
Sweden	Volunteering communities can request up to up to SEK 2 million (~£0.14M) from the Waste Management Fund to support local review groups, to monitor SKB's work and for public information programmes. No specific provision for other community benefits.
Switzerland	Swiss law also requires both the host community and the Canton to receive financial and material 'remuneration' once it has accepted hosting a facility. For the proposed L/ILW repository at Wellenberg, it is understood that a one off payment of SFr 2.3 million (~£0.9M) would be have been made available to the Canton government. If a facility had been developed, then about SFr 3.5 million (~£1.4M) per year for the 40 year operational period would have been paid. On a similar basis at Community level a one off payment of SFr 3 million (~£1.2M) and an annual payment of SFr 300,000 (~£0.12M) would have been made.
UK	
USA	To facilitate the siting of a Monitorable Retrievable Store, the 1987 Nuclear Waste Policy Act (NWPA) established the Office of the Nuclear Waste Negotiator whose task was to find a willing host state or Indian Tribe in exchange for negotiated benefits. However, although some progress was made with a number of Indian Tribes, the negotiation process was terminated without result. For Monitorable Retrievable Store: Payments or grants to assist the affected community in deliberating the issues. $10 million (~£6.7M) in annual payments to State/Local governments, during the lifetime of the facility. Note that the MRS siting process now in abeyance. Potential benefits available also included: infrastructure, recreational and environmental improvements, public and higher education programmes, health care programmes, tax subsidies, local employment agreements and direct financial assistance. The siting programme for HLW and spent fuel is centred on Yucca Mountain, Nevada under the 1987 Nuclear Waste Policy Act (NWPA). The NWPA provides for a benefit package for Nevada of $10-20 million (~£6.7-£13.4M) per year provided the right to object to the proposal is waived; but to date this has not been taken up by the State.

Appendix One

1 Introduction

This appendix considers the processes of site selection in the following countries:

- Belgium
- Canada
- Sweden
- Finland
- France
- Germany
- Spain
- Switzerland, and
- the USA.

The information has been derived from a number of sources, some published and some provided directly by the radioactive waste management agencies, or equivalent, in the countries concerned. As precise provisions of overseas law and policy may be complex, this note attempts no more than a summary.

2 Belgium

2.1 General

There is no specific legislation covering site selection in Belgium, nor is financial compensation required to be made to affected local communities. The radioactive waste management agency, ONDRAF/NIRAS, a public body set up under Royal Decree, is responsible for site selection and for proposing waste management strategies to Government.

2.2 Low and short-lived intermediate-level waste

Following an unsuccessful attempt to site a near-surface facility in the mid-nineties, for low and short-lived intermediate-level waste, ONDRAF/NIRAS since 1999 has concentrated its activities on the development of local 'partnerships' to facilitate project proposals in sites showing an interest to host a facility.

Such local partnerships involve ONDRAF/NIRAS working through independent (University research – based) mediators with local stakeholders in the development of a proposal for a disposal project which is seen as an integrated part of local development. The project is intended to satisfy both technical/scientific and socio-economic criteria before being proposed to government.

Membership is specific to the individual partnership but the general intent is that it should comprise representatives of all the local political parties (opposition included), the various economic, social, cultural and ecological stakeholders actors, and local industry. It is structured around a general assembly, a management committee, and working groups who perform most of the detailed work. The partnership has its own budget provided by ONDRAF/NIRAS.

On 30th September 1999, the first partnership was signed between ONDRAF/NIRAS and the local authorities of Dessel (on whose territory the centralised interim storage buildings of conditioned waste are located). The local authority of Mol (where the national nuclear research centre CEN/SCK is located) was signed in October 1999. The authorities of the zone Fleurus-Farciennes (where the national Institute for Radio-Elements - IRE - is located) were initially interested but decided to let their final agreement depend on the results of preliminary soil examinations on the site of the IRE that are presently taking place.

The authorities of the municipality of Huy (where Tihange NPP is located) have shown no interest so far, while the authorities of the municipality of Beveren (where Doel NPP is located) have yet to decide on starting negotiations with ONDRAF/NIRAS.

The partnerships function at four levels:

1. The 'general assembly' (or Partnership Council) which involves all the parties and formally represents the 'Partnership';
2. The management committee which is appointed by the general assembly;
3. Project Co-ordination on a day-to-day basis; and
4. Working Groups which are the active basis of the partnerships.

Briefly, the working groups will review and develop draft project proposals with the support of ONDRAF/NIRAS acting as 'partner and expert', but also with access to independent expertise. The partnerships as a whole will decide on priorities and take decisions, organise dialogue and be responsible for keeping the local population informed. Final proposals will have to be approved by the local councils concerned prior to submission to the federal government in 2001–2002.

2.3 High-level waste and long-lived intermediate-level waste

For the disposal of high-level and long-lived intermediate-level waste, ONDRAF/NIRAS has been investigating the Boom Clay geological formation at the Mol-Dessel nuclear site. If the safety assessment results continue to show that Mol is favourable then ONDRAF may propose detailed investigations in the Boom Clay at a potential site in 2015 (though not necessarily at Mol itself). Disposal could commence from 2050, but possibly not before. Current plans are to publish a technical report - SAFIR 2 – by the end of 2000, on research undertaken to date, which will be submitted to the NEA for independent peer review. An accompanying strategic document will address potential approaches for stakeholder dialogue on high-level waste and long-lived intermediate-level waste in Belgium.

3 Canada

3.1 General

Canada has a diversity of wastes arising from nuclear power generation (spent fuel and LLW), industrial and medical wastes, and uranium mining and milling (which is not considered further here). In July 1996 the Federal Government announced a new policy framework for radioactive waste intended to guide Canada's disposal approach for all such wastes into the next century.

3.2 Nuclear fuel waste

There is no specific legislation relating to siting of disposal facilities for spent fuel. In 1978 the Governments of Canada and Ontario established the Nuclear Fuel Waste Management Program. This provided for a disposal concept to be developed by Atomic Energy of Canada Limited (AECL, a Crown Corporation) in co-operation with Ontario Hydro (now Ontario Power Generation, OPG), the largest single producer of spent fuel.

In 1989 the Government appointed a Federal Environmental Assessment Review Panel to review the disposal concept prior to the start of work on siting. Public hearings to consider AECL's Environmental Impact Assessment ('EIA') for the concept were held between March 1996 and March 1997, covering a broad range of issues. Included in AECL's EIA were its recommendations for the siting process, which included volunteerism and shared decision-making. Whilst the new Policy Framework does provide that an organisation be put in place to implement the disposal concept, none exists as yet. However, AECL and OPG have formed a joint task team to consider such an action.

The hearings, held in numerous communities across Ontario, took place in front of a panel of experts drawn from both technical and sociological backgrounds, and was managed by the independent Canadian Environmental Assessment Agency (CEAA). Organisations and members of the public who wished to make submissions to the panel were able to apply for so-called 'intervenor funding', which allowed for the use of external consultants and advisors. 'Participant funding', to allow individuals and members of community councils etc. to attend hearings in their localities, was also made available.

The Panel publicly released its report on 13 March 1998. Chairman Seaborn said that although AECL's plan appeared technically sound, *'in its present form it does not have the required level of acceptability to be adopted as Canada's approach for managing nuclear waste.'*

Amongst its recommendations the Panel said that a new nuclear fuel waste management agency (NFWMA) should be set up. By May 2000, the utilities had signed an MOU to create a waste management organisation and a draft plan for long term options is being developed, but it is understood that no decision on deep disposal will be taken before 2004.

3.3 Low-level waste

Low-level waste is defined in Canada to include all waste from nuclear activities (except spent fuel and uranium mine and mill tailings). It includes materials which in the UK would be classified as short-lived intermediate-level waste. It is further administratively classified as either 'historic waste' or 'ongoing waste'.

3.4 Historic waste

A large proportion of the LLW inventory comprises historic wastes, consisting mainly of contaminated soils (1,000,000m^3) for which the original producer is no longer responsible. In 1982, the Government established a Low-level Radioactive Waste Management Office to assume responsibility for these wastes. In 1988 the Minister for Natural Resources appointed an independent Siting Task Force to carry out a voluntary siting process to find a disposal site. In 1995, the Task Force issued its final report to the Minister, identifying Deep River in Ontario as a willing host community.

However, problems arose during late 1996. Natural Resources Canada (NRCan) refused to accept the *'Community Agreement in Principle'*, which had been negotiated between the Deep River community council and the Task Force. The Agreement formally lapsed at the end of 1996.

Employees of AECL dominate the population of Deep River, and plans announced in late 1996 to downsize that organisation, as a precursor to privatisation, had caused uncertainty about long-term employment prospects in the area, and so job guarantees were included in the Agreement.

The issue finally came to a head in late October 1997 when the Council formally voted to withdraw from the process completely, although NRCan has still not ruled the community out.

In August 1997, Hope Township asked to be considered as a potential repository host location.

3.5 Ongoing waste

LLW from continuing nuclear research and power generation will require disposal in one or more facilities. The waste producers are working on options that include developing an independent OPG facility or a multi-user facility. AECL has developed a prototype Intrusion Resistant Underground Structure for the disposal of short-lived waste at its Chalk River plant in Ontario. This is currently undergoing licensing.

4 Finland

4.1 General

The Nuclear Energy Act, as amended in 1994, requires radioactive waste generated in Finland to be disposed of within the country and prohibits the import of such waste. The Ministry of Trade and Industry (MTI) formulates disposal policy, sets objectives, supervises activities and undertakes its own research and development. The power companies, IVO and TVO, are responsible for waste management and disposal and in 1995 they set up the spent fuel disposal company, Posiva Oy. Operational arisings of low and short-lived intermediate-level waste from the two power station sites (Olkiluoto and Loviisa) are disposed of in repositories constructed at around 100m depth at those sites and are not considered further here.

The Ministry of Trade and Industry sets target schedules for Posiva to implement spent fuel disposal policy, including the siting process. Community benefits are not required to be provided at any stage of the process.

Spent fuel

In 1983 TVO drew up a list of 101 sites and undertook a consultation process with the affected communities. This resulted in the identification in 1985 by TVO of 5 potential 'volunteer' sites at which more detailed investigations were carried out. In 1992, TVO announced that further investigations would only be carried out at Romuvaara in Kuhmo, Kivetty in Äanekoski and Eurajoki (near to the Olkiluoto nuclear site). Interim reports on these sites were produced at the end of 1996. However, following indications by the local community in Loviisa, that they too wished to be included, that site was also added to the list.

According to the Nuclear Energy Act, the first authorisation step towards a final repository of nuclear waste is the so-called Decision in Principle (DiP). At this step the Government had to consider whether 'the construction project is in line with the overall good of society'. In particular, the Government paid attention to the need of the facility, the suitability of the proposed site and its environmental impact.

Under the legal requirements the Radiation and Nuclear Safety Authority (STUK) had to make a preliminary safety appraisal of the DiP application and the proposed host municipality must state its acceptance or rejection for siting the facility. The decision has then to be endorsed by the Parliament. The application for the DiP includes also an Environmental Impact Assessment (EIA) report for the planned facility.

In May 1999, Posiva Oy submitted an EIA report to the MTI and a DiP application to the Government. The EIA report addressed all four candidate sites. After hearings in November 1999, the Ministry gave its statement, which completed the EIA process. During the hearing period 15 authorities and public bodies, 5 civic organisations and communities and 23 municipalities submitted their statements on the EIA report to the MTI. In addition, some 15 private persons sent their opinions.

The opinions expressed by the authorities and municipalities were mainly positive and the EIA report was regarded as wide and thorough, although one concern was the potential deterioration of the image of a municipality. The anticipated impact on health rendered by the transport of spent fuel was also of concern. The opinions of private individuals and civic organisations on the EIA, as well as on the whole disposal project, were in general critical and opposing. Their viewpoints were, however, mainly focused on issues outside the scope of the EIA.

The MTI concluded in its statement that the EIA was sufficiently comprehensive and detailed and fulfilled the requirements set by the EIA legislation. The Ministry, however, points out that a construction licence application for the disposal facility, scheduled to be submitted after 10 years at the earliest should include an enclosure corresponding to an updated EIA report.

The DiP application addressed only the Eurajoki municipality. STUK engaged an international review team, to support its preliminary safety appraisal of the DiP application. The team summarised their findings in a consensus report to STUK in October 1999. In addition, STUK requested statements from several Finnish research institutes which have participated in the publicly funded waste management research programme. STUK submitted a preliminary safety appraisal of Eurajoki to MTI in January 2000. In this appraisal STUK concluded that the prerequisites for a DiP from the standpoint of nuclear and radiation safety were met.

In January 2000, the Eurajoki council gave its approval to the DiP application (20 votes for, 7 against). The Government's decision and Parliament's ratification may be delayed due to an appeal to administrative court by a citizen of Eurajoki but are expected to take place by the end of this year. The Nuclear Energy Act provides that the Council must reject the application if either the municipal council or the safety authority is opposed and that Parliament has to confirm or veto the Decision in Principle by the Council of State.

It is planned that in 2003 an investigation shaft will be constructed at the chosen site and in 2010 a construction permit will be sought. If the permit is granted by 2013 then construction will start and first emplacement of spent fuel could take place by 2020.

5 France

5.1 General

The waste management organisation in France is ANDRA, established as the national disposal agency under the 'Law of 30 December 1991' governing research activities on HLW disposal. It operates near-surface disposal facilities for low and short-lived intermediate-level waste at Centre de la Manche (now closed and not considered further here) and Centre de l'Aube.

5.2 Low and short-lived intermediate-level waste - Centre de l'Aube

The site selection process for the near-surface repository at Centre de l'Aube, which commenced operation in 1992, began in 1985. ANDRA's predecessor organisation identified five potential sites, from which the Aube site was selected as the preferred one. The original shortlist included a number of 'volunteer' sites where the local mayors had indicated that they wished for their communities to be considered by ANDRA, but none was eventually deemed geologically acceptable.

5.3 High-level waste and long-lived intermediate-level waste disposal

5.3.1 The Law of 1991

The 1991 law on R&D redirected the French deep site investigation process following the abandonment of an earlier HLW programme; (that programme sought to identify promising disposal sites primarily by reference to geological considerations). The 1991 law contains several parallel provisions:

- a 15-year research programme covering:
  - separation and transmutation of long-lived radionuclides in waste,
  - deep disposal studies 'through the creation of underground research laboratories (URLs)', and
  - long-term surface storage techniques;
- at the end of the 15-year programme (in 2006) the preparation of a report (by a National Review Board) together with a draft law to be submitted to Parliament for a decision on the creation of a deep disposal facility at one of the URL sites; and
- a requirement that local officials and members of the public from the affected sites be consulted before any site investigations begin preliminary to URL construction.

5.3.2 The Underground Research Laboratories

A mediator - M. Christian Bataille - was appointed under the 1991 law and was specifically 'charged with leading public involvement prior to the selection of URL sites'. His mediation mission established three objectives: information provision to the public, open dialogue and decision facilitation.

The siting process for the URLs began in January 1993. By December of that year some 30 sites had volunteered for consideration. Ultimately, M. Bataille recommended four potentially suitable sites. Two were subsequently merged so that three locations were then under consideration: a clay geology in north-eastern France on the border of the Meuse and Haute Marne Departments (the Bure site); a clay geology beneath the Marcoule nuclear site in the south of the country in the Gard Department; and a granite geology in the Vienne Department in western France. Programmes of surface-based investigations at these sites, which comprised drilling between two and four boreholes plus geophysical measurements, were completed in April 1996.

In May 1996 the Council of Ministers authorised ANDRA to submit requests for the installation and operation of URLs at each of the three sites. Authorisation of the URLs was scheduled to be completed in 1998, following review of the submissions by DSIN (the nuclear regulator) and Ministry of Research, together with public hearings and other forms of local consultation. Public hearings at the sites ran from January to May 1997.

In December 1998, the Government confirmed that two sites should be investigated: the Bure site and a granite site to be selected. A decree was issued in August 1999 allowing ANDRA to commence construction of the URL and the establishment of a local information committee at Bure, and launching the consultation exercise to select the granite site.

The granite site selection process is expected to finish in 2002/3. An initial geological screening, begun in February 1999, identified 180 'plutons' (granite formations) in the country and by July 1999 this had reduced to about 15 sites following consideration of hydrogeology. After a further screening phase, 7 sites were still under consideration in February 2000. The Granite Advisory Committee of 12 experts involving ANDRA and BRGM (national geological agency) manages the programme which comprises a number of stages:

- Stage 1 - seek consensus through consultation / volunteerism (by June 2000, but essentially stalled at the moment);
- Stage 2 - selection by government by end of August 2000 of a sites or sites wishing to be considered further;
- Stage 3 - confirmation by ANDRA of geological suitability; confirmation by DSIN; setting up of Local Information Committees;
- Stage 4 - public inquiries plus endorsement by local authorities within 10km radius of sit. This is seen as a consultation process rather than giving the LA's a specific veto.
- Stage 5 - 2002/3. Decision by government to authorise construction of URL.

6 Germany

6.1 General

The overall regulation of radioactive waste management is controlled by the Federal Atomic Energy Act, but licensing of disposal facilities lies with the *Länder* (State) Government. As radioactive waste disposal in Germany is intended to be undertaken exclusively in mined repositories, the Federal Mining Act is also relevant.

The Federal Government is currently considering amendments to the Atomic Energy Act. If accepted, licensing would become a federal responsibility through the Federal Office for Radiation Protection, BfS.

BfS is currently responsible for the construction and operation of repositories, with technical work sub-contracted to the company DBE. If BfS do take over the licensing responsibility from the Länder, then disposal responsibility would be given to a new body yet to be created.

Two potential repositories are located in Lower Saxony (Gorleben and Konrad) and a facility at Morsleben, in Saxony-Anhalt in the former East Germany, has been in operation since 1970. Until 1978, some disposal was undertaken at a salt mine at Asse, but subsequently the site has been used for research purposes only. Government policy is that all toxic waste, both chemical and radioactive, should be disposed of (though not co-disposed) in geological formations.

Under the new German government, a working group on site selection has been set up by BMU, membership of which includes anti-nuclear experts, use of the Internet, MP's workshops, NGO's and unions. They will review existing criteria and will look at international practice and propose the 'relatively best site' in the country. Their first report is expected later this year. The exiting sites under investigation will be part of the process. There is also a stated government aim of having just one repository for all German wastes but this conflicts with some arguments in Germany that heat generating and non-heat generating wastes should be separate.

6.2 Gorleben

The Gorleben site (for the disposal of heat-generating radioactive waste in a salt dome) was proposed in 1977 by the President of Lower Saxony. By way of financial benefits, the Government of Lower Saxony was offered an annual grant of several million DM from the Federal Government, but the payments were refused and the arrangement remains suspended.

Two shafts are linked at a depth of about 840m and underground infrastructure is in place. Given the pattern of ownership of mineral rights, only part of the area has been investigated to date but this is expected to provide sufficient capacity for the expected disposal volumes. It was intended to complete long-term safety assessment at a date between 2003 and 2005 but currently there is a moratorium of further detailed investigations. If a licence were then granted by 2008 the repository could be operational by 2015.

6.3 Konrad

Investigations carried out from 1976 indicate this is a potentially good site for low and intermediate-level non heat-generating waste. Konrad was previously an iron ore mine and in 1976 the Federal Government asked GSF (Federal Research Centre) to investigate its suitability for repository use.

The current licensing process allows for public consultation of the licence application. In the case of the Konrad application, the Lower Saxony Ministry of Environment held a public hearing to consider technical objections to the application. A report was subsequently submitted by the Ministry to BfS resulting in a number of changes. The licensing process is still continuing but a stand off exists between BfS and the *Länder*.

6.4 Morsleben

Since the start of operation in 1970, until September 1998 when the Länder courts stopped disposal, some 22,320m^3 of waste (mostly LLW) had been disposed of. The licensing procedure for the sealing and closure of Morsleben is under way.

7 The Netherlands

Following abandonment of its sea-dumping programme, in 1984 the Dutch Government produced a policy paper on radioactive waste management, which called for long-term (100 years), above ground storage, and also set up the waste management company COVRA.
A site selection procedure was started under the direction of a Government committee. In less than a year the committee found three sites in two municipalities willing to accept a long-term storage facility.

A pre-requisite for the siting choice was that it should be an industrial location, large enough to store 100 years worth of radioactive waste. COVRA had the final say in site choice and having chosen Borsele (close to the nuclear power station) the licensing procedure for the construction of low and intermediate level radioactive waste storage facilities started in 1987.

For the handling and storage of HLW the construction of a naturally cooled storage vault is in its engineering phase. The construction of this vault started in 1997 and the first shipment of conditioned HLW from reprocessing is scheduled for 2001.

R&D on final disposal is a task primarily for Government since no final decision has been taken on the policy for disposal. As the volumes of waste produced are small, only a single facility for LILW and HLW is required.

8 Spain

8.1 General

Responsibility for siting, constructing and operating repositories lies with ENRESA under a Royal Decree of 1984. ENRESA is a limited liability company, independent of the waste producers and responsible to the Ministry of Industry. Further Decrees (the latest issued in 1998) authorise ENRESA to compensate local communities for hosting both storage and near surface disposal sites.

Periodically, ENRESA prepares and submits to Government a General Radioactive Waste Plan (GRWP) covering all aspects of radioactive waste management. Four such plans have been adopted in the past and a fifth is currently before the Government.

8.2 High-level waste and spent fuel

The policies for identifying definitive solutions for these wastes are presented in the Fifth General Radioactive Waste Plan of 1999. That indicated that the strategy adopted until then regarding geological disposal would be supplemented by research on separation and transmutation. Decisions on options, including site selection, will now not be taken until 2010.

8.3 Low and short-lived intermediate-level waste disposal

Low and short-lived intermediate-level waste was initially stored at a facility sited at El Cabril near Cordoba. Characterisation work to assess suitability for disposing of waste there began in 1986. In 1989 the local planning authority approved a disposal application and the facility came into operation in 1992.

9 Sweden

9.1 General

Under the 1984 Nuclear Activities Act, the disposal company SKB is required to submit R&D plans for review every three years; these include proposals on site selection. As site selection progresses beyond drilling into more detailed characterisation, an investigation permit is required under the Act from SKI/SKN (the nuclear inspectorate and the nuclear fuel board respectively). Approvals are also required under the Conservation of Natural Resources Act and the Planning and Building Act.

9.2 CLAB spent fuel store and the Swedish Final Repository

The siting in 1978 of a 'CLAB' facility, for the interim underground pond storage of spent fuel, was decided following open negotiation with Government, regulators, external reviewers and local authorities at a number of sites. The site chosen lies alongside the Oskarshamn nuclear power station on the Baltic coast which also hosts the Äspö underground rock laboratory.

The siting at Forsmark of the Swedish Final Repository (SFR) for low and short-lived intermediate-level waste underwent a similar process to CLAB, with no objections to the proposal from the local authorities. Forsmark is also the site of an established nuclear power station on the Baltic coast.

9.3 Spent fuel

In 1995 SKB published plans for site investigations and other work envisaging first stage operation of a deep repository in 2008. The Government gave broad approval to SKB's proposed siting process and emphasised the importance of a well-defined and transparent process. The main steps include publication of siting factors (covering safety, technology, land and environmental impact, and societal aspects); publishing countrywide siting studies; and undertaking feasibility studies of between five and ten sites. These would be followed by more intensive surface-based investigations at two or more sites, after which an application would be made for construction of a shaft and/or tunnel for detailed investigation of a preferred site.

In September 1998 SKB submitted its new programme to SKI. The programme has been reviewed by a large number of national organisations, including SSI. In April 1999 SKI delivered its recommendations to the government. In its decision in January 2000 on SKB's RD&D programme -98 the government said that the programme fulfils the requirements in the Act on Nuclear Activities.

Whilst there is no special legislation governing siting in Sweden, SKB has agreed to respect the results of local referenda in municipalities proposed for siting studies. But any veto has no statutory force and the Swedish Government could override local objections and grant permission for studies to be carried out. KASAM (the Swedish National Council for Nuclear Waste, an independent review body) has requested the Government to specify the circumstances in which it might judge such action appropriate.

Environmental Impact Assessments are to be carried out at a number of sites and information in a standardised format is to be provided to the municipalities concerned. In 1996 the Government appointed a National Co-ordinator to promote information exchange and co-ordinate liaison between local authorities.

A feasibility study for Malå (a mining community) was completed in March 1996. A negative local referendum result in September 1997 led SKB to announce that it would not proceed further there. Similarly, the town of Storuman (southern Lapland) rejected further involvement in the siting process in September 1996. However, six further surface-based feasibility studies are taking place:

- in the Nyköping municipality, near the nuclear research centre at Studsvik, which started in 1995;
- in the Östhammer municipality, near the Forsmark nuclear power station site which again started in 1995;
- at three sites in the municipality of Oskarshamn, a location with the spent nuclear fuel store (CLAB) and the Äspö underground research laboratory. The municipality volunteered to take part in the process in October 1996 where sophisticated arrangements have been developed to build confidence in the concept of co-operation between communities and SKB – the so called 'Oskarshamn model';
- in the municipality of Tierp, where the council, in June 1998, voted unanimously to allow SKB to conduct a feasibility study;
- in the municipality of Hultsfred, where again the council, in May 1999, voted unanimously to give SKB the go ahead to conduct a feasibility study; and
- in the municipality of Älvkarleby where the council gave their assent to SKB in June 1999.

By the end of 2000 SKB will have completed its compilation of reports on the feasibility studies. Following evaluation of these reports, and taking account of the views of the Regulators, in 2001 SKB will propose two sites for further more detailed surface-based investigations to commence in 2002; it is anticipated these will take between 4 and 8 years. Following this period will be a 6 to 10 year period of detailed underground characterisation and construction. Before a decision is taken on continued operation, a trial phase of 'deposition' of 10 per cent. of the spent fuel inventory (about 400 canisters) which could be as early as 2012.

10 Switzerland

10.1 General

Waste management in Switzerland is governed by the 1959 Atomic Law, amended in 1978; a complete revision is expected in 2000. All licensing procedures are within the remit of the Federal Government whilst the Cantons and Communities grant building licences. The Federal Commission on the Safety of Nuclear Installations (KSA) and the Federal Office of Energy, Nuclear Safety Department (HSK) draw up guidelines for disposal.

In 1972 the Swiss Federal Government and nuclear utilities set up the National Co-operative for the Disposal of Waste (NAGRA) to deal with radioactive waste arising in the country. The company is responsible to the Department of the Interior and to the Department of Trade and Energy.

A licence is required from the Federal Government before a repository can be constructed. Federal law also requires that Cantons be consulted prior to the grant of licences. In practice this means that the public are consulted through a referendum, ballot or a Cantonal assembly, although the outcome is not legally binding on the Federal Government. To accelerate the licensing procedure, an amendment to the Atomic Act has been proposed in which all local and federal licensing requirements (both nuclear and conventional) would be encompassed into one Federal licensing process.

An expert Group on Disposal Concepts for Radioactive Waste (EKRA) was set up by the Federal Council in June 1999 and presented their final report in February 2000. They proposed, as a new concept 'monitored long-term geological disposal, which combines final disposal with the possibility of reversibility'. In March 2000, the Federal Council opened discussions on the draft of a new nuclear energy law. This will be considered by Parliament in 2001. Important decisions will be made on keeping open the option of nuclear energy; restricting the operating lifetime of the nuclear power plants; the waste disposal concept; reprocessing; licensing procedures; right of expropriation.

10.2 Low and short-lived intermediate-level waste

The Swiss concept for the disposal of low and short-lived intermediate-level waste is a repository mined into the side of a mountain. NAGRA began the process of selecting a suitable site in 1978. In 1993 one hundred locations were identified for their geological promise rather than because they volunteered. Through a screening process, these were narrowed down to four in three different host rocks. From these, in 1994, NAGRA selected Wellenberg (in the community of Wolfenschiessen within Canton Nidwalden) for recommendation to Government as its preferred repository location.

NAGRA sought the opinion of the Government inter-agency body AGNEB when it proposed Wellenberg. AGNEB agreed that the process had been transparent and that the site was a 'good choice'. However, in 1995 the Canton Nidwalden voted narrowly against NAGRA continuing its investigations despite the local community voting in favour.

EKRA has recently indicated support of this project. A decision by the Federal Government and the Canton on developing Wellenberg is expected soon and if the decision is positive a technical group will be set up together with an Advisory committee set up by GNW (a daughter company of NAGRA) and a Cantonal referendum is expected to be held on constructing exploratory drift in 2001.

10.3 High-level waste and long-lived intermediate-level waste

For HLW, spent fuel and LLILW, official Government policy requires NAGRA to look at international solutions for its small volume of waste as well as looking at disposal options within the country. Deep repository site selection is focused in the north of Switzerland (away from the Alps in the south of the country) in areas containing crystalline and sedimentary rock formations. A feasibility study and the site selection report is expected in 2002.

11 USA

11.1 General

The Federal Low-level Waste Policy Amendments Act of 1985 made disposal of commercially generated LLW (as defined in the US, which includes certain materials classified as SLILW in the UK) a State responsibility. Disposal of longer-lived transuranic (TRU) waste (roughly comparable to UK LLILW) Defence LLW, spent fuel and HLW are the responsibility of the US Department of Energy (DOE) as set out in the Nuclear Waste Policy Act of 1982 amended in 1987.

11.2 Low-level waste

LLW repositories have been operating at Barnwell, South Carolina, and Richland, Washington, and at several other locations across the USA prior to the 1985 LLW Act. Site selection for new LLW repositories began in 1985 under the 1985 LLW Act. This required states to have repositories operational by 1992 and allowed for inter-state 'compacts' to be created. Many compacts engaged in siting processes which included the possibility of communities 'volunteering' to be included in the site assessment process. All of the siting programmes initiated by the inter-State compacts are suffering legal delays and political difficulties.

11.3 Transuranic waste

A Waste Isolation Pilot Plant (WIPP) for the disposal of TRU waste opened for disposal in May 1999. It was constructed between 1980 and 1990, following siting studies which commenced subsequent to a 1957 report by the National Academy of Sciences recommending disposal in salt formations. WIPP is located in a salt formation at 650m depth some 30 miles from Carlsbad, New Mexico.

In 1996 DOE submitted a Compliance Certification Application (CCA) to the EPA to demonstrate that the WIPP complies with the EPA criteria. EPA public consultation, including public hearings in New Mexico, began in February 1997. The EPA concluded in October 1997 that, subject to certain provisions, WIPP complies with its disposal standards and should be certified. This action initiated a 120-day public consultation period involving further hearings. The details of the EPA CCA and Resource Conservation and Recovery Act (RCRA) consultation and permitting processes, including the relationship between the State of New Mexico, Carlsbad and the US DOE are extensive and complex. Suffice to say that the licensing of the WIPP facility was subjected to some of the most innovative and transparent methods of stakeholder review to have been applied in the USA if not elsewhere.

11.4 High-level waste and spent fuel

The US siting programme for HLW and spent fuel is centred on Yucca Mountain, Nevada, following an amendment in 1987 to the 1982 Nuclear Waste Policy Act (NWPA) which directed DOE to examine only that site. (Previously, a number of locations in various geological settings across the USA had been under consideration.) The 1987 legislation was criticised by the State of Nevada as 'unfair', although the Act specified that if studies showed the site to be unsuitable then investigations would cease..

The NWPA requires DOE to take title to the spent fuel from utilities prior to disposal in a deep repository. To cater for this it is proposed to store the fuel on the surface in a centralised Monitorable Retrievable Store (MRS). To facilitate the siting of this facility, the 1987 NWPA amendment established the independent Office of the Nuclear Waste Negotiator. The negotiator's task was to try to find a willing host state or Native American Tribe in exchange for negotiated benefits. However, although some progress was made with a number of Tribes, the negotiation process was terminated without result. Characterisation work at Yucca Mountain has included the construction between 1993 and 1997 of an Experimental Studies Facility. Taking the form of a tunnel five miles long, it allows the direct *in situ* study of rock conditions and the hydrogeology at depths of up to 1,000 feet.

Progress at the Yucca Mountain site has been criticised as being slow and expensive by a number of review bodies. The 'Viability Assessment' published in 1998 was seen as a positive indication that site investigations should continue (and money appropriated).

In the next year or so, DOE will recommend the site to start the licensing process which will require the approval of the President. However, the State of Nevada enjoys a State's rights of veto powers over the President's decision. If exercised, however, the State veto can itself be overturned by a two-thirds majority vote of the US Congress.

If the site is found to be technically suitable, DOE state that a repository at Yucca Mountain could become operational by 2010.

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ABSTRACT

This technical note outlines how the concepts of veto, volunteerism and community benefits have been used internationally in the process of identifying and selecting sites for hosting radioactive waste management facilities. This Technical Note replaces the one published in 2000 and includes references to the documents and sources used when developing the Technical Note. The original note was produced as an internal document and did not contain references, however since its production Nirex has given it to several individuals and organisations, therefore it was felt important to publish a revised version of the note including references, as it is being used for a wider purpose than originally anticipated. The content of the note has not changed from the original publication.

CONTENTS

Concepts That Could Aid a Site Selection Process

1. INTRODUCTION

In the UK the history of inadequate public involvement in decision making in radioactive waste management has contributed to the overall failure to implement government policy. A key feature of any analysis is the nature of the 'contract', implicit or explicit, between a host community, the developing agency and UK plc in general. One perspective on the UK experience is that the implicit 'contract' between UK plc and Cumbria 'required' a repository in return for the continued prosperity of the nuclear industry in West Cumbria. This was not acknowledged openly and certainly not generally accepted by the local population. In future we believe the process within which issues surrounding the location of a radioactive waste management facility are discussed will need to involve open and transparent discussion of the terms of the 'contract' between society in general and any host community. Any such 'contract' must be based on the absolute need to meet appropriate safety requirements.

The process itself of how a site selection methodology is established, communicated and implemented will be a strong determinant of how legitimate final decisions are perceived to be. It may be the case that features of processes used elsewhere would be helpful in creating a framework for future public involvement in the UK. Two of the most common concepts in site selection processes are 'volunteerism' and 'veto'; however, even these need to be set within the overall framework of public involvement and government commitment to the process. A wider commitment to financial or structural support for potential future host communities may well have to be a feature of any future site selection process **whether or not communities 'volunteer', or have a veto**.

This note outlines certain features of the site selection processes used in a number of national programmes for the management of solid radioactive waste. Some programmes have encompassed aspects of 'volunteerism' in selecting potential sites for radioactive waste facilities.

By 'volunteerism' we refer here to a community expressing an interest in participating in a process to determine the suitability of siting a radioactive waste management facility in its location. Such an expression of interest must be seen as independent, but may be in response to an invitation by those authorities responsible for carrying out a site selection exercise or it may be an unsolicited offer. It should also be recognised that some countries (notably France and the US) actively encourage volunteerism through cash or social incentives.

With some national programmes, the additional concept of a local community veto has been applied. The term 'veto' perhaps also needs expansion and should be seen in the context of the decision-making hierarchy between the local and the national government levels. In some examples overseas, communities may have a *de facto* veto whereby the implementer may agree to abide by the voting of the community (as in Sweden) although there is no legal requirement to do so. There are also examples of where a formal veto may be overridden by a higher decision making authority. Moreover, in other examples, while a definitive veto does not exist, the community may exert a high degree of influence on the development of a programme.

The long-term management of radioactive waste involves issues of intra- and inter-generational equity. We define intra-generational as meaning 'between members of the same generation', and inter-generational as meaning 'between members of different generations'. The current generation has benefited from the electricity, medical treatment and other processes that have led to the creation of the wastes. It could therefore be argued

that there is a duty to find a solution to the waste problem on behalf of future generations and to ensure that they do not suffer a detriment at the expense of the present generation's activities.

Finding a solution to radioactive waste could also entail one community 'hosting' the waste. This could be viewed as intra-generational inequity, as one group is agreeing to 'host' the waste for the rest of the population. The issues of intra- and inter-generational equity need to be addressed and any inequity towards the 'host' community or future generations must be dealt with.

Table 1 provides an overview of volunteer siting experiences and the use of a local veto in site selection for radioactive waste facilities around the world; while Appendix One provides more expansive comment on:

- the legal framework that applies to the process;
- the role of Government and / or the legislature in the decision-making process;
- the role and nature of local decision making, including voluntary involvement and rights of veto;
- the benefits on offer for local communities and related issues.

2. LEGISLATIVE CONSIDERATIONS

In some countries, wide public involvement is part of the history and culture of their democratic process. The degree of legislative basis for interaction with the public in the site selection process, whether volunteerism and/ or use of the veto is part of the process, varies between countries, for example:

- in France, specific legislation (the so called 'Law of 1991') specifies the process in some detail, either directly or through secondary legislation;
- in both Sweden and Finland, more general Environmental Impact Assessment legislation is used to formalise the interactions between the developer and the public;
- in Belgium, the interaction arrangements have been established through initiatives of the waste management organisation, supplemented by signed contracts between the parties.

It is recognised that in the UK context, consideration may have to be given in the consultation exercise to introducing measures, which may or may not require special legislation, to enable formal interactions to take place between the siting authority and the hosting community. In particular, consideration may need to be given to integration with planning law and environmental impact assessment legislation.

3. TECHNICAL AND SOCIO-POLITICAL REQUIREMENTS

There is a general consensus that, as with any controversial project, the future consideration of siting options for whichever option is chosen for the long-term management of radioactive waste, will comprise both technical and socio-political aspects. While technical aspects of site selection may be seen to follow internationally accepted methods (such as the guidelines published by the IAEA), socio-political processes do vary quite considerably between nations. In particular, the extent and manner of local community engagement with the site selection process is worthy of careful review. What should not be overlooked, however, is that the technical requirements themselves encompass both socio-political and

socio-cultural choices and can become highly contested and controversial. Thus, it should not be taken for granted that there is a clear division between technical and social issues; the technical aspects of site selection need to be open to deliberative consultation, and a common understanding of their interpretation established as part of the site selection methodology.

However, it should also be recognised that in countries such as Canada, Finland and Sweden, (and to a certain extent France), the nature of relatively large areas of uniform potentially suitable geology, makes volunteerism in respect of a deep geological facility, less of a technical challenge to the investigating organisation. Within the UK, greater consideration would need to be given to the variance in geology across the country and the relatively small continuous areas of potential suitability.

It needs to be made clear that 'volunteering' is against a background of *openly discussed and agreed conditions*. The 'volunteer sites' are not given any technical dispensation to favour them on such requirements over other sites – they have to satisfy the same technical, safety and environmental requirements as any other site. However, volunteering may be linked to anticipated social and economic benefits. For example, France historically has provided such benefits for nuclear power station sites as a normal part of the development process; and the US has offered financial benefits to States hosting the monitorable retrievable store, and to the State of Nevada for hosting the Yucca Mountain HLW facility (although in return for relinquishing its right to object to the facility).

Site selection processes therefore have to be seen in the context of a comprehensive package of measures, specifically tailored to meet the socio-political and cultural needs and expectations of the communities involved. Volunteer processes and the use of a local veto are potentially important concepts in developing an effective process, but they must be seen to be part of a wider package of procedural measures.

4. LEVELS OF DECISION MAKING AND REPRESENTATION

Decisions to slow down or opt out of the process have not tended always to be made by those directly engaged in the dialogue, but often at higher levels of Government (Regional, Federal, or Cantonal) where wider socio-political issues appear to have contradicted local decisions. Related considerations are:

- recognition by all affected parties as to who is deemed to represent local communities;
- how the views of a wide range of members of those communities are elicited and encompassed; that is, who has the right to volunteer; and
- the extent to which this commands support from all those within the community.

Taking these considerations, when looking at overseas examples, one must be clear as to what the 'entity' is that is taking the decisions on participation in the procedures, what level that represents in government hierarchy, and whom such an entity represents. Again this varies between countries, for example:

- in Sweden, it is the Municipality (the administrative unit below county level) that takes the decisions, based on referenda, on accepting the waste management organisation into its area;

- in France, it was at Départment level that decisions on the question of expressing an interest in the volunteer site selection exercise were made. However, it was at the town council level that local public inquiries were heard and at Ministerial level that the final directions on investigations were made. In some cases local Mayors arranged for referenda to be carried out, but these are regarded as non-constitutional and carried no legal weight;
- in Switzerland, the Wellenberg site, in the community of Wolfenschiessen, proposed by the waste management company NAGRA, was accepted through a referendum by that community but rejected in a further referendum at the higher Cantonal level; and
- in Canada, there has been some dispute over representation and the meaning of local acceptance. Given the dispersed and diverse nature of the populations in some areas, there was not always agreement between various interested groups on representation.

Moreover, it should be recognised that site selection is progressively definitive. The Swedish example is quite instructive in this sense. Siting studies range from countrywide studies, through to 'county specific general studies', then to feasibility studies at municipality level. This has the aim of identifying 'areas of interest' and ultimately prioritising these for further investigation, before deciding on a more exact location.

5. FEATURES OF VOLUNTEERISM AND THE VETO

Based on observations of other programmes, the features of allowing or encouraging communities to put themselves forward for consideration as a potential host site, include the following:

- the early establishment of open dialogue at the local level;
- communities do not feel that selection has been imposed upon them by some unknown entity applying only technical criteria without due consideration of their involvement in decision making;
- local representatives, including Members of Parliament, are fully aware of the commitments and are not embarrassed by an unanticipated announcement;
- an early understanding by all parties that meeting the technical selection requirements is essential, but not sufficient, for the establishment of a facility;
- clear commitments from all stakeholders to engage in open discussions;
- increased accountability between the facility development organisation and the local community;
- the volunteering community has to recognise its responsibilities with respect to the long-term nature of its decisions. A local government representative is elected typically for four years but may be participating in a decision, which will last well beyond that timescale and span generations. Further, the siting organisation needs to receive some comfort that such a decision will not be revisited within the timescales suggested by its degree of commitment to the stage it has reached within that community. Feasibility studies may take place within an election period, underground investigations within several, and if the site is ultimately chosen, operations may last well over one or two generations;

- related to the last point, a risk that, assuming veto powers to ‘walk away’ from the process are established, they may be exercised at some point, thereby resulting in wasted expenditure. Experience suggests that this risk is primarily related to those who are not directly engaged in the dialogue process from the outset. Those who are so involved are less likely to exercise the veto. This emphasises the need to encourage opponents and critics to participate in dialogue;
- the potential misinterpretation of the arrangement – for example that relaxed safety principles may be applied to a site that has ‘volunteered’. Effective communication and dialogue should overcome this; and
- the need to make clear that any social and/ or economic investments in a volunteer community are entered into within a transparent and agreed framework. Any future processes will need to establish the range of appropriate measures or agreements that can legitimately be entered into.

6. EQUITY AND COMMUNITY BENEFITS

The equity issue may need to be addressed in the form of benefits to the local community; these might be, for example, in the form of enabling them to participate in the dialogue surrounding the siting and development of the waste management facility, and/or the provision of community facilities. Providing community benefits has to be handled carefully to avoid the criticism that the local community is being ‘bribed’ to accept a facility, and the benefits must be appropriate to the facility and of the right order of magnitude.

In the case of future generations, it may be necessary to set up a trust fund (as has been considered in Switzerland), to help them to deal with any issues identified as being passed to them by the present generation (e.g. evaluation of long-term monitoring results to inform consideration of eventual repository closure).

Issues to be considered include:

- are the community benefits defined before the community volunteers to host a facility, or do they develop over time?
- at what stage should benefits be provided? e.g. when a community volunteers, when the investigations start, when the site is identified as technically feasible, when construction begins or when the facility is operational;
- who controls the community benefits funds and how they are spent?
- who should be involved in negotiation about the community benefits: can the community influence what is paid and where the money is spent? and
- should the community benefits be defined by law?

Table 2 indicates where community benefits measures have been used in other countries. Several types of benefits have been made available to local communities and most of these are to enable a community to engage in the debate surrounding the siting of a facility or to help to alleviate the increased pressure put on infrastructure due to the development. Thus there is a timing issue of when benefits are first paid, which can date from the initial approach to carry out initial investigations, all the way through to construction and operation of a facility. Moreover, in the examples shown it can be seen that the contributions associated with the various phases escalate by orders of magnitude.

The benefits can be categorised as follows:

Community Empowerment Measures: Such measures are designed to enable the community to participate and influence the debate surrounding the development of the site:

- provision of information about the development;
- establishment of local groups to monitor the facility and engage in debate with the development organisation;
- funding for the community to hire their own experts to check the investigations carried out by the development organisation; and
- funding for the community to hire advocates to present their case in formal proceedings.

Social Benefits: These are designed to offset the potential stigma attached to volunteering to host a facility.

- payment of local taxes;
- guarantees of employment for local people;
- local training, so people in the area can be recruited for jobs;
- support of local service industries;
- investment in public services (e.g. new roads, hospitals, recreation facilities); and
- guaranteed property prices.

Economic Benefits (or Recompense): These benefits could include a variety of mechanisms for economic regeneration at a local and regional level. Infrastructure projects and ongoing business incentives could be partly tied to the project. The ideas for exact form(s) of assistance would have to be worked up with representatives of key stakeholder groups.

Under the existing legal regime in the UK the possible range of benefits to a local community include:

Planning benefits, often referred to as 'planning gain'. The Department of the Environment Circular 1/97 sets out guidelines for the types of benefits which can be accepted by the local planning authority in connection with the grant of a planning permission. The benefits are usually proportional to the size of the development and its perceived impacts on the local community.

Provision of an assistance scheme for property owners indirectly affected by the development. Under present UK law compensation for 'planning blight' is only available where the developer has powers of compulsory purchase and is further restricted to those owners whose property is required for the development or will be physically affected by the development. It is possible for a developer to establish a voluntary system of assistance which goes beyond the requirements of the law, which may assist in meeting public concerns with regard to the perceived impact of proposals on property prices. There are precedents for such schemes in the UK.

Payments of consultants fees for the planning department and local community. A fee has to be paid when a planning application is made that in part reflects the amount of time and resources that the planning department will have to incur to review the plans. There are also precedents where the developer has voluntarily reimbursed the fees of consultants hired by the local planning authority. This could be extended to pay for consultants hired by the local community.

The land use planning system in countries providing host fees is very different to the system in the UK. The UK system is founded on the principle that planning permission should be neither bought nor sold. Therefore, current UK law would not allow the payment of host fees.

The consideration of community benefits should not be dependent on a community volunteering, all communities should qualify, independent of how their area had been chosen.

At another level consideration could be given to a change in policy, whereby a particular community was seen to be taking the waste on behalf of the rest of the UK. In this situation ethical issues would be key, safety must be sacrosanct and recompense could be substantial and geared at meeting the key requirements of the community. The requirements of surrounding, associated communities would also need to be considered, but to a lesser degree. This approach would allow the community itself to define the need for benefits.

7. CONCLUSIONS

To conclude, experiences in other countries indicate that while 'volunteer sites' have been encouraged, they have not always necessarily proved to be successful in terms of ultimately establishing a facility at that site. However, they have been successful in establishing a process of open dialogue between the facility developer, regulators, and other stakeholders at the local level. Taking account of these experiences, and recognising that there are historical and cultural differences, consideration of a contract between society and a local community and within that context volunteerism, the use of the veto and benefits for a community should be an integral part of the forthcoming DETR[1] consultation exercise. Several other issues are also worth debating at the beginning of the process:

- the establishment of mechanisms to promote open dialogue with all stakeholders at all levels;
- consideration of communities involvement in decision making about siting and facility development;
- early understanding by all parties that meeting the technical selection requirements is essential, but not sufficient, for the establishment of a facility;
- increased accountability between the facility development organisation and the local community; and
- the range of and control of community, social and economic benefits that could be made available during the siting, development and operation of a facility.

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Summary Table 1

Country	Experience of Site Selection including aspects of 'volunteerism'	Application of local Veto powers	Comment
Belgium	Yes, ongoing now for L/ILW disposal. HLW programme under consideration.	Yes, partnership community can 'walk away' at any time.	Several communities have agreed to enter into 'partnerships' with no irrevocable commitment to establishing a facility
Canada	Some, for LLW and historic wastes, but now in abeyance for these and HLW.	Yes.	LLW siting seen as good example of volunteerism, despite failures.
Finland	Yes. Potential sites selected through mixture of volunteer and geological screening process.	Yes, law requires local community to give a positive indication.	Volunteer sites have been actively engaged by the EIA consultation.
France	Yes, for URLs, under 1991 French Law a Mediator was appointed to guide the process.	Public Inquiry process results in Govt. decrees directing ANDRA to investigate.	Volunteer URL site under investigation. Volunteer sites are common in France for a wide range of industrial activities including NPPs in return for economic and social benefits.
Germany	No.	Historically no.	Since new German Government elected, site selection process under review through 'consensus talks'.
The Netherlands	Site selection by Govt. committee in 1984 identified 3 'willing' sites. Borsele storage site chosen by COVRA.	No.	Dutch policy is above ground storage for 100 years at an industrial site.
Spain	No. HLW programme in abeyance. El Cabril L/ILW facility was an existing storage facility.	In effect for El Cabril, through planning process.	Site selection for HLW in abeyance. El Cabril L/ILW facility in operation since 1992.
Sweden	Yes. Since 1992 SKB have invited participation of communes.	SKB have agreed to abide by community decision. But Govt can override local veto.	A total of 8 sites have volunteered for feasibility studies, 3 have nuclear traditions, and 2 have withdrawn.
Switzerland	No.	Yes through referenda at various local levels but which can be overridden by higher Cantonal and Federal Govt.	Role of referenda important and question can be re-put at later dates.
USA	Yes for LLW and the temporary fuel store (MRS), but not for the operating TRU deep disposal facility (WIPP) in New Mexico or the HLW programme at Yucca Mountain, Nevada.	Yes, but Congress can override State's decision.	Historically proactive and innovative processes but limited success away from established nuclear sites. Siting of the MRS failed despite financial compensation and use of special Negotiator.

Table 2 Overseas Examples of Community Benefits

Country	Community benefits offered*
Belgium	ONDRAF/NIRAS finance the costs of the local partnerships within budgetary limits. Other economic benefits are not prescribed.
Canada	In the LLW siting programme, property values and employment were 'guaranteed' for a potential host community. Pure financial recompense had been proposed for a particular site, but the programme is now in abeyance. Finance was made available for community liaison groups, 'open houses', publicity materials and visits to other management facilities.
Finland	No incentives or compensation required to be paid directly by the Government. However, nuclear facilities pay a local property tax at the highest rate of 2.2% while the average rate is 0.5-1.0%. This property tax is seen as the most obvious benefit for the local community. As reported in the 1999 EIA report, the direct effect of such increases in tax revenue from the siting a facility (income, property, and corporation) may be partially offset by 'national tax revenue equalisation'.
France	In the URL programme, financial aid to contribute to local development and improving the natural environment is required to be paid under the 1991 Law. FF5 million / year (~£0.5M) is payable to a local authority during the borehole drilling phase to compensate for loss of business tax due to the peripatetic nature of process. Up to FF60 million (~£5.6M), as a 'economic supporting measure' for the Départment hosting the URL (both Meuse and Haute Marne receive this payment as the URL is located near the border of the two). FF60 million (~£5.6M) is equivalent to twice the 'host fees' payable to a Départment hosting a single reactor 900 MW(e) PWR. Moreover, this package is in addition to the normal finance received from the Central Government for local government purposes. For the near-surface repository at Centre de l'Aube, which commenced operation in 1992, ANDRA (with the Ministry of Industry) set up a 'matching' fund of FF35 million (~£3.3M) which has to be targeted at specific projects attracting equal funding from the local community. ANDRA also pays an additional FFr1.5 million (~£0.1M) in local taxes each year and guarantees to fill specified proportions of construction and operational jobs with local labour.
Germany	Notwithstanding the new site selection process, no incentive requirements are currently explicitly stated in the Law. However, the Government of Lower Saxony was offered an annual grant of several million DEM (DEM 1 million ≈ £0.3M) from the Federal Government in respect of Gorleben, but the payments were refused and the arrangement remains suspended.
The Netherlands	No specific incentive requirements regarding the interim storage site at Vlissingen are specified.
Spain	Allocation of monies from the Waste Management Fund for guaranteeing minimum incomes to hosting communities is prescribed by Ministerial Order and is dependent on the type of facility under consideration (nuclear site spent fuel storage, central fuel storage, NPP undergoing decommissioning, L/ILW storage / disposal facility) population density, and distance from the facility. No compensation order yet exists for a deep disposal facility for HLW / spent fuel. Low and short-lived intermediate-level waste is disposed of at El Cabril near Cordoba,

* Note: Currency conversions are as at October 2000 so should be treated with some caution when referring to historical figures.

Country	Community benefits offered*
	which came into operation in 1992. About Ptas 3,000 million (~£1.1M) is paid each year to the town councils located near to El Cabril.
Sweden	Volunteering communities can request up to up to SEK 2 million (~£0.14M) from the Waste Management Fund to support local review groups, to monitor SKB's work and for public information programmes. No specific provision for other community benefits.
Switzerland	Swiss law also requires both the host community and the Canton to receive financial and material 'remuneration' once it has accepted hosting a facility. For the proposed L/ILW repository at Wellenberg, it is understood that a one off payment of SFr 2.3 million (~£0.9M) would be have been made available to the Canton government. If a facility had been developed, then about SFr 3.5 million (~£1.4M) per year for the 40 year operational period would have been paid. On a similar basis at Community level a one off payment of SFr 3 million (~£1.2M) and an annual payment of SFr 300,000 (~£0.12M) would have been made.
UK	
USA	To facilitate the siting of a Monitorable Retrievable Store, the 1987 Nuclear Waste Policy Act (NWPA) established the Office of the Nuclear Waste Negotiator whose task was to find a willing host state or Indian Tribe in exchange for negotiated benefits. However, although some progress was made with a number of Indian Tribes, the negotiation process was terminated without result. For Monitorable Retrievable Store: Payments or grants to assist the affected community in deliberating the issues. $10 million (~£6.7M) in annual payments to State/Local governments, during the lifetime of the facility. Note that the MRS siting process now in abeyance. Potential benefits available also included: infrastructure, recreational and environmental improvements, public and higher education programmes, health care programmes, tax subsidies, local employment agreements and direct financial assistance. The siting programme for HLW and spent fuel is centred on Yucca Mountain, Nevada under the 1987 Nuclear Waste Policy Act (NWPA). The NWPA provides for a benefit package for Nevada of $10-20 million (~£6.7-£13.4M) per year provided the right to object to the proposal is waived; but to date this has not been taken up by the State.

APPENDIX A

1. INTRODUCTION

This appendix considers the processes of site selection in the following countries:

- Belgium
- Canada
- Sweden
- Finland
- France
- Germany
- Spain
- Switzerland, and
- the USA.

The information has been derived from a number of sources, some published and some provided directly by the radioactive waste management agencies, or equivalent, in the countries concerned. As precise provisions of overseas law and policy may be complex, this note attempts no more than a summary.

2. BELGIUM

2.1 General

There is no specific legislation covering site selection in Belgium, nor is financial compensation required to be made to affected local communities. The radioactive waste management agency, ONDRAF/NIRAS, a public body set up under Royal Decree, is responsible for site selection and for proposing waste management strategies to Government.

2.2 Low and short-lived intermediate-level waste

Following an unsuccessful attempt to site a near-surface facility in the mid-nineties, for low and short-lived intermediate-level waste, ONDRAF/NIRAS since 1999 has concentrated its activities on the development of local ‘partnerships’ to facilitate project proposals in sites showing an interest to host a facility.

Such local partnerships involve ONDRAF/NIRAS working through independent (University research – based) mediators with local stakeholders in the development of a proposal for a disposal project which is seen as an integrated part of local development. The project is intended to satisfy both technical/scientific and socio-economic criteria before being proposed to government.

Membership is specific to the individual partnership but the general intent is that it should comprise representatives of all the local political parties (opposition included), the various economic, social, cultural and ecological stakeholders actors, and local industry. It is structured around a general assembly, a management committee, and working groups who perform most of the detailed work. The partnership has its own budget provided by ONDRAF/NIRAS.

On 30th September 1999, the first partnership was signed between ONDRAF/NIRAS and the local authorities of Dessel (on whose territory the centralised interim storage buildings of conditioned waste are located). The local authority of Mol (where the national nuclear research centre CEN/SCK is located) was signed in October 1999. The authorities of the zone Fleurus-Farciennes (where the national Institute for Radio-Elements - IRE - is located) were initially interested but decided to let their final agreement depend on the results of preliminary soil examinations on the site of the IRE that are presently taking place.

The authorities of the municipality of Huy (where Tihange NPP is located) have shown no interest so far, while the authorities of the municipality of Beveren (where Doel NPP is located) have yet to decide on starting negotiations with ONDRAF/NIRAS.

The partnerships function at four levels:

1. The ‘general assembly’ (or Partnership Council) which involves all the parties and formally represents the ‘Partnership’;
2. The management committee which is appointed by the general assembly;
3. Project Co-ordination on a day-to-day basis; and
4. Working Groups which are the active basis of the partnerships.

Briefly, the working groups will review and develop draft project proposals with the support of ONDRAF/NIRAS acting as ‘partner and expert’, but also with access to independent expertise. The partnerships as a whole will decide on priorities and take decisions, organise dialogue and be responsible for keeping the local population informed. Final proposals will have to be approved by the local councils concerned prior to submission to the federal government in 2001–2002.

2.3 High-level waste and long-lived intermediate-level waste

For the disposal of high-level and long-lived intermediate-level waste, ONDRAF/NIRAS has been investigating the Boom Clay geological formation at the Mol-Dessel nuclear site. If the safety assessment results continue to show that Mol is favourable then ONDRAF may propose detailed investigations in the Boom Clay at a potential site in 2015 (though not necessarily at Mol itself). Disposal could commence from 2050, but possibly not before. Current plans are to publish a technical report - SAFIR 2 – by the end of 2000, on research undertaken to date, which will be submitted to the NEA for independent peer review. An accompanying strategic document will address potential approaches for stakeholder dialogue on high-level waste and long-lived intermediate-level waste in Belgium.

3. CANADA

3.1 General

Canada has a diversity of wastes arising from nuclear power generation (spent fuel and LLW), industrial and medical wastes, and uranium mining and milling (which is not considered further here). In July 1996 the Federal Government announced a new policy framework for radioactive waste intended to guide Canada’s disposal approach for all such wastes into the next century.

3.2 Nuclear fuel waste

There is no specific legislation relating to siting of disposal facilities for spent fuel. In 1978 the Governments of Canada and Ontario established the Nuclear Fuel Waste Management Program. This provided for a disposal concept to be developed by Atomic Energy of Canada Limited (AECL, a Crown Corporation) in co-operation with Ontario Hydro (now Ontario Power Generation, OPG), the largest single producer of spent fuel.

In 1989 the Government appointed a Federal Environmental Assessment Review Panel to review the disposal concept prior to the start of work on siting. Public hearings to consider AECL's Environmental Impact Assessment ('EIA') for the concept were held between March 1996 and March 1997, covering a broad range of issues. Included in AECL's EIA were its recommendations for the siting process, which included volunteerism and shared decision-making. Whilst the new Policy Framework does provide that an organisation be put in place to implement the disposal concept, none exists as yet. However, AECL and OPG have formed a joint task team to consider such an action.

The hearings, held in numerous communities across Ontario, took place in front of a panel of experts drawn from both technical and sociological backgrounds, and was managed by the independent Canadian Environmental Assessment Agency (CEAA). Organisations and members of the public who wished to make submissions to the panel were able to apply for so-called 'intervenor funding', which allowed for the use of external consultants and advisors. 'Participant funding', to allow individuals and members of community councils etc. to attend hearings in their localities, was also made available.

The Panel publicly released its report on 13 March 1998. Chairman Seaborn said that although AECL's plan appeared technically sound, *'in its present form it does not have the required level of acceptability to be adopted as Canada's approach for managing nuclear waste.'*

Amongst its recommendations the Panel said that a new nuclear fuel waste management agency (NFWMA) should be set up. By May 2000, the utilities had signed an MOU to create a waste management organisation and a draft plan for long term options is being developed, but it is understood that no decision on deep disposal will be taken before 2004.

3.3 Low-level waste

Low-level waste is defined in Canada to include all waste from nuclear activities (except spent fuel and uranium mine and mill tailings). It includes materials which in the UK would be classified as short-lived intermediate-level waste. It is further administratively classified as either 'historic waste' or 'ongoing waste'.

3.4 Historic waste

A large proportion of the LLW inventory comprises historic wastes, consisting mainly of contaminated soils (1,000,000m3) for which the original producer is no longer responsible. In 1982, the Government established a Low-level Radioactive Waste Management Office to assume responsibility for these wastes. In 1988 the Minister for Natural Resources appointed an independent Siting Task Force to carry out a voluntary siting process to find a disposal site. In 1995, the Task Force issued its final report to the Minister, identifying Deep River in Ontario as a willing host community.

However, problems arose during late 1996. Natural Resources Canada (NRCan) refused to accept the *'Community Agreement in Principle'*, which had been negotiated between the Deep River community council and the Task Force. The Agreement formally lapsed at the end of 1996.

Employees of AECL dominate the population of Deep River, and plans announced in late 1996 to downsize that organisation, as a precursor to privatisation, had caused uncertainty about long-term employment prospects in the area, and so job guarantees were included in the Agreement.

The issue finally came to a head in late October 1997 when the Council formally voted to withdraw from the process completely, although NRCan has still not ruled the community out.

In August 1997, Hope Township asked to be considered as a potential repository host location.

3.5 Ongoing waste

LLW from continuing nuclear research and power generation will require disposal in one or more facilities. The waste producers are working on options that include developing an independent OPG facility or a multi-user facility. AECL has developed a prototype Intrusion Resistant Underground Structure for the disposal of short-lived waste at its Chalk River plant in Ontario. This is currently undergoing licensing.

4. FINLAND

4.1 General

The Nuclear Energy Act, as amended in 1994, requires radioactive waste generated in Finland to be disposed of within the country and prohibits the import of such waste. The Ministry of Trade and Industry (MTI) formulates disposal policy, sets objectives, supervises activities and undertakes its own research and development. The power companies, IVO and TVO, are responsible for waste management and disposal and in 1995 they set up the spent fuel disposal company, Posiva Oy. Operational arisings of low and short-lived intermediate-level waste from the two power station sites (Olkiluoto and Loviisa) are disposed of in repositories constructed at around 100m depth at those sites and are not considered further here.

The Ministry of Trade and Industry sets target schedules for Posiva to implement spent fuel disposal policy, including the siting process. Community benefits are not required to be provided at any stage of the process.

Spent fuel

In 1983 TVO drew up a list of 101 sites and undertook a consultation process with the affected communities. This resulted in the identification in 1985 by TVO of 5 potential ‘volunteer’ sites at which more detailed investigations were carried out. In 1992, TVO announced that further investigations would only be carried out at Romuvaara in Kuhmo, Kivetty in Äanekoski and Eurajoki (near to the Olkiluoto nuclear site). Interim reports on these sites were produced at the end of 1996. However, following indications by the local community in Loviisa, that they too wished to be included, that site was also added to the list.

According to the Nuclear Energy Act, the first authorisation step towards a final repository of nuclear waste is the so-called Decision in Principle (DiP). At this step the Government had to consider whether ‘the construction project is in line with the overall good of society’. In particular, the Government paid attention to the need of the facility, the suitability of the proposed site and its environmental impact.

Under the legal requirements the Radiation and Nuclear Safety Authority (STUK) had to make a preliminary safety appraisal of the DiP application and the proposed host municipality must state its acceptance or rejection for siting the facility. The decision has then to be endorsed by the Parliament. The application for the DiP includes also an Environmental Impact Assessment (EIA) report for the planned facility.

In May 1999, Posiva Oy submitted an EIA report to the MTI and a DiP application to the Government. The EIA report addressed all four candidate sites. After hearings in November 1999, the Ministry gave its statement, which completed the EIA process. During the hearing period 15 authorities and public bodies, 5 civic organisations and communities and 23 municipalities submitted their statements on the EIA report to the MTI. In addition, some 15 private persons sent their opinions.

The opinions expressed by the authorities and municipalities were mainly positive and the EIA report was regarded as wide and thorough, although one concern was the potential deterioration of the image of a municipality. The anticipated impact on health rendered by the transport of spent fuel was also of concern. The opinions of private individuals and civic organisations on the EIA, as well as on the whole disposal project, were in general critical and opposing. Their viewpoints were, however, mainly focused on issues outside the scope of the EIA.

The MTI concluded in its statement that the EIA was sufficiently comprehensive and detailed and fulfilled the requirements set by the EIA legislation. The Ministry, however, points out that a construction licence application for the disposal facility, scheduled to be submitted after 10 years at the earliest should include an enclosure corresponding to an updated EIA report.

The DiP application addressed only the Eurajoki municipality. STUK engaged an international review team, to support its preliminary safety appraisal of the DiP application. The team summarised their findings in a consensus report to STUK in October 1999. In addition, STUK requested statements from several Finnish research institutes which have participated in the publicly funded waste management research programme. STUK submitted a preliminary safety appraisal of Eurajoki to MTI in January 2000. In this appraisal STUK concluded that the prerequisites for a DiP from the standpoint of nuclear and radiation safety were met.

In January 2000, the Eurajoki council gave its approval to the DiP application (20 votes for, 7 against). The Government’s decision and Parliament’s ratification may be delayed due to an appeal to administrative court by a citizen of Eurajoki but are expected to take place by the end of this year. The Nuclear Energy Act provides that the Council must reject the application if either the municipal council or the safety authority is opposed and that Parliament has to confirm or veto the Decision in Principle by the Council of State.

It is planned that in 2003 an investigation shaft will be constructed at the chosen site and in 2010 a construction permit will be sought. If the permit is granted by 2013 then construction will start and first emplacement of spent fuel could take place by 2020.

5. FRANCE

5.1 General

The waste management organisation in France is ANDRA, established as the national disposal agency under the 'Law of 30 December 1991' governing research activities on HLW disposal. It operates near-surface disposal facilities for low and short-lived intermediate-level waste at Centre de la Manche (now closed and not considered further here) and Centre de l'Aube.

5.2 Low and short-lived intermediate-level waste - Centre de l'Aube

The site selection process for the near-surface repository at Centre de l'Aube, which commenced operation in 1992, began in 1985. ANDRA's predecessor organisation identified five potential sites, from which the Aube site was selected as the preferred one. The original shortlist included a number of 'volunteer' sites where the local mayors had indicated that they wished for their communities to be considered by ANDRA, but none was eventually deemed geologically acceptable.

5.3 High-level waste and long-lived intermediate-level waste disposal

5.3.1 The Law of 1991

The 1991 law on R&D redirected the French deep site investigation process following the abandonment of an earlier HLW programme; (that programme sought to identify promising disposal sites primarily by reference to geological considerations). The 1991 law contains several parallel provisions:

- a 15-year research programme covering:
  - separation and transmutation of long-lived radionuclides in waste,
  - deep disposal studies 'through the creation of underground research laboratories (URLs)', and
- long-term surface storage techniques;
- at the end of the 15-year programme (in 2006) the preparation of a report (by a National Review Board) together with a draft law to be submitted to Parliament for a decision on the creation of a deep disposal facility at one of the URL sites; and
- a requirement that local officials and members of the public from the affected sites be consulted before any site investigations begin preliminary to URL construction.

5.3.2 The Underground Research Laboratories

A mediator **-** M. Christian Bataille - was appointed under the 1991 law and was specifically 'charged with leading public involvement prior to the selection of URL sites'. His mediation mission established three objectives: information provision to the public, open dialogue and decision facilitation.

The siting process for the URLs began in January 1993. By December of that year some 30 sites had volunteered for consideration. Ultimately, M. Bataille recommended four potentially suitable sites. Two were subsequently merged so that three locations were then under consideration: a clay geology in north-eastern France on the border of the Meuse and Haute Marne Departments (the Bure site); a clay geology beneath the Marcoule nuclear site in the south of the country in the Gard Department; and a granite geology in the Vienne

Department in western France. Programmes of surface-based investigations at these sites, which comprised drilling between two and four boreholes plus geophysical measurements, were completed in April 1996.

In May 1996 the Council of Ministers authorised ANDRA to submit requests for the installation and operation of URLs at each of the three sites. Authorisation of the URLs was scheduled to be completed in 1998, following review of the submissions by DSIN (the nuclear regulator) and Ministry of Research, together with public hearings and other forms of local consultation. Public hearings at the sites ran from January to May 1997.

In December 1998, the Government confirmed that two sites should be investigated: the Bure site and a granite site to be selected. A decree was issued in August 1999 allowing ANDRA to commence construction of the URL and the establishment of a local information committee at Bure, and launching the consultation exercise to select the granite site.

The granite site selection process is expected to finish in 2002/3. An initial geological screening, begun in February 1999, identified 180 'plutons' (granite formations) in the country and by July 1999 this had reduced to about 15 sites following consideration of hydrogeology. After a further screening phase, 7 sites were still under consideration in February 2000. The Granite Advisory Committee of 12 experts involving ANDRA and BRGM (national geological agency) manages the programme which comprises a number of stages:

- Stage 1 - seek consensus through consultation / volunteerism (by June 2000, but essentially stalled at the moment);
- Stage 2 - selection by government by end of August 2000 of a sites or sites wishing to be considered further;
- Stage 3 - confirmation by ANDRA of geological suitability; confirmation by DSIN; setting up of Local Information Committees;
    - Stage 4 - public inquiries plus endorsement by local authorities within 10km radius of sit. This is seen as a consultation process rather than giving the LA's a specific veto.
- Stage 5 - 2002/3. Decision by government to authorise construction of URL.

6. GERMANY

6.1 General

The overall regulation of radioactive waste management is controlled by the Federal Atomic Energy Act, but licensing of disposal facilities lies with the *Länder* (State) Government. As radioactive waste disposal in Germany is intended to be undertaken exclusively in mined repositories, the Federal Mining Act is also relevant.

The Federal Government is currently considering amendments to the Atomic Energy Act. If accepted, licensing would become a federal responsibility through the Federal Office for Radiation Protection, BfS.

BfS is currently responsible for the construction and operation of repositories, with technical work sub-contracted to the company DBE. If BfS do take over the licensing responsibility from the Länder, then disposal responsibility would be given to a new body yet to be created.

Two potential repositories are located in Lower Saxony (Gorleben and Konrad) and a facility at Morsleben, in Saxony-Anhalt in the former East Germany, has been in operation since 1970. Until 1978, some disposal was undertaken at a salt mine at Asse, but subsequently

the site has been used for research purposes only. Government policy is that all toxic waste, both chemical and radioactive, should be disposed of (though not co-disposed) in geological formations.

Under the new German government, a working group on site selection has been set up by BMU, membership of which includes anti-nuclear experts, use of the Internet, MP's workshops, NGO's and unions. They will review existing criteria and will look at international practice and propose the 'relatively best site' in the country. Their first report is expected later this year. The exiting sites under investigation will be part of the process. There is also a stated government aim of having just one repository for all German wastes but this conflicts with some arguments in Germany that heat generating and non-heat generating wastes should be separate.

6.2 Gorleben

The Gorleben site (for the disposal of heat-generating radioactive waste in a salt dome) was proposed in 1977 by the President of Lower Saxony. By way of financial benefits, the Government of Lower Saxony was offered an annual grant of several million DM from the Federal Government, but the payments were refused and the arrangement remains suspended.

Two shafts are linked at a depth of about 840m and underground infrastructure is in place. Given the pattern of ownership of mineral rights, only part of the area has been investigated to date but this is expected to provide sufficient capacity for the expected disposal volumes. It was intended to complete long-term safety assessment at a date between 2003 and 2005 but currently there is a moratorium of further detailed investigations. If a licence were then granted by 2008 the repository could be operational by 2015.

6.3 Konrad

Investigations carried out from 1976 indicate this is a potentially good site for low and intermediate-level non heat-generating waste. Konrad was previously an iron ore mine and in 1976 the Federal Government asked GSF (Federal Research Centre) to investigate its suitability for repository use.

The current licensing process allows for public consultation of the licence application. In the case of the Konrad application, the Lower Saxony Ministry of Environment held a public hearing to consider technical objections to the application. A report was subsequently submitted by the Ministry to BfS resulting in a number of changes. The licensing process is still continuing but a stand off exists between BfS and the *Länder.*

6.4 Morsleben

Since the start of operation in 1970, until September 1998 when the Länder courts stopped disposal, some 22,320m3 of waste (mostly LLW) had been disposed of. The licensing procedure for the sealing and closure of Morsleben is under way.

7. THE NETHERLANDS

Following abandonment of its sea-dumping programme, in 1984 the Dutch Government produced a policy paper on radioactive waste management, which called for long-term (100 years), above ground storage, and also set up the waste management company COVRA.

A site selection procedure was started under the direction of a Government committee. In less than a year the committee found three sites in two municipalities willing to accept a long-term storage facility.

A pre-requisite for the siting choice was that it should be an industrial location, large enough to store 100 years worth of radioactive waste. COVRA had the final say in site choice and having chosen Borsele (close to the nuclear power station) the licensing procedure for the construction of low and intermediate level radioactive waste storage facilities started in 1987.

For the handling and storage of HLW the construction of a naturally cooled storage vault is in its engineering phase. The construction of this vault started in 1997 and the first shipment of conditioned HLW from reprocessing is scheduled for 2001.

R&D on final disposal is a task primarily for Government since no final decision has been taken on the policy for disposal. As the volumes of waste produced are small, only a single facility for LILW and HLW is required.

8. SPAIN

8.1 General

Responsibility for siting, constructing and operating repositories lies with ENRESA under a Royal Decree of 1984. ENRESA is a limited liability company, independent of the waste producers and responsible to the Ministry of Industry. Further Decrees (the latest issued in 1998) authorise ENRESA to compensate local communities for hosting both storage and near surface disposal sites.

Periodically, ENRESA prepares and submits to Government a General Radioactive Waste Plan (GRWP) covering all aspects of radioactive waste management. Four such plans have been adopted in the past and a fifth is currently before the Government.

8.2 High-level waste and spent fuel

The policies for identifying definitive solutions for these wastes are presented in the Fifth General Radioactive Waste Plan of 1999. That indicated that the strategy adopted until then regarding geological disposal would be supplemented by research on separation and transmutation. Decisions on options, including site selection, will now not be taken until 2010.

8.3 Low and short-lived intermediate-level waste disposal

Low and short-lived intermediate-level waste was initially stored at a facility sited at El Cabril near Cordoba. Characterisation work to assess suitability for disposing of waste there began in 1986. In 1989 the local planning authority approved a disposal application and the facility came into operation in 1992.

9. SWEDEN

9.1 General

Under the 1984 Nuclear Activities Act, the disposal company SKB is required to submit R&D plans for review every three years; these include proposals on site selection. As site selection progresses beyond drilling into more detailed characterisation, an investigation permit is required under the Act from SKI/SKN (the nuclear inspectorate and the nuclear fuel board respectively). Approvals are also required under the Conservation of Natural Resources Act and the Planning and Building Act.

9.2 CLAB spent fuel store and the Swedish Final Repository

The siting in 1978 of a 'CLAB' facility, for the interim underground pond storage of spent fuel, was decided following open negotiation with Government, regulators, external reviewers and local authorities at a number of sites. The site chosen lies alongside the Oskarshamn nuclear power station on the Baltic coast which also hosts the Äspö underground rock laboratory.

The siting at Forsmark of the Swedish Final Repository (SFR) for low and short-lived intermediate-level waste underwent a similar process to CLAB, with no objections to the proposal from the local authorities. Forsmark is also the site of an established nuclear power station on the Baltic coast.

9.3 Spent fuel

In 1995 SKB published plans for site investigations and other work envisaging first stage operation of a deep repository in 2008. The Government gave broad approval to SKB's proposed siting process and emphasised the importance of a well-defined and transparent process. The main steps include publication of siting factors (covering safety, technology, land and environmental impact, and societal aspects); publishing countrywide siting studies; and undertaking feasibility studies of between five and ten sites. These would be followed by more intensive surface-based investigations at two or more sites, after which an application would be made for construction of a shaft and/or tunnel for detailed investigation of a preferred site.

In September 1998 SKB submitted its new programme to SKI. The programme has been reviewed by a large number of national organisations, including SSI. In April 1999 SKI delivered its recommendations to the government. In its decision in January 2000 on SKB's RD&D programme -98 the government said that the programme fulfils the requirements in the Act on Nuclear Activities.

Whilst there is no special legislation governing siting in Sweden, SKB has agreed to respect the results of local referenda in municipalities proposed for siting studies. But any veto has no statutory force and the Swedish Government could override local objections and grant permission for studies to be carried out. KASAM (the Swedish National Council for Nuclear Waste, an independent review body) has requested the Government to specify the circumstances in which it might judge such action appropriate.

Environmental Impact Assessments are to be carried out at a number of sites and information in a standardised format is to be provided to the municipalities concerned. In 1996 the Government appointed a National Co-ordinator to promote information exchange and co-ordinate liaison between local authorities.

A feasibility study for Malå (a mining community) was completed in March 1996. A negative local referendum result in September 1997 led SKB to announce that it would not proceed further there. Similarly, the town of Storuman (southern Lapland) rejected further involvement in the siting process in September 1996. However, six further surface-based feasibility studies are taking place:

- in the Nyköping municipality, near the nuclear research centre at Studsvik, which started in 1995;
- in the Östhammer municipality, near the Forsmark nuclear power station site which again started in 1995;
- at three sites in the municipality of Oskarshamn, a location with the spent nuclear fuel store (CLAB) and the Äspö underground research laboratory. The municipality volunteered to take part in the process in October 1996 where sophisticated arrangements have been developed to build confidence in the concept of co-operation between communities and SKB – the so called 'Oskarshamn model';
- in the municipality of Tierp, where the council, in June 1998, voted unanimously to allow SKB to conduct a feasibility study;
- in the municipality of Hultsfred, where again the council, in May 1999, voted unanimously to give SKB the go ahead to conduct a feasibility study; and
- in the municipality of Älvkarleby where the council gave their assent to SKB in June 1999.

By the end of 2000 SKB will have completed its compilation of reports on the feasibility studies. Following evaluation of these reports, and taking account of the views of the Regulators, in 2001 SKB will propose two sites for further more detailed surface-based investigations to commence in 2002; it is anticipated these will take between 4 and 8 years. Following this period will be a 6 to 10 year period of detailed underground characterisation and construction. Before a decision is taken on continued operation, a trial phase of 'deposition' of 10 per cent. of the spent fuel inventory (about 400 canisters) which could be as early as 2012.

10. SWITZERLAND

10.1 General

Waste management in Switzerland is governed by the 1959 Atomic Law, amended in 1978; a complete revision is expected in 2000. All licensing procedures are within the remit of the Federal Government whilst the Cantons and Communities grant building licences. The Federal Commission on the Safety of Nuclear Installations (KSA) and the Federal Office of Energy, Nuclear Safety Department (HSK) draw up guidelines for disposal.

In 1972 the Swiss Federal Government and nuclear utilities set up the National Co-operative for the Disposal of Waste (NAGRA) to deal with radioactive waste arising in the country. The company is responsible to the Department of the Interior and to the Department of Trade and Energy.

A licence is required from the Federal Government before a repository can be constructed. Federal law also requires that Cantons be consulted prior to the grant of licences. In practice this means that the public are consulted through a referendum, ballot or a Cantonal assembly, although the outcome is not legally binding on the Federal Government. To accelerate the licensing procedure, an amendment to the Atomic Act has been proposed in

which all local and federal licensing requirements (both nuclear and conventional) would be encompassed into one Federal licensing process.

An expert Group on Disposal Concepts for Radioactive Waste (EKRA) was set up by the Federal Council in June 1999 and presented their final report in February 2000. They proposed, as a new concept ‘monitored long-term geological disposal, which combines final disposal with the possibility of reversibility’. In March 2000, the Federal Council opened discussions on the draft of a new nuclear energy law. This will be considered by Parliament in 2001. Important decisions will be made on keeping open the option of nuclear energy; restricting the operating lifetime of the nuclear power plants; the waste disposal concept; reprocessing; licensing procedures; right of expropriation.

10.2 Low and short-lived intermediate-level waste

The Swiss concept for the disposal of low and short-lived intermediate-level waste is a repository mined into the side of a mountain. NAGRA began the process of selecting a suitable site in 1978. In 1993 one hundred locations were identified for their geological promise rather than because they volunteered. Through a screening process, these were narrowed down to four in three different host rocks. From these, in 1994, NAGRA selected Wellenberg (in the community of Wolfenschiessen within Canton Nidwalden) for recommendation to Government as its preferred repository location.

NAGRA sought the opinion of the Government inter-agency body AGNEB when it proposed Wellenberg. AGNEB agreed that the process had been transparent and that the site was a ‘good choice’. However, in 1995 the Canton Nidwalden voted narrowly against NAGRA continuing its investigations despite the local community voting in favour.

EKRA has recently indicated support of this project. A decision by the Federal Government and the Canton on developing Wellenberg is expected soon and if the decision is positive a technical group will be set up together with an Advisory committee set up by GNW (a daughter company of NAGRA) and a Cantonal referendum is expected to be held on constructing exploratory drift in 2001.

10.3 High-level waste and long-lived intermediate-level waste

For HLW, spent fuel and LLILW, official Government policy requires NAGRA to look at international solutions for its small volume of waste as well as looking at disposal options within the country. Deep repository site selection is focused in the north of Switzerland (away from the Alps in the south of the country) in areas containing crystalline and sedimentary rock formations. A feasibility study and the site selection report is expected in 2002.

11. USA

11.1 General

The Federal Low-level Waste Policy Amendments Act of 1985 made disposal of commercially generated LLW (as defined in the US, which includes certain materials classified as SLILW in the UK) a State responsibility. Disposal of longer-lived transuranic (TRU) waste (roughly comparable to UK LLILW) Defence LLW, spent fuel and HLW are the responsibility of the US Department of Energy (DOE) as set out in the Nuclear Waste Policy Act of 1982 amended in 1987.

11.2 Low-level waste

LLW repositories have been operating at Barnwell, South Carolina, and Richland, Washington, and at several other locations across the USA prior to the 1985 LLW Act. Site selection for new LLW repositories began in 1985 under the 1985 LLW Act. This required states to have repositories operational by 1992 and allowed for inter-state ‘compacts’ to be created. Many compacts engaged in siting processes which included the possibility of communities ‘volunteering’ to be included in the site assessment process. All of the siting programmes initiated by the inter-State compacts are suffering legal delays and political difficulties.

11.3 Transuranic waste

A Waste Isolation Pilot Plant (WIPP) for the disposal of TRU waste opened for disposal in May 1999. It was constructed between 1980 and 1990, following siting studies which commenced subsequent to a 1957 report by the National Academy of Sciences recommending disposal in salt formations. WIPP is located in a salt formation at 650m depth some 30 miles from Carlsbad, New Mexico.

In 1996 DOE submitted a Compliance Certification Application (CCA) to the EPA to demonstrate that the WIPP complies with the EPA criteria. EPA public consultation, including public hearings in New Mexico, began in February 1997. The EPA concluded in October 1997 that, subject to certain provisions, WIPP complies with its disposal standards and should be certified. This action initiated a 120-day public consultation period involving further hearings. The details of the EPA CCA and Resource Conservation and Recovery Act (RCRA) consultation and permitting processes, including the relationship between the State of New Mexico, Carlsbad and the US DOE are extensive and complex. Suffice to say that the licensing of the WIPP facility was subjected to some of the most innovative and transparent methods of stakeholder review to have been applied in the USA if not elsewhere.

11.4 High-level waste and spent fuel

The US siting programme for HLW and spent fuel is centred on Yucca Mountain, Nevada, following an amendment in 1987 to the 1982 Nuclear Waste Policy Act (NWPA) which directed DOE to examine only that site. (Previously, a number of locations in various geological settings across the USA had been under consideration.) The 1987 legislation was criticised by the State of Nevada as ‘unfair’, although the Act specified that if studies showed the site to be unsuitable then investigations would cease..

The NWPA requires DOE to take title to the spent fuel from utilities prior to disposal in a deep repository. To cater for this it is proposed to store the fuel on the surface in a centralised Monitorable Retrievable Store (MRS). To facilitate the siting of this facility, the 1987 NWPA amendment established the independent Office of the Nuclear Waste Negotiator. The negotiator’s task was to try to find a willing host state or Native American Tribe in exchange for negotiated benefits. However, although some progress was made with a number of Tribes, the negotiation process was terminated without result. Characterisation work at Yucca Mountain has included the construction between 1993 and 1997 of an Experimental Studies Facility. Taking the form of a tunnel five miles long, it allows the direct *in situ* study of rock conditions and the hydrogeology at depths of up to 1,000 feet.

Progress at the Yucca Mountain site has been criticised as being slow and expensive by a number of review bodies. The ‘Viability Assessment’ published in 1998 was seen as a positive indication that site investigations should continue (and money appropriated).

In the next year or so, DOE will recommend the site to start the licensing process which will require the approval of the President. However, the State of Nevada enjoys a State's rights of veto powers over the President's decision. If exercised, however, the State veto can itself be overturned by a two-thirds majority vote of the US Congress.

If the site is found to be technically suitable, DOE state that a repository at Yucca Mountain could become operational by 2010.

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TECHNICAL NOTE BY BURGES SALMON FOR NIREX ON

LEGAL ISSUES RELATING TO VETO, VOLUNTEERISM AND COMMUNITY BENEFITS

Author: Patrick Robinson

This Technical Note is part of an ongoing programme of research conducted by Nirex and its contractors. It is a component of the research into options for the long-term management of radioactive waste in the UK.

Nirex want to develop the thinking outlined in this Technical Note through discussions with others. Therefore, this Technical Note should be viewed as 'work in progress' (i.e. interim or provisional status) and Nirex would be grateful for any comments on the ideas put forward. Nirex recognises that the Technical Note only outlines our view and that others may have different views on the issues.

Conditions

Bibliography

A complete bibliography of Nirex publications is available at the Nirex website, www.nirex.co.uk, or from Nirex Corporate Communications at the address below or e-mail: info@nirex.co.uk.

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We welcome feedback on our reports. Readers are invited to provide comments to Nirex on this Technical Note.

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PREFACE

This technical note has been produced for Nirex by Burges Salmon and outlines some of the legal issues relating to the concepts of veto, volunteerism and community benefits.

LIST OF CONTENTS

1 Introduction

The purpose of this paper is to investigate some of the present legal issues that arise in relation to the concepts discussed in the Stepwise Process document currently being developed by Nirex. In particular these include the following documents:

(a) Stepwise Process – PCD357335 (version 3).

(b) Concepts that could aid a site selection process – PCD 344524 (version 2).

(c) Site selection – PCD357803

In particular the Stepwise Process document identifies 11 key principles to which a legitimate and effective consultation process must adhere. In the conclusion section of this paper we will highlight which of those principles are particularly effected by the legal issues we raise in this paper.

The Stepwise Process paper (PCD357335 version 3) particularly raises the issue of veto, volunteerism and community benefits as an issue most likely to be relevant to the development of a site selection process for a final waste management solution. Again, in the concluding section we will investigate whether the legal issues surrounding veto, volunteerism and community benefit prevent those issues being constrained solely to the site selection process.

The analysis of the existing role of veto, volunteerism and community benefit inevitably focuses on instances that are drawn from existing processes by which new development projects are approved. As such, these examples most obviously equate with the later stages of a site selection process, in so far as the Stepwise process includes such a phase. There is no reason, however, why the role veto, volunteerism and the provision community benefits play should be limited to just this phase of the identification of a waste management solution. It is explained below that the scope of this paper falls short of analysing the manner in which the law might develop to further embrace these principles. It will be in this further development of the law that the application of these principles throughout the Stepwise process (i.e. not limited just to the later stages of site selection) will be apparent.

2 Legal Issues surrounding veto

The UK planning system has historically never operated on any basis of absolute veto in the hands of any party. The combination of appeals against refusal of planning permission, planning applications that can made on another party's land, compulsory purchase of land for planning purposes and judicial supervision of Government planning decisions has effectively meant that no single party, be it individual landowner all the way through to Government itself, could truly be seen as having a veto over planning decisions.

That is not to say veto on a more limited basis does not exist and appendix 1 to this text attempts a list of the range of instances where veto might be said to exist in one form or another. The best example of these would probably be the ability of a local planning authority to refuse planning permission. This is by no means an absolute veto but it is a strong statement of disapproval of a development and places very much greater obstacles in the path of a promoter by reason of a public inquiry needing to be pursued to obtain that planning permission. Local communities have increasingly come to see the refusal of planning permission at the behest of local residents as a key means of exercising local democracy. In contrast, however, the process of public

inquiry that then ensues has, however, been increasingly criticised as a poor forum in which those local interests can be ventilated.

A separate legal issue raised by veto (and one that will be seen to arise in a similar fashion with the issue of volunteerism) is the potential burden that it could place on other communities. With any development that relies upon minimum geographical conditions to give a suitable development site it must be correct that there will be a finite number of such sites available. If all of the communities in which such sites are found exercise a veto but there nevertheless remains an overriding national need to press ahead with that development it increases the risk that the siting will be located in an area that might be less than ideal from the physical and operational point of view, but acceptable to the local population.

If it is accepted that community approval is a factor as important to site selection as geographical and operational criteria then the point made above is not necessarily a point of objection to the role of veto in the site selection process. If, however, veto operates at too early a stage it raises the possibility that full investigation of the physical attributes of alternative sites might be curtailed by the early operation as a result of veto. Should that occur it increases the possibility that the fact finding exercise which must accompany any site selection process and which must be shown to be thorough and comprehensive, especially in relation to potential alternative sites, may be rendered vulnerable to challenge because of the too early operation of veto preventing proper investigation of alternative sites.

One of the most significant examples of the concern that might arise over veto operating in this way is the disadvantage that it could work on those communities that host interim storage facilities. Those communities could be faced with the prospect of having to host the storage of such waste over an indeterminate period of time with no practical means of registering a veto if the exercise of veto prevents an adequate number of potentially suitable sites coming forward for consideration.

If there is a balancing factor to this, however, it is that the approval of a site is almost certainly going to be based upon adequate compliance with prevailing performance criteria (safety, technical performance, etc.) rather than a search for the optimum site possible. This objective seriously risks impasse when sites can be removed from consideration at an early stage, before sufficient investigation has been possible to allow those sites to be discounted against those performance criteria.

3 Public Concerns Over Health : An Existing Parallel With Veto

3.1 Is public concern a material consideration?

It is clearly established law now that public concern is a material consideration, certainly in every case it is capable of being in material consideration and that can be so even if it is objectively unfounded. The parallel here with veto is that public fear over health risks that has no objective backing in evidence equates well with a simple exercise of veto, without the need for that veto to be justified. For the law on such unsubstantiated public concern in the planning process:

> *See Newport County Borough Council, The Secretary of State for Wales and Browning and Ferris Environmental Services Limited [1998] JPL377.*

3.2 What weight should be attached to that public concern?

The decision in *Newport* and the previous authorities that had led up to that judgement established the simple proposition that public concern can be material but gave no indication as to the weight that should be attached to it.

The leading case on this point is *Webbs Country Foods Limited –v- The Secretary of State for the Environment in Kennet District Council* [citation needed]. The critical part of the judgement is at page 37:

> *"Where the development plans lay down a clear test, whether in terms of the likelihood of harm or in any other form, then of course the decision-maker should apply that test or give reasons as to why he was not applying it. The same position might exist because of some specific test enshrined in national policy guidance on planning matters. Where, however, the decision-maker was merely having to apply the long established test nowadays enshrined in PPG 1 of whether the proposed development would cause demonstrable harm to interests of acknowledged importance, there could be no single universally applicable measure of what amounted to demonstrable harm. The decision-maker might perfectly properly decide that a small but real risk of harm to a nationally or regionally important resource or such as to amount to demonstrable harm and consequently sufficient to justify a refusal of permission. In other words the level of risk to be demonstrated would depend on all the circumstances of the case. Subject to Wednesbury unreasonableness, that was a matter for the decision-maker. In the present case structure plan policy C6 did not give guidance on the test that was to be applied and it was therefore open to the inspector to approach the issue of demonstrable harm in the way in which he had done".*

The Court directed attention first to whether local or national planning policy attaches any specific test as to the level of risk that would act as a threshold in such a case. If not, the decision-maker is required to consider both the extent of the risk of pollution occurring and the likely magnitude of that pollution and, in fixing the weight to attach to those factors, is required only to act reasonably.

Some examples from previous cases may assist but they are recognised as relevant on their facts alone, not as case law authority for imposing a particular standard of risk adopted in that case outside the facts of that case.

In Bannertown Developments Limited the Secretary of State for the Environment, Cotswold District Council and Kimberly Securities plc [1999] JPL 1016 the Court of Appeal considered a case where retail developments on the edge of Cirencester were considered with regard to whether they would harm the vitality and viability of the town centre. The Court of Appeal upheld the approach of the Secretary of State who refused permission having given consideration to the relevant material matters and concluded that there was a "real risk potential" of such harm being caused. The Court (at page 1025) indicated that conclusive proof or conclusive proof on the balance of probability was not a test the Secretary of State was bound to impose, he had the ability to take the view that if there was a risk of the harm in question permission could be refused. The judge added that it would have to be a "real risk" but apprehended that was what the Secretary of State had in mind.

Further illustration may come from the case of *Envirocor Waste Holdings Limited –v- Secretary of State for the Environment and others* [1996] JPL 489. In this decision an inspector's reasoning was challenged where he had refused planning permission for a waste transfer facility predominantly for liquid wastes at the objection of a nearby food processor who feared that their products might be tainted by spills of materials. In this case the inspector adopted a test of "likely occurrence", the decision was quashed

when it was found that his assessment of the factual data in no way approached that test in the way that his reasoning suggested. Illustrating the "likelihood" test the Court said that would have required a 1 in 30 probability of a tainting incident during the course of the thirty year life span of the facility.

The finding in *Envirocor* is of assistance on one other regard that is in further illustrating the minimum standard beneath which he could not reasonably have made a refusal. At page 9 the judge stated

> *"If he really meant that he was entitled to take account of any risk, however exiguous, that might be posed by an otherwise desirable development, then in my judgement he misdirected himself".*

That wording is really just amplification of the reasoning in *Webbs Country Foods* which stated that the decision-maker was bound by the underlying principles of *Wednesbury* reasonableness.

3.3 Does the precautionary principle exist independently of the above considerations?

Case law now indicates that the precautionary principle does not exist in an independent manner. The first judgement to point in that direction was *R –v- Secretary of State for Trade and Industry ex parte Duddridge* [1996] Env.L.R. This was a case in which persons seeking the prevention of the laying of electric cables argued that the precautionary principle required the Government to act to issue regulations to prevent the laying of those cables where there was some possibility of a risk of damage to health. In a case where the best that could be said on the available science was that it was not possible to conclude with certainty that EMF exposure carried these health risks the Court concluded that the precautionary principle had no direct application of itself despite the existence of the wording in article 130 of the Treaty of Rome (now article 174 of the EC Treaty).

This point has been further underwritten by the case of *The Queen –v- Derbyshire County Council ex parte David Murray* unreported 6 October 2000. In paragraphs 16 to 17 the Court made it absolutely clear that the precautionary principle did not exist as a stand alone rule of law despite its existence in article 174 of the EC Treaty and that to the extent it "illuminated" the Waste Framework Directive and implementing provisions of the 1994 Waste Management Regulations that was the full extent of its direct application to UK law.

Compliance with the provisions of the Waste Framework Directive and the 1994 regulations are the guarantee of compliance with the precautionary principle in so far as the UK government has sought to incorporate it into domestic law.

3.4 Public Perception of Harm/Veto : What Conclusions Can Be Drawn?

Public concern is a material consideration which can continue to carry weight even if it is not supported by objective evidence. In this way it parallels veto.

Simple veto has not been accepted in the planning system which has sought to develop a framework by which weight can be attributed to this public concern. Inevitably that process has led back to the weight to attach being linked to the strength of evidence proving that risk. Where national or local policy sets a standard by which risk ought to be judged that is the appropriate test to apply but where no such standard applies the matter is at large before the Inspector, his decision subject only to *Wednesbury* reasonableness.

While previous decisions have often turned on there being a "real risk" or even "likelihood" of an event occurring the matter remains within the inspector's discretion to weigh up the extent of risk and likelihood of severity of harm provided that reliance is not placed on unreasonably small levels of risk.

Outside of the above propositions the precautionary principle does not have a separate existence in UK law, ie, the Courts do not favour some "catch-all" provision which allows an absolute standard of safety, effectively an absolute veto, to be exercised.

4 Volunteerism

Volunteerism is not a concept known as such to the law and so it is not possible to provide a simple case/statute law analysis of its terms. The UK has a 19th Century property law base, that protects rights of ownership as paramount which is overlain with a largely post-war regulatory framework which operated primarily to inhibit the use of land by an owner rather than to encourage novel use of land by the community at large, hence the inability to find an easy definition of the concept in our present legal system.

However, once the principle is sub-divided into some of its component parts it is possible to begin to find parallels with some existing elements of the system.

The question of who is in a position to volunteer is one for which there are some existing precedents. These might be considered as a hierarchy moving up from the individual landowner which historically has been one of the most important consents necessary in the UK, which has a private property based legal system. Those rights of ownership are an important contributor to an ability to volunteer the site because of the opposition that can be mounted to compulsory purchase but that importance falls far short of an absolute ability to volunteer a site not least because of the need for planning permission.

Next in the hierarchy would come local community bodies such as parish councils. Historically, certainly since 1947 and the inception of the modern planning system, these bodies have been accorded very little weight. They are however consultees and it is true that they have in many situations been the focus of very strong public opposition to development schemes. Their chief weakness is their great variability in terms of members of the public willing to participate, the standards to which those members are trained and the resources available to the council to act as a body in its own right. Properly resourced both in terms of members, and access to advice, community bodies such as parish councils have the potential to be an even stronger focus for local community involvement than the much larger and geographically diverse local planning authority. If, out of the existing strata of representative bodies in the UK, candidates were to be chosen as likely to be a worthwhile focus for the local community, the parish council strata would warrant close consideration.

Next in the hierarchy come local authorities, district, borough, county and metropolitan borough councils, all of whom exercise varying parts of the planning powers in the UK.

Their control of the planning system has traditionally accorded them very great weight. The inability to appeal against the merits of a decision by a local authority to grant planning permission has re-enforced their power. In schemes of national significance they have been relegated from this position of power by the Secretary of State's exercise of his call-in powers to recover jurisdiction of such a planning application and determine it himself. Even where this occurs, however, the local planning authority remain one of the principal parties in any planning determination, underwritten by factors such as their control over the local plan for the area, a key document which will have great bearing on the acceptability of impacts of any development on an individual

area, even where overriding national need might also be pleaded in favour of that development.

It is also at present speculated that the local planning authorities' powers may reduce further by the introduction of third party rights of appeal as a result of the Human Rights Act. At present it is very difficult to speculate on precisely what such a right of appeal would mean in terms of practical effects on the influence of a local planning authority in their locality given the unpredictability of just how such a fundamental change to the planning system could be introduced and what limitations might be placed upon it to ensure that the planning system was able to continue in practical operation.

Last in the hierarchy of those able to volunteer would come Central Government (including various limbs of Government, some of which are to a large extent independent of Government such as Regional Development Agencies). Central Government volunteerism would seem necessarily to import ideas of planning permission being granted centrally and land acquisition potentially being brought forward by compulsion and as such would be so far removed from any community or local involvement as to place it at the furthest end of the spectrum from the concept of volunteerism.

Referenda are very rare in the UK. There is certainly no clear rule on their use but given that the UK has an unwritten constitution, that is unsurprising. Recent practice appears to indicate that they are considered appropriate for major constitutional change, typically related to the EU and further treaties but even this principle has not been applied consistently. For example a referendum was granted on the joining of the EEC, but one was refused over the ratification of the Maastricht treaty. Apparently one is now promised for the adoption of the Euro.

Past practice would seem to indicate that a national referendum would not be considered to be appropriate in relation to waste management strategies, but further investigation of the use of referenda to guide more local impacts might be appropriate.

It should be noted here that the same issues that arose in relation to the potential veto as for constraining the investigation of alternatives also apply reciprocally to volunteerism. The potential for a local community's willingness to volunteer its site being a pre-requisite to any site being looked at can operate to have the same effect as a local community veto of investigation of that site, preventing sites being looked at.

4.1 How Might Volunteerism Develop As A Principle?

This question lies outside the scope of this paper but it represents a very important area of future research, to identify existing instances of volunteerism in their simplest sense (and indeed veto) and to investigate how they might be extended within the spirit of emerging regulatory principles, principally those from Europe (EIA, SEA, Aarhus etc.). It is too big a subject to do more than flag up within this paper as a worthwhile area for future research.

5 Community benefits

In recent years the UK planning system has come to think of community benefits as being drawn almost exclusively from the use of planning obligations i.e. agreements and unilateral undertakings executed under Section 106 of Town and Country Planning Act 1990. These are the vehicle by which developers have both offered and been required, to provide works, facilities, land, payments or restrictions on the use as part of the decision making process of whether to grant planning permission. It will be seen

from the section below on legal issues relating to community benefits that the planning system always has, and continues, to stop well short of any concept of the sale of planning permissions. There nevertheless remains an uneasy link between the objective and impartial weighing up of a planning application by the planning authority, assessing those proposals against local and national guidance, all of which is in the public domain and the negotiation of packages of benefits to be contained in a Section 106 Agreement, the negotiation of which is more usually undertaken as a private matter between planning authority and developer.

This has lead to litigation in a number of cases where third party objectors have claimed that undue pressure has been brought to bear on a planning authority by the offer of such inducements and just recently it has resulted in comments by the Government (Lord Falconer to the CBI, 26th November 2001) stating that the whole role of planning obligations within the planning system needs to be reviewed with regard to transparency and public acceptance, amongst other things.

The specific legal issues relating planning obligations are dealt with in more detail below but whilst considering the general principles, what has been said above about planning obligations can be contrasted with an entirely separate concept found in the present operation of the landfill tax and distribution of the percentage of that tax to local communities in the vicinity of those landfills via the landfill tax credit scheme. The landfill tax was introduced in October 1996 with a philosophy to make the disposal of waste to landfill reflect more realistically the cost to society in the environment. As part of that scheme the landfill tax credit scheme was introduced, again with the specific objective of offsetting the dis-benefit to communities that live in the vicinity of landfill sites. The tax credit scheme allows landfill operators to claim a tax credit against donations made to enrolled environmental bodies to be spent on registered projects. In the vicinity of an averagely sized municipal landfill the landfill tax credit scheme could lead to anything in the region of £2 million being available over the usual life of 10 years to be distributed for a range of environmental objectives in the locality. Since 1996 over £350 million has been contributed to environmental bodies under the scheme. The distribution of these monies in local communities for public purposes has generally taken place without any question arising of impropriety and certainly without any question being raised related to the original grant of planning permission for the landfill as the distribution of the monies is in no way linked to the grant of planning permission.

The landfill tax credit scheme and the bodies that presently administer it may well warrant further investigation as models for community benefit within the planning process.

A related area of community benefit is that of community empowerment arising from a promoter paying for consultants to allow the local community to test a development. Provided that the promoting body is not in any way prevented from making such payments by its constitution there is clearly no reason why such a process would be unlawful and indeed there are many examples in existing practice of developers meeting the costs of regulators charged with independently assessing their development proposals. Sometimes these are represented in application fees. They can however be wider and there are a number of regulatory mechanisms whereby costs of a public inquiry can be charged on to the promoter of the scheme (i.e. the cost of the Inspector and the venue).

Blight is a further area where community benefits may be offered most usually by an extra statutory blight/compensation scheme. Again, precedents exist for this, such as the scheme promoted in association with the construction of the Channel Tunnel Rail Link. Such schemes have, again, generally avoided any taint of unduly influencing the planning system as they are seen to be operated quite independently of the decision

on the merits of the proposal but also probably because they are seen to meet a very real need which arises from such schemes in the minds of the public.

There does however seem to be potential for conflict between open consultation and the protection of property owners from blight by limiting the dissemination of information about the sites that are being consulted. Many property owners would prefer that the situation giving rise to blight was never publicised in the first place if it is to eventually transpire that the development will not go ahead in that location. However generous a blight compensation scheme is it is very unlikely to be welcome in many cases and most usually landowners would prefer not to be affected at all if possible. Blight is another area where further research is justified to investigate how these conflicts might be resolved satisfactorily. This paper does not advocate any approach to the treatment of blight, policy on release of information or other related considerations, matters which lie outside the scope of this paper.

At this stage it might be pertinent to consider whether there can be such a thing as a binding contract between "UK plc" i.e. the government, and any local community. Clearly in strict legal terms it is difficult to see how that could exist without infringing the theoretical sovereignty of each parliament. Indeed where historically the government has given solemn binding undertakings to other countries, the people of Hong Kong, the Falkland Islands, Gibraltar etc., political expediency as often necessitated revision or withdrawal of those undertakings sometime hence. There is no reason to believe it can give any more binding form of undertaking to a local community within its own boarders.

Clearly it would be possible to have an all-party consensus and agreement on a settled state of affairs but that would be a political agreement, not a legal one.

5.1 Legal issues relating to community benefits

The present law on what may be described as community benefits provided by a Section 106 agreement is governed by a strong authority from the House of Lords in the case of *Tesco Stores Limited v Secretary of State for the Environment and West Oxfordshire District Council [1995] to PLR 72,* more commonly referred to as *Tesco (Witney).* In very broad terms the test is simply that there should be some connection with the development which gives the determining authority the ability to take the benefits contained in the Section 106 Agreement into account in deciding whether to grant planning permission. Once that link is established the weight to be attached to the decision is one for the decision maker, subject only to them acting rationally. That weight can be anything from insignificant to decisive. In that case the Court rejected the principle contrary view that was held prior to 1995 that the benefits contained in the Agreement should address only legitimate land use objection to the development and comprise proposals put forward by the developer to overcome those objections. The Lords found no compelling authority in the UK system to limit the use of Section 106 agreements in that way but, inevitably, stopped short of recognising any system whereby a grant of planning permission could simply be bought by an owner of land. It is for this reason that it is generally a safe proposition that host fees, in their purest sense, are unlawful if they simply represent a payment for the grant of planning permission.

It is clear, however, that this judgement leaves open a very wide field of economic benefits that can reasonably be linked to the development in question whether or not they are strictly required to overcome legitimate objections to the development. In this regard see in particular the Nirex response to DTLR on (inter alia) the reform of the planning system (PCD388062) which highlights those aspects of the proposals for

reform which touch upon the legality of offering community benefits and the support Nirex expressed for those principles as well as caveats that it felt necessary to sound.

5.2 Planning policy relating to community benefits

In the UK planning system policy on community benefits is represented by DoE circular 1/97. This is a relatively restrictive policy, certainly more restrictive than the above case law. Effectively the test imposed here picks up the more restrictive argument that was dismissed by the Lords namely but there must be a measure of proportionality between the offer of the community benefit and the planning permission sought and effectively that the offer should meet some objection that should otherwise mean that the planning permission should not be granted.

At first glance this policy may seem particularly restrictive and a bar to the consideration of wider community benefits. That is, however, not the case. Whilst the policy restrains the ability of local planning authorities to demand community benefits where a developer would otherwise be unwilling to offer them it does not operate to prevent the planning authority taking account of such an offer should it be minded to do so. That is precisely the point on which *Tesco (Witney*) was decided.

The reason for the policy being phrased in the way described is that it is directed at regulating mainstream planning applications where it is felt there is a need to curb the enthusiasm of planning authorities who, without a tight restraint requiring them to demand no more than the minimum necessary to allow planning permission to be granted, would regularly exert unreasonable pressure on developers to provide extraneous benefits. The policy is seen as necessary to ensure that the regular turnover of these mainstream planning applications is not unnecessarily slowed by disputes over such issues which, multiplied by the number of planning applications where such disputes could conceivably arise, could lead to an appreciable impediment to the planning system.

In the case of a one off development project such as Nirex contemplate, where the quality of the decision making process and public acceptance of it is more important than the speed of decision making, such a policy has no obvious effect. It does however signal a general need for whatever regime might be approached for community benefits to be fair and impartially applied throughout the site selection process so that it was not seen as favouring particular communities and thus unduly influencing the level of public acceptance in that community.

5.3 Community benefits and environmental assessment

It is relevant to note where the present environmental assessment process might allow for community benefits to be taken into account. Environmental assessment does allow for mitigation measures to be offered and does specifically address attention to the economic and social impacts of a development. Broadly speaking then, environmental assessment does have the latitude to take into account community benefits when assessing the impact of a development. This is important where it is felt in respect of any particular class community benefits that they must not become divorced from the development proposed and must be accounted for as part of the decision making process. Other classes of community benefit, perhaps those which might be represented by distributions of funds akin to those under landfill tax credit scheme would presumably be incapable of assessment as to their actual impact, given the inability to predict them prior to the decision making process, and those might be considered to be of neutral effect in terms of environmental impact.

6 Conclusions

6.1 Legal issues relating veto, volunteerism and community benefits by reference to principles underpinning a decision making process

In the Stepwise Process document reference PCD357335 (version 3) 11 principles underline a decision making process throughout. Of those, 6 have been highlighted below as being particularly affected by the concepts addressed in this paper. The other 5 either raise similar issues, within the constraints of this analysis, or raise issues that are outside of this paper. Approaching these in the order in which they are raised in that document the following conclusion can be drawn from the above analysis. For ease of reference the text of the principle is repeated in italics and where there is overlap with one of the other 5 principles that is highlighted.

Openness

The debate must take place in the public domain there should be free access to all the relevant information. The Process should be open to influence from different people with different opinions and perspectives.

Relevant to this issue we have seen that the present system of negotiation of community benefits by planning obligations has frequently been criticised as obscuring the key element of the decision making process from the public scrutiny.

As a separate consideration the issues we raised on blight and the concern to protect owners from blight by withholding information on areas of search can clearly operate as a factor working against openness although this may well be an issue that can be addressed simply through the timing of releasing information and allowing for full public involvement after that stage.

The principle of A*ccountability – that those responsible for the process should be accountable for their actions to all parties. This includes publicising the reasons behind decisions* – is felt to raise similar issues to *Openness*, in respect of the issues in this paper.

Transparency

The reasoning behind actions, deliberations and decisions should be made available. It must be clear from the outset how stakeholders and the public can be involved and how their opinions will be taken into account and used.

Again the same issues relating to openness can occur here with the present criticisms of the use of Section 106 Agreement. The lack of any public involvement until after terms have finally been settled on many Section 106 negotiations will constantly work against this objective of transparency.

Devolved process

It will not be possible to talk to every group of stakeholders in the same way, therefore the process must seek to reach people in a way that engages them and enables them to express their opinions. It is important to recognise the differences between various groups in the population and their experience of the issues.

The principles raised in section 4 on who is capable of volunteering a site is particularly relevant to this situation. A full recognition of the potential strata of representative groups and, where appropriate the bolstering of those groups (such as the suggestion in relation to parish councils in section 4 above) gives far greater opportunity to support the key principle of devolved process even if the level of veto or volunteerism eventually offered is qualified and not absolute.

Inclusive

All stakeholders should be given an opportunity to be involved and a wide range of views should be sought actively. It is never possible to obtain a truly representative sample of stakeholders, but the consultation process should enable all those who wish to participate to do so.

Independence

The management in reporting the consultation process should be seen to be independent of established interests.

Both of these factors combine to be relevant to the issues raised above relating both veto and volunteerism when they talk of the potential for veto to remove what would otherwise be good candidate sites from consideration thereby increasing the burden on other sites. In this respect making the consultation process inclusive could be seen also to mean that any other sites which really should be investigated to provide a fair comparison might need to be considered i.e. to be truly inclusive, even those who do not wish to participate might need to have some involvement of their area.

In terms of independence whilst the key principle addresses itself to those managing and reporting on the consultation process the same principle may also be brought into effect if those with established interests in particular areas of land are able to exclude consideration of them at too early an stage and thereby distort the independence of the fact finding exercise.

It is clearly the case that a planning permission cannot be bought or sold, a principle that is likely to become more firmly entrenched rather than less. The principle can be expanded however to encompass the fact that any process that seeks to provide community benefit should not risk straying toward this principle in such a way that it compromises the independence of the decision making process. It must remain a critical requirement that the determination process, and any part that the principles of veto and volunteerism legitimately play in that process, are not compromised by any suggestion that there has been undue influence placed or exerted, and thus an unrepresentative response obtained, because of the distorting effects of an unreasonable or unjustified offer of community benefits at any stage in the consultation or determination process.

This area particularly raises the question of how the principles of veto and volunteerism might develop and how the principles they represent are likely to find themselves under consideration outside of just the later stages of site selection referred to at the beginning of this paper.

Sufficient resources

It may be necessary to make the resources available to allow people to take part in a consultation process. People will need resources to be able to attend meetings and may be need to be compensated accordingly. There will also be the need to provide information from several perspectives and this will need both co-ordination and funding.

This area is clearly addressed by the comment on community empowerment and is a key decision making principle which ought to be able to be readily addressed in any decision making process even given present legal constraints.

6.2 Stepwise principles outside of this paper

Collaboration

The process must be accessible to as many people as possible and the process should be developed taking account of comments made. Stakeholders should be able to influence the decisions made and the development of the process itself.

A critical part of the thinking behind the Stepwise Process is that Stakeholders should be provided with real influence over the development and assessment of the scheme. Clearly, respecting the wishes of the community through the concepts of veto or volunteerism is something that achieves its optimum return if that is informed public opinion which has played a full and meaningful part in the development process.

It is important to highlight the fundamental importance of the link between veto and volunteerism and full public involvement in the development process but the detail of how that public involvement can be achieved in practice lies outside of this paper [although the subject is addressed and developed in the DTLR/DEFRA consultation responses (PCDocs Ref 388062 and 387100)

Deliberation

The whole process should be interactive and stakeholders must be given feedback to show how their views have been taken into account or why they have not been included.

This is another "process" related point which generally addresses issues outside of this paper, other than raising similar issues to those on *Collaboration,* above.

Commitment

It must be possible to keep the consultation going throughout the lifetime of the decision-making process and its implementation.

Timely

It is important to capture public and stakeholder interest in the consultation per se and provide them with sufficient time to reflect and respond. However, too long a period of consultation could dissipate interest and inhibit overall interest.

Again, both of these points are primarily ones directed at the process of consultation rather than the content, the latter of which is the primary target of this paper.

6.3 Overall constraints and opportunities associated with veto and volunteerism and recommendations for future action

Veto is a principle that is recognised in a partial form at present but extends no further than a number of different participants in the planning process having influence over decisions, usually negative. There is certainly no catch all provision that allows public concern to act as an overriding veto to development and although the fact of opposition to a scheme is something that will be accorded weight in current decision making processes that weight is small, particularly if the decision making process has not specifically recognised that as a factor that will be accorded a specified amount of importance.

It can be seen even now that however the principle of veto is extended in the planning process it must be specifically prevented from operating so soon in the decision making process that it renders the consultation process flawed on account of insufficient investigation of alternatives.

The next steps that are recommended in respect of veto are research into the ability of veto to operate more extensively than at present, but in doing so to respect the above mentioned constraints and, in particular to see how the principles could apply at earlier stages of the consultation process than has been experienced in the UK planning system up till now.

Volunteerism can be seen in limited forms throughout the UK planning system in the ability of many different parties having the ability to support and promote new development. There are already many areas of overlap between these different parties and the influence they exert for example, the overlap between the public and planning authorities and the influence that the former has over the latter even though legally they are quite separate bodies.

The next steps that are recommended in respect of volunteerism are research into how the principle could be further developed in the UK planning system, one direction in particular being further investigation of how these areas of overlap might be enhanced and unified into a common principle.

Community benefits are already a well known part of the UK planning system and the ability to provide them already extends far beyond the very limited policy guidance that the government has issued on the subject. One limitation, however is that these benefits are generally limited to post development, and there is little experience of benefits being provided during the consultation and determination process other than limited instances of developers funding independent expert advice on projects.

What is beyond any doubt is that planning permissions cannot be bought or sold, a principle that is, if anything, strengthening over time. A derivative point is that the provision of such benefits should not compromise the integrity of the consultation, fact finding or determination process.

The next steps that are recommended in relation to community benefits are further research into how these principles can be further developed as part of the UK planning system, particularly in relation to providing benefits in a proportionate manner but potentially earlier in the development approval process, not just linked to the final development of a scheme.

Appendix One : Instances of Veto

VETO: WHO CAN 'VETO' A PROPOSED DEVELOPMENT ?

Individuals and community groups have –

(a) no formal statutory powers to veto proposed developments;

(b) statutory powers to object to planning applications –

see e.g. *s. 71 TCPA 1990, GDPO 1995 arts 8, 19;*

(c) limited rights to make representations on planning appeals, for example on a call in or if the application is refused and the applicant appeals – *TCPA 1990*;

(d) rights to challenge public authorities or any legislation for any infringement of individual's **human rights** or incompatibility with the European Convention on Human Rights - *Human Rights Act 1998* see e.g. *Article 6 Right to a fair trial* "in the determination of his civil rights" (see *Alconbury* line of cases over whether Planning Inspectorate and associated procedures constitutes a 'fair trial'; *Article 8 Right to respect for private and family life* (including home); and *First Protocol Article 1 Protection of Property* (see post);

(e) rights to challenge decisions by public authorities by way of **judicial review**, e.g. if they are unreasonable, irrational or unlawful;

(f) rights to complain to the European Commission of any **infringement of EU law**, which can result in infraction proceedings being brought in the European Court of Justice against the UK.

Local authorities which are planning authorities have-

(g) first line power of 'veto' by refusing planning permission, subject to acting lawfully and consistently with e.g. development plans, guidance etc., appeals and call-in and decision by Secretary of State;

(h) statutory appeals to challenge planning decisions – see *sections 288, 289, TCPA 1990;*

Regulatory bodies, such as the Environment Agency *(Environment Act 1995, Radioactive Substances Act 1993)*, Nuclear Installations Inspectorate *(Nuclear Installations Act 1965)* and Health and Safety Executive (*Health and Safety at Work etc. Act 1974)* have –

(i) no formal power to veto developments expressed as such; but

(j) practical powers to make developments inoperable without their agreement, e.g. nuclear facilities require the agreement of the NII to be able to operate – see e.g. *Sellafield MOX Plant* decision process, where NII had to agree before plutonium commissioning could take place;

(k) the ability to give opinions which if ignored or not properly taken into account would render any decision at risk of a successful judicial review;

(l) persuasive authority as (usually) statutory consultees.

Government has –

(m) formal responsibility for the application by the relevant Secretary of State of the 'justification' test for new nuclear processes required by

Article 6 of Directive 96/29/Euratom (the Basic Safety Standards Directive);

(n) power to move the goalposts for permitted development by changing planning law policies or guidance;

(o) effective first line 'veto' power when the Secretary of State decides a planning appeal or decides a case on call-in, subject to judicial review, compatibility with EU and Human Rights legislation and so on.

The European Commission, on receipt of a complaint or on its own initiative may investigate the compatibility of a development with relevant EU law, and may challenge the UK as a Member State, ultimately by infraction proceedings before the European Court of Justice which can now result in an unlimited daily fine for continuing breaches of EU law – see *Cion v Greece.*

International Tribunals have recently been called on to exercise effective rights of veto on nuclear developments. This area of the law is fairly uncharted territory. See e.g. Ireland's challenge to the UK over the *Sellafield MOX plant* (a) before the OSPAR Convention Arbitral Tribunal and (b) before the Tribunal of the UN Convention on Law of the Sea.

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Ethical issues in the disposal of radioactive waste

A paper for Nirex by Kate Rawles

December 2000

This paper has been prepared by Dr Kate Rawles under contract to Nirex. The paper has been reviewed by Nirex, but the views expressed and conclusions reached are those of the authors and do not necessarily represent those of Nirex.

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ABSTRACT

This paper starts from the premise that radioactive material, generated as a by-product of the British nuclear industry, already exists in significant quantity. The question of what should be done with this material therefore needs to be answered, even if no more of it is created. Whether the industry should continue producing radioactive waste is a legitimate question, and one which raises significant ethical issues. The main focus here, however, is on the question of what should be done with existing waste; a question which must be answered whether or not the industry continues.

This paper does not to try to answer this question. Its aim is to show that *any* attempt to decide what should be done with radioactive waste will raise issues which are essentially ethical or evaluative in nature; and that these ethical and evaluative dimensions cannot be avoided.

Introduction and summary

This paper starts from the premise that radioactive material, generated as a by-product of the British nuclear industry, already exists in significant quantity. The question of what should be done with this material therefore needs to be answered, even if no more of it is created. Whether the industry should continue producing radioactive waste is a legitimate question, and one which raises significant ethical issues. The main focus here, however, is on the question of what should be done with existing waste; a question which must be answered whether or not the industry continues.

This paper does not to try to answer this question. Its aim is to show that *any* attempt to decide what should be done with radioactive waste will raise issues which are essentially ethical or evaluative in nature; and that these ethical and evaluative dimensions cannot be avoided.

I begin the paper (section one) with brief working definitions of the terms, ‘ethics’, ‘values’ and ‘normative’. I then explore the extent to which a contrast can usefully be drawn between issues of ethics and values on the one hand, and empirical issues on the other, in the context of animal husbandry. I use this example partly because it is one I am familiar with; partly, and more importantly, in order to discuss the normative/empirical distinction more generally than just in the context of nuclear waste.

In the next two sections (sections three and four) I assume that a distinction between normative and empirical issues can usefully be drawn. I then make an initial attempt at identifying the ethical and evaluative issues raised by the issue of radioactive waste disposal. The existence of these issues is frequently overlooked and ethical and evaluative judgments are thus often made implicitly rather than explicitly. I argue, however, that they cannot be avoided.

In the fifth section I suggest that scientific practice is imbued with values and that a sharp or absolute distinction between normative and empirical issues is therefore misleading. Once this is recognized, a further set of ethical and evaluative issues raised by the disposal of radio-active waste can be identified.

In the next section I argue that, for a variety of reasons, all the normative judgments discussed and identified above should be made explicit, and opened out

for critical discussion and debate. I then discuss two common misconceptions about ethics and values, and suggest that challenging these misconceptions is extremely important.

In the eighth section I offer some observations about the political and practical significance of philosophy and I conclude with some suggestions about how a debate about the ethical dimensions of radio-active waste management might be taken forward from here.

1. Working definitions

a) ethics

The term 'ethics' is commonly used as a shorthand for ethical principles or standards, which relate to human behavior, attitudes and character. These principles distinguish what is legitimate or acceptable in pursuit of our aims from what is not. 'Ethical issues' will thus include issues of right and wrong; issues about how others should, or should not, be treated; issues about which character traits are admirable. Ethical issues, in sum, are issues about how we ought to live.

b) values

Values are those things which individuals or societies hold to be important, and worth pursuing or protecting. The Royal Commission on Environmental Pollution has defined values as "beliefs, either individual or social, about what is important in life, and thus about the ends or objectives which should govern and shape public policies." (1)

c) normative issues

Issues which are either ethical or evaluative, or which include ethical or evaluative dimensions, may be referred to as 'normative'; as can claims or expressions which include, whether explicitly or implicitly, an ethical or evaluative judgment. For example, "factory farming" and "vivisection" are normative in that they imply disapproval, whereas "modern farming methods" and "medical research which uses live animals", while initially appearing more neutral, may be normative insofar as they imply approval.

2. Normative and empirical issues

a) the normative/empirical distinction

Normative issues can, on the one hand, be contrasted with empirical issues. Empirical questions are those which can, in theory at least, be answered by observation or experiment. They are questions about what *is* the case, or what was or would be the case, given certain conditions. Normative issues are to do with what should be the case, or what *ought* to be done, or what is held to be valuable.

Take, for example, the issue of whether particular animal husbandry systems have an unacceptable impact on the well-being of the animals kept in them. This issue has both empirical and normative dimensions. Empirical questions will include the nature of the physiological, psychological and behavioral effects of the system on the animals concerned and the implications of these effects for the overall welfare of the animals. These are empirical questions, because they are questions about what is the case, or what would be the case, under a particular set of circumstances. They are questions for veterinary science, and the answers will involve reference to information about animal behavior, physiology, stress and so on.

The normative questions will concern whether these sorts of effects, and this level of welfare, is acceptable. These are not questions which can be answered by science alone. Veterinary science can offer information about what the welfare of a

particular animal *is*. But it cannot by itself tell us what the welfare of the animal *ought* to be. Science by itself does not offer answers to ethical questions. Nor can it tell us that animal welfare matters in the first place. This is a value issue, as is the question of how much animal welfare matters relative to other things which are held to be important, such as economic gain.

b) problems with the normative/empirical distinction

It is, however, a serious mistake to suppose that a distinction between normative and empirical issues can be drawn in an absolute, or even particularly neat, manner. Arguably, it is an abstraction to draw it at all. The reality is more subtle.

Scientific investigation is inevitably carried out within an intellectual framework in which a wide range of value judgments are embodied, including judgments about what counts as relevant data and which questions are worth asking. Moreover, scientific investigation is carried out by particular people in particular social, historical contexts. The values held by scientists and their cultures inevitably inform the way science is practiced. Scientific investigation on the one hand, and ethics and values on the other, are in many respects interwoven, and can never be fully untangled from each other - though it is often assumed that they can be. These are points which will be returned to later.

c) circumstances where the normative/empirical distinction is useful

It doesn't follow from this that the distinction between normative and empirical issues should be abandoned altogether. Providing its problematic nature is borne in mind, a rough distinction between empirical and normative issues can usefully be made in some circumstances.

Take the issue of stag hunting, and whether or not it should be banned. Despite inevitable overlap and interconnection, there is a significant difference between the empirical question, "do stags suffer when they are hunted in this manner?" and the ethical question, "is this degree of suffering, imposed for these reasons, acceptable?"

This kind of difference is particularly worth highlighting when the ethical and evaluative dimensions of an issue are regularly overlooked or obscured, or where these issues are taken to be of little significance. In these cases, drawing the normative/empirical distinction can be useful as a means of focusing attention on the ethical and evaluative dimensions of an issue, which might otherwise go unnoticed.

3. Normative issues in the disposal of radioactive waste

It has often been argued that the question of what should be done with radioactive waste is a purely scientific and technological one. From this point of view, the expertise required to make a decision is purely scientific and technical; and the information required to do this is related solely to technological developments for containing radioactive material, geological information about particular sites, the scientific comparison of different kinds of risk, and so on.

I do not in any sense want to deny the importance of the scientific and technological dimensions to this issue. The problem clearly requires scientific understanding and expertise. But it is important to dispute the claim that the issue is

a scientific one alone, and to argue instead that ethical and evaluative issues are inevitably raised, alongside scientific and technological ones, by any attempt to decide how radioactive waste should be dealt with. I now want to identify some of these issues.

a) Value judgments

Value judgments are unavoidable in the context of radioactive waste disposal. This, in essence, is because choices have to be made. A range of possible answers can be offered to the question of what should be done with radioactive waste - leave it on the surface, bury it at x, y or z site, bury it retrievably at x, y or z, put it in the Dome, etc. Deciding what to do will therefore involve making choices; it will involve deciding the range of options and ultimately what is the *best* option. Identifying a 'best' option refers to criteria which rest on value judgments as well as scientific evidence.

In considering what the criteria for the 'best' option might be, numerous factors will be relevant, including, for example, empirical considerations about the geology of different parts of the country. Why the geology of one place might be considered more appropriate to that of another will include reference to factors such as stability of the rock over time, the behavior of groundwater and so on. But the reason these are relevant concerns is a consequence of concern about the safety of the site - safety in terms of the possible impact on people. In other words, the judgment about geology rests on the values put on human life and health. If human health were not valued, the geological criteria would not be the same.

This is such a fundamental point that it is often missed: *the basic values which underpin the concern to dispose of radioactive waste safely are the values put on human life and health*; the view that human life and health *matter.*

There will, of course, be other criteria that are relevant in identifying which is the best option, including economic and political ones. In each case, however, the criteria will be underpinned by value judgments. If no value at all were put on economic considerations, for example, the expense of one option compared to another would simply not be relevant.

Fundamental value-judgments are, then, inevitably involved in the course of deciding what to do with radioactive waste. They are entailed by the need to make choices, and they underpin the criteria that are taken to be salient in making these choices.

Given that there will clearly be more than one value involved - human safety and economics at the very least - value judgments will also be involved in deciding how different values weigh against each other. These judgments may be particularly acute when the values pull in different directions, as safety and economics, for example, often do; but they will also be a factor in less difficult cases.

In addition, a further series of value judgments will be made:

- in deciding what process for making these decisions is most appropriate
- in deciding who should take part in this process
- in deciding what structures will be put in place to monitor and assess the decision-making process, and who it should be accountable to

(b) Ethical judgments

Some, but not all values are ethical values. Most of the ones mentioned above are, as a matter of fact, ethical. But some value judgments may more usefully be classified in other ways, such as economic or aesthetic - though there will clearly be overlap. For example, deciding what count as questions worth asking in a given scientific discipline will involve making value judgments that will not necessarily have an ethical component. Deciding whether or not interest rates should be raised will involve economic value judgments, and it might well also involve ethical ones, for example, about whether keeping inflation low is more important than keeping unemployment low.

Various accounts have been offered as to what distinguishes ethical judgments or ethical issues from, for example, economic or aesthetic issues. Ethical judgments are often considered to be those which relate to actions or attitudes which have a significant impact on people's lives or happiness or well-being; or which are related to values which we consider central to people's lives, such as honesty or freedom. So, for example, questions about whether or not capital punishment should be reintroduced, or whether to tell the truth in a particular context would normally be considered ethical. Questions about which is the most visually attractive of a range of development options would typically be considered aesthetic. Questions about how public money should be spent will involve judgments which are both economic and ethical - ethical because these decisions involve opportunity costs which have significant implications for people's lives.

The central ethical question raised by the issue of radioactive waste disposal flows from the fact that radioactive waste is hazardous material. Its existence constitutes a potential threat to human - and non-human - life and well-being, and will continue to do so for thousands of years. Thus the question of what to do with it is irredeemably and inevitably ethical. How should this situation best be managed? From this central ethical question radiate a network of others, some of which have already been outlined above.

Some caveats: this is a preliminary paper, and I do not claim to have identified a complete list of the ethical questions raised by radioactive waste disposal. Nor do I attempt here to suggest what the answers should be, or by what process these answers should be reached. What follows should be taken as an initial account of the ethical issues as I am able to identify them at this point.

1) The fundamental ethical issue, as identified above, is what ought to be done with radioactive waste, given that this material constitutes a threat to human and non-human life and well-being. This fundamental issue then gives rise to a) intergenerational; b) intra-generational and c) environmental issues.

a) Radioactive waste has been created by current and recent generations, and it is these generations that have enjoyed the benefits of the nuclear industry. But the waste remains potentially hazardous for hundreds of thousands of years. The basic *intergenerational* ethical issue is thus whether and to what extent current generations have obligations to future generations, and what these obligations might be. For example;

i) Do we have the *same* ethical obligations to protect the health and well-being of future generations of people as we have to present ones? Will the answer to this be different in the case of the near future as compared to the very distant future?

ii) Is it our *duty* to solve the radio-active waste problem that we have created, or would it be acceptable to leave this problem for future generations? And,
iii) In our attempts to solve the problem now, how *far* into the future ought we to consider?
iv) What ethical assumptions, for example about the relative value of future human life, are implicit in the practice of discounting, and are these assumptions acceptable?

b) Whatever decision is made about the management of nuclear waste, the waste will be located in a specific place, in, or under, a specific community. The benefits of the nuclear industry, however, in terms of energy generation, are enjoyed across whole the country. The basic *intra-generational* ethical issue thus concerns the relationship between this larger constituency and the community which hosts the waste. For example;

(i) What would count as an appropriate relationship in this context?
(ii) Under what circumstances is it legitimate to expect or to ask one group of people to bear costs on behalf of another group?
(iii) What sorts of costs might be involved? and what sort of compensation might be appropriate?
(iv) At what point does compensation become bribery, and vice versa?

c) Radio-active waste is potentially dangerous for many (all?) forms of life, and for the environment as a whole. The basic *environmental* ethical issue thus concerns the extent to which we have ethical obligations to non-humans, and what these obligations would be. What, exactly, is the constituency of those we are required to respect and consider when thinking about risks in this context? And what does this respect actually entail?

2) Other ethical issues include those which arise with regard to a) the decision-making process; and b) the relationship between radioactive waste management and the broader context of energy production and consumption:

a) The basic ethical issue here concerns the nature of the *process* which should be used to make all the decisions identified above. For example;

(i) What sort of process should be used?
(ii) Which values - such as openness, impartiality, freedom of information - should guide this process?
(iii) Who should be consulted, and how?
(iv) What role should ‘the public’ play in the decision-making process, and which sections of it should be consulted?
(v) How should the views of those who live locally to proposed sites be compared with those distant from them? How should the views of locals be compared with those of ‘experts’?
(vi) What should be counted as relevant expertise in this context, given that the issues are normative as well as technical?

b) The relationship between radioactive waste management and the broader context of energy production and consumption raises numerous ethical issues. For example;

(i) What is the relationship between particular strategies for the management of radioactive waste and the continued production of radioactive waste? and
(ii) To what extent are possible or actual connections acknowledged and made available for critical discussion?
(iii) How do the problems of radioactive waste management compare with the negative implications of other means of generating electricity?
(iv) To what extent are the negative consequences of electricity generation in general made evident, and to what extent is the issue of energy *consumption* open for critical review?

This is not, as I have said, meant to be a fully comprehensive list of ethical issues, though it does attempt to indicate some of the most central. The key point is that, while empirical information about the geology of particular sites or the behavior of radionuclides in groundwater (for example) will be crucial in deciding what should be done with radioactive waste, *this kind of information cannot by itself provide answers to ethical questions of the kind identified above.*

4. Normative judgments - can be overlooked but not avoided

W*hatever is done with radioactive waste a position will be taken on these and other ethical issues.* Needless to say, this is not always done explicitly. They are often left implicit, unrecognized, unexplored and the cause of misunderstanding and conflict. Nevertheless, whether or not the issues are explicitly considered, judgments about them will inevitably be made.

For example, the question of how far into the future we should look when thinking about risks can be overlooked, but it can't be avoided. If it is overlooked, the different possible answers to it will not be debated. But a stand will be taken on it, whether that stand is that future generations are to be counted equally, or discounted or not considered at all.

The same point can be made for all the issues outlined above. It could be argued, for example, that the question of who, exactly, should be consulted in the process of deciding what should be done with radio-active waste, was for many years never fully articulated. Instead, it was largely assumed that this was an issue to be decided by people with particular kinds of scientific expertise and thus that the views of non-scientists were not relevant. The point here is not whether these assumptions were appropriate, nor whether this is an accurate picture of a particular era within the nuclear industry. The point is that if it were accurate, the value judgments about which kind of expertise is relevant, and whose voices should and should not be heard would not have been avoided. They would still have been made, and in a particular way - but implicitly and therefore with less critical reflection than might now be thought acceptable.

Another example refers to the concern for health and safety. This may in effect be limited to a particular group of humans, for example, those alive now and in the relatively near future. And it may well be limited to humans and not other species. Here, a position is being taken on value issues, whether this is done consciously, semi-consciously or completely unconsciously - in this example, issues about whether distant future generations of humans need to be considered; about how much they need to be considered relative to current generations; and about whether the health of non-human animals and the environment need to be considered at all.

Again, the point is not to assess whether these judgments are reasonable ones. It is simply to point out that they are being made, and that this is inevitable.

5. Normative judgments embedded within science

The points made above make use of the distinction between empirical and normative issues in order to highlight where normative issues arise in the issue of radioactive waste disposal.

There is an important sense, however, in which the distinction itself is suspect. Once this is acknowledged, other sets of ethical and evaluative issues come into view.

This can be illustrated with the example of stag hunting. I have argued that there is an important sense in which the question, “do stags suffer when hunted?” and the question, “is this level of suffering acceptable?” can be distinguished.

It might well be pointed out, however, that there is a distinct lack of consensus with regard to *answers* to the question about stags’ suffering. This could be partially ascribed to the vested interests of the particular groups which commission the science. But it also relates to deeper levels of uncertainty, for example about what counts as suffering, what counts as evidence of suffering, when counter-evidence should be taken seriously and when it can be dismissed, what suffering counts as ‘natural’ and so on. As in so many cases, the disagreement is within the science, not just in its application.

Answering such questions involves making value judgments: they are not questions about what is the case but about what is to be considered significant. Any statement about stags and the degree to which they suffer will have to take a stand on these issues. Thus any statement about stags and the degree to which they suffer will involve making value judgments of this kind.

This point can be broadened out. Wynne argues, for example, that contemporary scientific culture includes attitudes towards its own status, to the status of its knowledge relative to that of ‘the public’ and towards ‘the public’ itself (2). These attitudes are normative. They involve value judgments, for example, about the relevance of scientific expertise compared with other forms of expertise in the context of decisions about radioactive waste.

This is, of course, a huge topic, which I can only touch on here. A summary of the kinds of value judgments often taken to be embedded within the practice and culture of science include the following.

(i) The intellectual framework and culture within which science is carried out includes an array of value judgments about which questions are worth asking; what counts as data and evidence in answering them; what claims can be made from the evidence; how research should be carried out; what counts as consensus and so on. In times of controversy, different scientists will make different value judgments.
(ii) The practice of science is informed by a set of values, including rigor, intellectual honesty, precision, comprehensiveness, views of intellectual property.

(iii) Value judgments are made when these values pull in different directions; for example, when precision suggests a narrow focus while comprehensiveness the opposite.
(iv) Value judgments are made in deciding how to respond to uncertainty and contingency and unpredictability; judgments about trust often become central.
(v) Ethical and evaluative judgments are made in deciding what quality of knowledge can legitimately be used to inform or prescribe particular policies.
(vi) Value judgments are embedded in the view taken of competing claims by other scientists and non-scientists, and in the view of public and political concern and responses to these.

6. Why make normative issues explicit?

The judgments outlined above, like the ethical and evaluative judgments discussed in previous sections, are not necessarily, or even usually, made consciously and deliberately. On the contrary, they are often semi-conscious habits of thought embedded in the general scientific culture (3). But, as I have argued, when ethical and evaluative judgments are not noticed it does not mean that they are no longer made; only that they are made implicitly rather than explicitly. And, if made implicitly, they are by definition not open to critical reflection, debate and scrutiny.

This is highly problematic, for a range of reasons.

(i) Ethical and evaluative judgments which are made implicitly are made without much thought. Arguably, they stand a good chance of being made better if they are made thoughtfully, and subject to some kind of critical scrutiny.
(ii) The ethical and value dimensions of radio-active waste management have extremely significant implications for people's lives and well-being. Arguably it is itself unethical for such judgments to be made implicitly without recognition, evaluation, wide consultation and debate.
(iii) Imposing ethical and evaluative judgments on others without such debate is certainly, as has been seen in the past, tactically unwise, even if not unethical.
(iv) Ethics and values which are not subject to critical reflection and debate are not likely to change. This may not be an issue if the ethics and values embedded in current radioactive waste policy are absolutely ideal and beyond all reach of improvement. But this is a big if.
(v) Ethics and values which are not subject to critical reflection and debate are likely to remain uninformed, lacking in understanding and a basis for further misunderstanding and conflict.

A crucial first task, then, is to *identify the ethical and evaluative judgments that are and will be made in the course of formulating policy decisions about radio-active waste.* It is only when they are identified and made explicit that we can have a careful, reasoned discussion about them.

A second, equally fundamental, task is to challenge various extremely common misconceptions about the kinds of things that ethics and values are.

7. Misconceptions about ethics and values

The comments above assume that ethics and values are the kinds of things we can have a reasoned debate about. This introduces the first misconception. This misconception is extraordinarily common. It is that ethics and values are purely

subjective and 'soft'; that they are matters of personal opinion or taste. This conception of ethics and values is often accompanied by and contrasted with a view of science as objective, universal, hard and full of facts.

I have already suggested that such a view of science can be readily undermined; that science is shot through with values. I want now to argue that the conception of values and ethics as radically subjective is also profoundly mistaken.

a) ethics and values are radically subjective - like preferences or tastes

If ethics and values were radically subjective, like personal preferences or tastes, it would not make sense to argue about them, nor to suggest, as I have done, that they should be open to reasoned debate and critical scrutiny. If you have a taste for thin-cut marmalade and I have a taste for thick-cut, there is not much we can say about this, except that you have your taste and I have mine.

But ethical views are not like this. If one person thinks that apartheid is an unethical system and another thinks it is an acceptable one, their response is unlikely to be, well you have your taste in political systems and I have mine. Rather they are likely to ask each other *why* they hold the views they do, and then assess the reasons offered.

Ethical and evaluative views are not like tastes in marmalade because they are held for reasons, and these reasons can be critically assessed. Some reasons are seen as better than others, because they too are supported by reasons, experience and argument and/or because they draw on particular values which are more widely held, such as justice, civilization, freedom, honesty, social order. If this were not the case, there would be no way of discriminating between, for example, the ethical views of Gandhi and of Ghengis Khan; it would just be a matter of personal preference which is chosen.

In summary, issues of right and wrong, good and bad, are not like preferences for thin versus thick cut marmalade. Ethics and values, unlike tastes and preferences, are accountable in various ways - to argument, to reasons, to experience, to strongly held intuitions and to evidence.

There is of course a great deal of interest currently in the ethical and evaluative aspects of issues raised by scientific innovation. The genetic modification of animals and plants is just one example. But this interest is often underpinned by the above misconceived dichotomy between hard science and soft ethics. To put it another way, the issue is typically framed in terms of a fairly sharply drawn distinction between objective (science) and subjective (ethics and values).

The result of this is that the significance of people's ethical concerns may be downplayed or even dismissed as "politically real but intellectually vacuous". (4) In the nuclear context, for example, it has often been maintained that the risks presented by the industry can be measured objectively, by scientists with relevant expertise. As a consequence, public worries about the industry which diverge from the scientific account of these risks have correspondingly been conceived as resting on subjective, emotional responses and a misunderstanding of the science.

In fact, as Wynne argues, public concerns about nuclear technology typically rest on the subtle and intellectually sophisticated recognition that science has to deal, not just with risks - which are predictable consequences - but also with consequences which are completely unforeseen and unexpected. This situation generates a range of highly pertinent ethical questions and value judgments about the quality of the information used in the formulation of policy decisions, and about

the trustworthiness and track record of the institutions which will have to deal with the unforeseen when it happens.

There is thus both a logical and an empirical point here. Ethical and evaluative judgments are logically distinct from preferences and tastes. Ethical and evaluative judgments have, or are capable of having, grounds, which can be evaluated. They can be rationally defended, and they can be contradicted. Preferences are things we just have. Of course, this may be more of a spectrum than a sharp either/or distinction. I can offer at least some reasons in support of my taste for Islay Malt, whereas my preference for thick-cut marmalade is difficult to justify at all. But a disagreement about for example, the ethical acceptability of the death penalty or abortion or apartheid would involve appeal to a very much wider range of arguments and considerations than a disagreement about either whisky or marmalade choices.

The empirical point concerns whether and how people's ethical and evaluative judgments about, for example, the trustworthiness of the nuclear industry, are actually explored. If they *are* explored, and in a way that doesn't preempt any possibility that they might be intellectually grounded, it is typically found that these views have significant intellectual content and are grounded in a range of intellectually sophisticated ways.

(b) ethics and values are only held by individuals

The second common misconception, which I have already touched on above, is that ethics and values only exist at a personal level. They are things held by individuals, and only individuals. This is also false. Ethical and evaluative positions and judgments are also embedded in a wide range of institutions, businesses, political and economic systems, and so on. Laws, policies, codes of practice, principles and mission statements, for example, commonly embody ethics and values.

In the context under discussion, the scientific and policy culture and institutions dealing with radioactive waste embody a range of judgments about what counts as good science, what is an appropriate response to unpredictable consequences; how public views of the nuclear industry are to be understood relative to scientific interpretations of risk, and so on.

(c) why these two misconceptions matter

If these two, related, misconceptions about the general characteristics of ethical and evaluative issues are left unchallenged, a variety of undesirable consequences are likely to follow, some of which have already been introduced above.

(i) Ethical concerns can be effectively marginalised and/or dismissed.
(ii) Critical debate about ethical issues will not happen.
(iii) Those who raise ethical concerns, often 'the public' can be effectively marginalised and/or dismissed.
(iv) The scientific culture can be protected from critical reflection and examination of its own practices.
(v) Change in ethics and values is unlikely.
(vi) Decision-making procedures for issues with normative dimensions will be put in place which assume and reinforce the subjective/objective dichotomy; for example, cost-benefit analysis, and many surveys of public consensus and belief, which leave no room whatsoever for assessing why people hold the positions they do.

8. Philosophy and habit

Two fundamental tasks have been identified in the discussion above. The first is to unearth and identify ethical and evaluative issues and bring them to the surface for critical discussion and debate. The second is to challenge misconceptions about the nature of ethical and evaluative issues. These are essentially philosophical tasks. Together they suggest, perhaps surprisingly, that philosophy has significant practical and political relevance - at least in so far as philosophy is understood in a broad sense, as a critical reflective approach to institutions, cultures and lifestyles, and the ideas and assumptions embodied within them.

Tolstoy wrote that the greatest threat to life is habit. By familiarizing us to the point that we no longer really see them, habit destroys our friends, family, landscapes and lovers; or at least, it renders them invisible. Tolstoy argued that the remedy is literature, or at least, great literature. Great literature restores our lives to us, by refocusing our attention on the people and things around us. Literature makes the taken for granted visible again.

A similar point can be made about ideas, concepts and assumptions, and the intellectual frameworks that these ideas and assumptions exist within. Concepts such as ethics, values and science, for example, are extremely familiar, and we often take them for granted. Yet they are extremely difficult to define, and the relationships between them are difficult to explain. Attempts to do either will rapidly bring a range of complexities to light. (5)

Moreover, these concepts carry with them a raft of interconnected assumptions. These assumptions influence the way we think about a range of issues. But they often go unnoticed. They become routinised habits of thought, which then feed into the way we decide and act, without ever having been subject to critical scrutiny.

An important remedy here is philosophy. This has been recognized for centuries, but is often overlooked in the current empiricist culture. A key task for philosophy, and one that lends it its practical significance, is thus to help us to undo habit; to render the habitual patterns of thought embedded in individuals and institutions visible, and make them available for critical review (6).

9. Summary and next steps

I have argued that the question of how radioactive waste should be managed raises a range of ethical and evaluative issues. Judgments about these issues will be made in any attempt to answer this question. These judgments may be made implicitly rather than explicitly, but they cannot be avoided.

I have also argued that the ethical and value judgments made in the context of radio-active waste management should be identified and brought out into the open, so that a full and open debate about them can be initiated.

How this debate is best conducted, and who should take part in it, are questions which will need to be addressed. Meanwhile, a useful next step will be to focus on some of the most central of the ethical issues and questions identified here, and to offer a more detailed exploration of the factors and arguments which need to be considered in answering them.

Previous Page

Notes

(1) RCEP *Setting Environmental Standards* 21st Report, October 1998,Cm 4053
(2) Brian Wynne; "Expert Discourses of risk and Ethics on GMO's: the weaving of public alienation" (Forthcoming, 2001)
(3) Brian Wynne; op cit
(4) Brian Wynne; op cit
(5) Kate Rawles; "Philosophy and the Environmental Movement" in D.Cooper and J.Palmer eds; *Spirit of the Environment* (Routledge, 1998)
(6) Mary Midgley; "Philosophical Plumbing" in P.Griffiths ed; *The Need to Philosophise* (Cambridge University Press, 1992)

Annex 1

Committee on Radioactive Waste Management

CoRWM DOCUMENT "NAMEPLATE"

1. Author	**Secretariat...**
2. Date	**24/2/04...**
3. Title / subject **Summary ...**	**Presentation by Nirex to CoRWM 2004, London**
4. Status (e.g. 1st draft, final)	**Final...**
5. Who is receiving a copy (delete as necessary:) All Members ... **(please also send a copy to Sam Bains in the Secretariat)**	
6. Confidentiality Reasons (if any) why the document should not be published: ...	
(Secretariat to complete:) **Document number** **File** **Folder**	 **236...** **...** **...**

PRESENTATION BY NIREX TO CoRWM, 20 FEBRUARY 2004, LONDON - SUMMARY

1. **In brief**:

This was the second event in Members' learning programme. It was not a formal meeting involving decision making. The next learning event would be a presentation by NGOs on 5 March.

2. **Present**:

CoRWM: Gordon MacKerron (Chair), Fred Barker, Mark Dutton, Lynda Warren, Pete Wilkinson. Secretariat: Steve Mansfield, Adam Scott. Nirex: Chris Murray, Ann McCall, Samantha King, Elizabeth Atherton.

3. **Nirex presentation:**

Nirex gave a presentation ***Nirex update - February 2004*** (document 232, copy attached) setting out the history of radioactive waste management in the UK, the role of Nirex, the lessons it had learned, and its hopes for the future including its working relationship with CoRWM.

Nirex handed over a series of reports:

- ***Concepts that could aid a site selection process***, 2000 (document 226)

- ***Ethical issues in the disposal of radioactive waste***, 2000 (document 235)

- ***Nirex response to the Defra and Devolved Administrations' consultation paper***, March 2002 (document 231)

- ***Technical note by Burges Salmon for Nirex on legal issues relating to veto, volunteerism and community benefits***, 2002 (document 229)

- ***Compensation in radioactive waste management: ethical issues in the treatment of host communities***, May 2002 (document 230)

They listed other areas which they had researched, including radioactive waste management and social science issues, on which they could send reports to CoRWM.

4. **Questions:**

Individual CoRWM Members put questions to Nirex on points raised in its presentation, so that they could better understand issues relevant to radioactive waste management.

5. Conclusion:

The Chair thanked Nirex for its presentation and for a useful meeting. This was not a decision making meeting and CoRWM was not at present making any specific requests of Nirex. Nirex were, however, a vital resource which CoRWM would draw on, for example through its waste inventory working group. He would consider how to ensure that other Members were aware of the information they had imparted. He welcomed the assurance that Nirex would not engage with stakeholders in areas where CoRWM was in the lead. CoRWM would be transparent about all information received from Nirex.

CoRWM would not consider potential sites. It would consider generic siting issues, but probably not in the early stages of its programme.

Secretariat February 2004

Committee on Radioactive Waste Management

CoRWM DOCUMENT "NAMEPLATE"

1. Author	Fred Barker..
2. Date	24/2/04...
3. Title / subject	Report to CoRWM Plenary Meeting from the PSE Working Group ...
CoRWM 3rd Meeting 2004. 1 & 2 March. Agenda Item 8	
4. Status (e.g. 1st draft, final)	**Final**...
5. Who is receiving a copy	
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All Members	
(please also send a copy to Sam Bains in the Secretariat)	
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REPORT TO CORWM PLENARY MEETING FROM THE PSE WORKING GROUP

1 The PSE WG met on 23 February 2004. It welcomed three new members to the group, Mary Allan, David Ball and Brian Clark. This report to the plenary meeting summarises the main decisions and actions.

Terms of Reference

2 The WG reviewed its terms of reference (see appendix 1, PSEWG/3/13) and agreed that a further update was required. **It requests that the Committee consider the status and objective of the WG.**

3 With regard to the **objective,** there may be a number of options for carrying forward the PSE work. These include:

- for the current WG to oversee all aspects of the committee's PSE programme;
- for the current WG to oversee the trialling of Multi Criteria Mapping (MCM, for CoRWM members) and Deliberative Mapping (DM, for citizens) in phase 0 (with a separate WG formed to oversee the wider review and assessment of engagement methods); or
- for the WG to be disbanded so that overseeing the PSE work becomes a core function of the full committee.

4 With regard to **status,** if the committee wishes the WG to oversee all aspects of PSE work, the lifetime of the WG might be extended to cover (a) phase 0, or (b) all phases of the PSE programme.

CoRWM MCM

5 The Secretariat is in discussion with Jacquie Burgess about the practical arrangements for undertaking the CoRWM MCM. It is hoped to provide a verbal update for the Committee. In the meantime, it was agreed to circulate further briefing material to members about the nature of the MCM process.

Critical Review of DM

6 In addition to review and assessment based on the CoRWM MCM and Citizen DM trialling, a wider two-stage critical review of DM was agreed. The first stage would be to have discussions with the sponsors and evaluators of the 'kidney gap' project (currently the only example of the use of DM) and report back to the next meeting of the WG on options for undertaking a wider review. The second stage would be to undertake the wider critical review. This might explore, for example, the views of participants in the 'kidney gap' project, or of sponsors who had considered DM but made a decision not to use it. Options for the wider review are to let a sub-contract, or for the PSE WG to hold a series of discussions with relevant parties, including engagement

specialists. The WG asked the secretariat to establish the practicalities of pursuing the first option. The options for the second stage would need to be addressed alongside ways of undertaking the review of other PSE methods (see next item).

Developing a PSE Programme: Critical Review of PSE Methods

7 The WG also agreed a two-stage review of other PSE methods. The first stage is for WG members to review the 'Participatory Methods Working Paper' (PSEWG/3/INF10), prepared as background for the MRWS 'Process' Workshop. This paper discusses PSE methods (around 40 are identified) and PSE experience up to early 2003. At its next meeting, the WG will discuss which PSE methods appear to hold promise as 'building blocks' for developing a participative options assessment programme, and how to carry forward a more detailed review. Options for the latter are to let a sub-contract, or for the PSE WG to hold a series of discussions with relevant parties, including engagement specialists. It is possible that the second stages of the critical review of DM and of other methods could be undertaken together.

8 It was also agreed that the Chair of the WG would undertake a brief review of recent experience of participative Multi-Criteria Assessments, both within and outside the nuclear industry, and that members would supply references for relevant case studies.

Extensive Methods

9 The WG noted the range of methods for engaging the wider public that had been discussed to date. These included representative public surveys, publishing intensive PSE strand inputs for wider comment, and an interactive website (which might include, for example, the public survey questionnaires and on-line MCM). Discussion about how to build on these proposals focussed on two broad aspects: media work and using existing 'networks'.

10 On media work, which would be primarily to raise awareness, **it was agreed to recommend to the full Committee that the earliest opportunity be taken to organise a 'brain storming' session, where interested members could contribute their ideas**, including ways of 'launching' CoRWM's profile in the media. It was noted that CoRWM was about to appoint a media advisor, who would have a central role in this work.

11 On the use of existing networks that might enable engagement, it was agreed that this should include, but extend beyond, the 'usual suspects' (e.g. local government and NGOs). Examples included the Scottish Youth Parliament the Women's Institute, Church groups and the Housewives' Register. It was agreed that a range of engagement methods should be identified for use in such networks. These might include direct mailing of intensive strand inputs for comment, provision of MCM packages (on-line or software, for use e.g. in Town Halls or libraries), and deliberative 'tool kits' (e.g. such as the DEMOCs game used in self-organising events during the GM Nation debate).

COWAM

12 The WG considered an invitation to participate in the COWAM2 project, which is a three-year (2004-6) EC funded research programme on the governance of radioactive waste management. COWAM focuses in particular on ways of improving the decision-making process for siting facilities. **The WG considered that it was important to be briefed on developments within the COWAM programme, and recommends that the Committee indicate its desire to participate in COWAM's annual seminars.**

Forthcoming Meetings

13 Members of the WG are involved in the following meetings:

- *Young Foresight*, 24 February, to be briefed on the inclusion of radwaste within a new science curriculum for schools;
- *DEMOCs*, 25 February, to discuss potential for the DEMOCs 'game' to be developed to address radioactive waste management options;
- *DTI*, 3rd March, to exchange information on PSE processes that might be used by CoRWM and the Nuclear Decommissioning Authority; and
- *CSEC, Lancaster University*, 31st March, to be briefed on the lessons from the latest stage of consultation in Project ISOLUS.

14 The next meeting of the WG is on March 16.

FB, 24 February 2004

Appendix 1 (PSEWG/3/13)

CoRWM public and stakeholder engagement WG Membership and ToR

Chair	Fred Barker
Members	Gordon MacKerron, Keith Baverstock; Pete Wilkinson; Lynda Warren and when available Brian Clark and Mary Allan.
Secretary	Katherine Mondon
Support	Administrative & project management (Secretariat, WS Atkins)
Objective:	To recommend to the Committee, by its March 2004 meeting, a public and stakeholder engagement programme to form part of a detailed CoRWM work programme to be agreed with sponsor Ministers by April 2004.
Status	Temporary - should complete its task by April 2004 (Committee can decide later whether a WG is needed to oversee the P&SE process)
Co-options	None
Dates of meetings	15/16 January (incl. UCL); 2nd February 2004; 23rd February 2004.

1.	Author	WG A & C/Secretariat
2.	Date	October 2008
3.	Subject	Meeting with BGS 26 September 08
4.	Status	Final
5.	Recipients	All Members and BGS
6.	Confidential	No
7.	Document no.	2456

Location and Date: Keyworth, Nottingham, 26 September 08.

Present:
From BGS: John Ludden, Denis Peach, Andy Howard, David Ovadia, John Powell, Ben Klinck and Richard Shaw.

From CoRWM: Simon Harley (meeting Chair), Fergus Gibb, Becky Lunn, Bill Lee, Andy Sloan and Tarsam Bains (Secretariat). Observer: Chris Franklin (NERC).

Meeting notes

- John Ludden, Director of BGS, introduced the BGS and gave an overview of the structure of organisation. This reflects a recent re-organisation which re-focuses the BGS to increase the visibility of science in its operations. BGS currently has 500 employees at Keyworth, 200 in Edinburgh and 50 in Wallingford (hydrogeology) with a small office in Cardiff.

- Richard Shaw, Team Leader, Radioactive Waste in the BGS, gave an overview of the organisations capabilities, experience and current research in the radioactive waste sphere. The BGS currently has 3 science budget projects – Geosphere Containment (transport of radionuclides in the geosphere, including barriers), Biotran (Influence of biological processes on the migration of radionuclides) and Palaeohydrology. They are involved in a range of commercial commissioned projects including inter alia NDA, DEFRA, the Large Scale Gas Injection Test (Lasgit) project at ASPO, and the study of Fe bentonite for SKB.

- R&D commissions include Lasgit for SKB, the Cu/Ur interaction and long term corrosion potential and is in contract negotiation on a FP7 Euratom Project, FORGE, (12ME) looking at gas generation and migration, specifically in relation to bentonite/plastic clay buffers.

- John Powell gave an overview of the BGS's general capabilities with particular reference to the GDF site screening process. This highlighted the BGS's pre-eminent position as the custodian of large amounts of geoscience data combined with the skills and experience to model at a range of scales to produce 3D models of the UK's geology.

- John Powell emphasised that the process of reviewing data and assimilation into models follows a quality assured process. However BGS realise that

understanding and quantifying "uncertainty", particularly with respect to rock mass heterogeneity is an important issue. It will impact on the validity and confidence that can be put in attributed subsurface geological models. BGS recognises this issue as very important and in its research is working towards an appropriate methodology to satisfy quality assurance requirements. The problems of quantifying and managing uncertainty are manifest throughout the "geological" sciences and associated industries.

- BGS Funding: 55% from the research councils (mostly NERC) and 45% from 300 clients.

Geological Disposal (WG-A) Issues for the British Geological Survey.

The following questions were put together by CoRWM's Working Group A (Geological Disposal) and Working Group C (Research and Development). They were sent to BGS before the meeting and answered during the meeting.

Subsurface Site Exclusion Criteria (SSEC) at MRWS Stage 2

1. What is the BGS understanding of the SSEC process, including how the site exclusion criteria may impact on the nature of any Desk Study?

   BGS have seen the MRWS White Paper and are aware of the process. Richard Shaw was a member of the 'Criteria Proposals Group' (CPG) and had many discussions on what could reasonably be applied as 'exclusion criteria'. The criteria proposed by CPG/CRP are 'black and white' and make good sense to BGS. They can only start on applying the 'sub-surface unsuitability test' (White Paper term for the SSEC) once volunteer communities have expressed interest to government. Defra will produce terms of reference for these studies and contract BGS to carry out a 'Geological Sub-surface Screening Report' for each of the volunteer areas .

2. BGS / NDA Interactions: P18, para 6 of the NDA R&D Strategy Document refers to a MoU between NIREX and the BGS. Given the role envisaged by the Government for the BGS in site characterisation and selection, it is essential that there is no perceived conflict of interest. The important issue of public perception and trust in the MRWS process requires that serious consideration should be given to the ways in which BGS might work with, or for, the NDA in future.

   BGS said that it considers that a 'Memorandum of Understanding' between it and the NDA is not the best way to move forward on this issue. Any role given to the BGS by NDA will be under standard tendering arrangements through standard procurement channels to provide transparency and maintain confidence in the process. The NDA and BGS are in agreement that a MoU is not appropriate, and none will be put in place.

   How would the BGS structure itself internally to ensure that it is seen to be entirely independent and how would this be assured?

BGS said no contract has been agreed with government in terms of the scope of work for application of the SSEC and under what contractual arrangements this would be done. Assuming that a contract and a scope could be agreed with government the BGS would put an expert team together from varying backgrounds to undertake the studies. The experts will predominantly be picked from their HQ in Keyworth and their offices in Edinburgh and Wallingford, and would include geoscientists with relevant regional geology experience. The BGS recognised the great importance of demonstrating independence to maintain public confidence in the process. To this end the team involved in applying the SSEC will be demonstrably independent from any other contracts in the radioactive waste sector being undertaken by the BGS for the NDA or government. The individuals in the team will be named and the team's management and reporting structure well defined. To assure quality the team will have expert competencies and be chartered geologists/scientists. The data employed will have been quality assured and the BGS processes are quality assured to ISO9001.

It was noted that clear "Terms of Reference" from Government are required before these studies are commenced.

3. Does the BGS currently have a contract to carry out initial development work relating to the desk study process? If so, what type of work?

   BGS stated that no contract has been agreed with government or the NDA in relations to desk study work.

4. What is the role of the NDA's Geosphere Characterisation Panel (GEOCAP)? Are BGS represented on this panel?

   Richard Shaw is currently on the panel on behalf of BGS but there will be a greater role for BGS in MRWS Stage 4. The BGS's work really starts when there is a shortlist of sites and new investigations have been started, assuming it is successful in being appointed to undertake the work.

5. What allocation of time is expected for application of SSEC?

   BGS will not know until government instructs them further.

6. Has the BGS conducted "trial runs" of a SSEC application process?

   No such work has been undertaken as they have no contract. As the 'Terms of Reference' from Government have not yet been published the need for such trial runs is not defined.

7. Nowhere in the White Paper is the independent review and verification of the application of the exclusion criteria detailed. A process, reviewers, and quality assurance all need to be put in place.

   What are BGS plans for Independent peer review of the application of SSEC and who or what organisation could carry this out?

What plans exist for a quality assurance process for consistent application of the SSEC?

BGS said there will be normal internal reviews (under ISO 9001) .The BGS recognised the importance of external peer review but considers that government guidance will be required in establishing this. The BGS consider it is not for them to plan or manage the external review process.

8. Nowhere in the White Paper is an appeal process defined for the outcome of the SSEC. CoRWM is concerned that a process should be in place at the time of applying the sub surface exclusion criteria.

   Does the BGS have a view on this and on how it may impact on their work?

   BGS has not been told of any appeals process. The BGS consider that they are not in a position to comment other than to reiterate that in all areas the BGS will insist on robust independence.

   Is the BGS aware of any appeals process in relation to exclusion of a volunteer community on SSEC grounds?

   BGS is not aware of any appeals process but considers that Government would allow a community to appeal. They consider that the BGS would be best placed to investigate the outcome/evidence. This uncertainty needs to be clarified in the Government "Terms of Reference".

Geosphere desk studies at MRWS Stage 4

9. There is some ambiguity within the process as to what is meant by "Desk Study". It is clear that the SSEC applied at Stage 2 will not suffice in order to assess sites that have passed them. It appears that a further light-touch exercise reviewing volunteer sites with regard to these exclusion criteria and the additional criteria tabled by the CPG and CRP is anticipated by the Chairs at Stage 4 of the NDA site selection process. This may (or may not) be the desk study referred to in the White Paper to be carried out by the NDA through contract(s). However, before undertaking drill hole-based underground site characterisation (Stage 5) there would need to be a geosphere desk study that examined the site in as much detail as possible. This involves a much larger scale of effort, cost and time. WG-A is concerned that this may not have been fully planned for in the whole process as yet, in terms of the BGS or any other organisation tendering for the NDA contracts being provided with a clear model of what will be required.

   Are these concerns shared by the BGS?

   BGS understand that the desk study process will be substantial.
   BGS members stated that to their knowledge Government has not yet established a framework for these desk studies. In essence the BGS does not know how prescriptive Government and/or NDA intend to be, but the BGS is of

the view that it is important the desk study process is iterative. In practice BGS presume the detailed desk study will be conducted by NDA after Government has finished screening (MRWS Stage 2). NDA will shortlist sites, engage with the relevant communities (MRWS Stage 3) and initiate the desk studies. As the process moves forward these studies will become more detailed with fewer and fewer sites to look at, during MRWS Stage 4.

If the contract(s) awarded to conduct the Desk Study work are not awarded to BGS, is the BGS in a position to act as an independent reviewing body?

BGS has no views on how the NDA contract out work other than to say that in their experience the process is correct and proper i.e NDA will invite tenders for the work through its framework contracts. NDA has said it recognises the specialised services the BGS could offer in this area.

10. What are the BGS views on the application of those criteria considered by CPG/CRP but excluded as SSEC and likely to emerge as criteria in Stage 4?

    The BGS felt the iterative process of an increasingly refined desk study will incorporate all criteria at some stage in the process.

11. What is the BGS position on the general nature and depth of a desk study in terms of geosphere characterisation for continued inclusion, or exclusion, of a participating community at Stage 4 of the MRWS process?

    It is envisaged that this will be undertaken in an iterative manner with each stage undertaken increasing in detail (ref answer 9).

12. How would desk studies, if undertaken by the BGS, be conducted, and by what type of expert team?

    Refer to answer 9.

13. If the Desk Studies are not undertaken by the BGS, what would be the process through which the relevant geosphere data held by the BGS is accessed attributed and quality assured?

    BGS stated that their records are accessible to all parties. However, it should be recognised that BGS staff know these data better than anyone else as they house and manage the information.

14. The content of a desk study is critical to its acceptance, both at a professional level and by the public and stakeholders. We would like BGS views on:

    - The types of data that should be used in a desk study.
    - How these should be attributed, assessed or prioritised in the light of exclusion criteria and additional criteria.
    - The quality control measures that should be applied to ensure integrity of the geological data used.

BGS will need more guidance from NDA on these issues but the BGS is looking at how data should be stored and retrieved within the site characterisation process.

15. Is the BGS aware of any database frameworks and data management / interrogation systems that are in place or to be developed by the NDA to enable consistent and auditable evaluation of the desk studies?
Has the BGS contributed to any such systems and has international experience in this area been used to guide the process?

    BGS is not aware of any global data management system/process that NDA are putting in place.

16. Does the BGS consider it to be desirable to conduct trial runs of a geosphere desk study, at 'light touch' and more detailed levels?

    BGS confirmed it did think trials were appropriate and they will be in a position to conduct them when needed. BGS is familiar with this type of work as it follows the procedures adopted when it renews and updates maps. The BGS is unsure as to how extensive and detailed Government may want this process to be, and if it wants trials at all.

17. Is the BGS aware as to whether formats have been developed for preparation and presentation of the Desk Study reports?

    The BGS is not aware of any formats.

18. Has a quality assurance process for management of geosphere desk studies been planned or put in place as part of Stage 4 of MRWS?

    The BGS is not aware of whether a quality assurance process has been put in place.

The Integrated and Long Term Picture

19. Is the BGS aware as to whether a project management, internal quality assurance, external review and assessment and integrated reporting structure been planned or put in place (by RWMD / NDA) that links between application of the SSEC at MRWS Stage 2 and the geosphere desk studies that are likely to contribute significantly to MRWS Stage 4?

    BGS is not aware of any such structure being put in place.

NDA R&D Strategy (WG-C) Issues for the BGS

WG-C recently produced a report / critique on the NDA R&D draft strategy document. Several of the comments in that report have relevance for the role that may be played by the BGS in MRWS. The main R&D issues highlighted below are:

a) NDA R&D work streams and how work aimed at site characterisation is distinguished from R&D for more generic purposes;
b) Multiple waste streams and co-disposal, in so far as this affects the volume of subsurface required and the nature of geosphere R&D;
c) Reliance on 'inherited' or imported R&D;
d) Limited extent of GDF-relevant R&D;
e) Need for an underground laboratory.

We would welcome BGS thoughts and views on these issues, particularly in terms of how they may impact on BGS activity with respect to MRWS.
In addition, the key area of skills for R&D in relevant geosciences is one that is of great concern to WG-C. We will wish to explore this with the BGS.

NDA R&D Work Streams

1. CoRWM WG-C considers that a distinction needs to be drawn between the work to be done in delivering the desk study and site characterisation and more generic and understanding-based R&D. WG-C also feels that this distinction needs to be reflected in a procurement distinction between the two. The NDA has selected organisations and is about to furnish them with framework contracts to undertake characterisation studies in, *inter alia*, geology, geophysics, hydrogeology, geochemistry, geotechnics, transport of radionuclides, data management, investigation techniques.

   Does the BGS see a distinction between its SSEC and future desk study / site characterisation work and more generic R&D that it may be involved in within partnerships with Universities and other organisations?

   BGS confirmed that there should be a distinction between R&D and site characterisation but that some R&D would be site specific. These streams had also been kept separate in the Nirex Science and Research Programme (NSARP). BGS considers that clear leadership is required in both areas.
   The BGS suggested that NDA should be an intelligent client and possibly adopt the model applied by ANDRA in France. In this model an independent directorate provided guidance on R&D but remained independent. The main R&D was developed through proposals from academics which were reviewed with respect to their applicability.

   The BGS will send CoRWM details of this setup.

   What links and collaborations on broadly MRWS-related work / R&D and does the BGS currently have, or have planned, with other organisations?

   BGS does have partnerships with Universities. They are working with Loughborough on NDA-related work and are partners with Strathclyde and Birmingham Universities on a EPSRC bid. Other collaborations with universities are under discussion and include Imperial College and Manchester University. The BGS will comment on the NDA's R&D strategy after the R&D meeting in Loughborough.

Has the BGS been commissioned by the NDA to prepare for carrying out geosphere desk study work and/or R&D?

The NDA has not commissioned the BGS to carry out work for either of these.

2. WG-C considers that the NDA R&D strategy would benefit from establishing what collaboration between relevant bodies is anticipated, how this will be fostered, managed, funded and assessed for technical output and overall value for money.

   Has the BGS been made aware of any NDA / RWMD co-ordination of R&D in relation to disposal, and in particular made familiar with its own role within this broader context?

   BGS has not been made aware of any NDA/RWMD co-ordination and has not been made familiar with its own role.

Multiple Waste Issues and Co-disposal

3. Despite assurances from the NDA that a variety of concepts are under consideration, the NDA R&D strategy appears to be centred on a single GDF that can be engineered to accommodate a multiplicity of wastes including ILW, varied HLW and SF (co-disposal). A major uncertainty is whether it will actually be technically possible to co-dispose ILW, HLW, SNF (perhaps plus Pu and/or Ur) in a single repository – for example the strongly alkaline environment proposed for the repository (resulting from containment in cement) must be addressed.

   Is the BGS involved in any current (or planned) research on the interactions between waste-forms, rocks and alkaline solutions?

   Some work is being carried out on the interactions between alkaline solutions and bentonite clay. No work by the BGS is currently being carried out with HLW.

   Has the BGS been commissioned by the NDA to produce reports or undertake any R&D on fluid-rock interaction and co-location issues?

   The BGS has not been commissioned to produce such reports or R&D.

Over Reliance on "Inherited" R&D in NDA Strategy

4. The current NDA R&D strategy gives us the impression that their RWMD sees the KBS-3 concept as being, to a first approximation, transferable to the UK's wastes and geology. CoRWM considers that this is an untested hypothesis that should be tested through R&D.

   What is the BGS position on the applicability or otherwise of the KBS-3 concept to the UK situation?

The BGS said that the KBS-3 concept is designed for a particular groundwater chemistry and geology. There are a number uncertainties in this area e.g. is spent fuel to be included? BGS do not think the KBS-3 concept is applicable to the UK situation due to the combination of the UK's geology and variety of waste forms.

Does the existence of the KBS-3 model exert any influence on how the BGS might apply the SSEC, subsequently develop a desk study, and structure any geosphere R&D to underpin disposal?

The BGS consider that the development of the screening characterisation and R&D should not be geared to a single concept.

Limited Geological Disposal Relevant R&D

5. Section 4.7 (Geosphere Research) of the NDA RWMD R&D Strategy suggest to WG-C that little relevant R&D is being done on many of the key issues for geological disposal. Statements about undertaking generic research until a site is identified highlight the difficulties of trying to progress such R&D in the absence of specific geological and hydrogeological settings, on which almost all of these issues are dependent.

    a. The reliance on "volunteerism" to produce a site could mean that only sites with problematic geology come forward, creating pressures to try to compensate for unknown or unquantified potential weaknesses in the geological barrier by over-reliance on the Engineered Barrier System (EBS).

    b. Even if a geologically-suitable site does emerge, the time required to introduce site specific data into the R&D programme could result in significant delays before meaningful safety cases can be made for a GDF.

    Does the BGS recognise these as issues of concern?

    The BGS does recognise these as concerns.

    If so, what R&D strategies could be adopted or processes put in place to ensure that the effects of 5a and 5b are minimised?

    The BGS is not sure what its role is in this part of the process but it will do everything possible to ensure the site is as good as can be in terms of its geological characteristics and potential for robust disposal with minimum risk of leakage to the surface environment.

6. The R&D is determined by the site characterisation process, potentially leaving little time for more generic research that will lead to the development of testable models. It is WG-Cs position that the NDA should be conducting or sponsoring R&D that is (or becomes) site-specific (for example in developing technologies for characterisation), *and* R&D that is transferable and hence aimed at

understanding processes across a range of possible geosphere geometries and properties.

Does the BGS have a view on the balance between R&D related to site characterisation and R&D that is generic and transferable?

The BGS said it is too early to have a view on the issue of balance. They are also not sure how this work will transfer to the next stage – the desk studies.

Does the BGS see itself having a role in both?

The BGS confirms it wishes to have a role in both.

7. Intelligent Customer: In CoRWM's view, the NDA requires a high level of in-house geological expertise that will enable external work and R&D, especially in geosphere studies, to be fully integrated effectively into its overall strategy (i.e. the 'intelligent customer' concept). We feel this is particularly true when the Desk Based Study is considered at MRWS Stage 4. The NDA have informed CoRWM that they have appropriate geological expertise to fulfil this role. Does the BGS consider that the NDA has sufficient in-house geological expertise, and at appropriate levels within its structure, to act as an intelligent customer in making decisions based on the geosphere information/ interpretations provided to it by BGS, consultants and other organisations?

   The BGS said the NDA will be appropriate as an intelligent customer. They are recruiting for relevant expertise at the moment.

Underground Rock Laboratory / Subsurface Characterisation Facility

8. It is common international practice to develop a URL and carry out site-specific research before moving forward to full scale repository construction. We consider that a URL is essential to the MRWS R&D programme, for both sound scientific and public confidence reasons. In order not to have some form of URL the NDA would have to demonstrate that there was sufficient site-specific knowledge to obviate the need for one. We believe it is unlikely that work done elsewhere will be fully transferable to a UK site, and consider that specific R&D will be needed to support underground characterisation work. At the minimum, advance works such as tunnelling/underground construction would need to be done to prove the results of surface based site characterisation works prior to repository construction.

   Does the BGS have a view on the need for, and nature of, a URL or subsurface characterisation facility?

   The BGS did not necessarily see the need for a URL to undertake fundamental R&D but this would depend on site characteristics. The opinion was expressed that the NDA can rely upon other countries models if it is viable to do so in the light of the chosen geology. The BGS feel, however that some form of underground rock mass characterisation would be required to validate the characterisation process and allow design optimisation.

If the URL concept is supported, at what stage of the process should the URL be established? If two sites pass the SSEC and go forward to MRWS Stage 4 (participation), would the URL be established only after one site is eliminated based on borehole and other subsurface investigations?

BGS recognised that there is an experimental phase in building a disposal facility which takes the form of a URL in which advanced work/testing takes place. In relation to the location of URL at more than one location the BGS could not comment.

BGS Skills Strategy for GDF and R&D

1. Skills for SSEC, Desk Studies and GDF characterisation:

Does the BGS believe that it has within its current science and related personnel the range of skills necessary skills to perform all relevant geosphere work in relation to SSEC, site desk studies and GDF area investigations?

If so, does the BGS have a long-term strategy to replace and enhance this skills portfolio?

If not, does the BGS have a strategy for developing, retaining and growing the appropriate skills base, and how will this strategy be implemented?

The BGS has the skills necessary to undertake the work and is continuously investing in its skills base. It has strong links with universities and recruits across a range of disciplines.

The BGS has the relevant experience to manage their work in the MRWS process but will recruit if specific skills are needed to move forward in the future and is confident it can do so.

2. Skills in Geoscience R&D:

Does the BGS believe that it has within its current science and related personnel the range of skills necessary skills to perform its envisaged role in R&D related to the MRWS project?

If so, does the BGS have a long-term strategy to replace and enhance this skills portfolio?

If not, does the BGS have a strategy for developing, retaining and growing the appropriate skills base, and how will this strategy be implemented?

As stated above the BGS does have the necessary skills and if specific skills are required then it will recruit for them.

The BGS expressed the opinion that in general the UK produces good graduates in the geosciences area. The problem mainly lies in recruiting from the Nuclear Engineering area and this needs more funding at post graduate level (MSc level). If research councils do not fund this then the industry must.

The BGS noted there is a big gap in numeracy skills among geology graduates which could impact on modelling capability, a development of great concern that may be due to school students doing fewer science A-levels in general, and fewer students with good science A-levels going to universities to read natural sciences. The nuclear industry needs to develop a strategy whereby they develop and retain graduates by retraining them and providing competitive salaries.

BGS comments on CoRWM Activities

As noted in the letter to the Director of the BGS, we would welcome BGS comments, insights and feedback on:

- Our timescales for producing specific drafts, position papers and final results, and how you think the BGS might wish to engage with us.

BGS is comfortable with CoRWM's timescales but it still does not have any ToR from Government about the BGS's prospective role. It highlighted that any progression to the next stage in this process must be preceded by a full closure of the previous one.

- BGS suggestions for any people or organisations with whom we should be speaking regarding the definition and management of geological data incorporated in desk studies and regarding the R&D and skills issues embedded within MRWS.

The BGS recommend that CoRWM talk to ANDRA in France as their working strategy/programme is one of the best in this field in terms of disposal and R&D. Contacts within the BGS for further engagement are:

Richard Shaw – WG A & WG C (R&D) contact.
John Powell - SSEC contact (WG A).

The BGS also recommend that CoRWM meets with the site characterising companies from the previous process in the 1990's. E.g. Serco, Jacobs, Golders, Quintessa.

Committee on Radioactive Waste Management

CoRWM REPORT TO GOVERNMENT

REPORT ON NATIONAL RESEARCH AND DEVELOPMENT FOR INTERIM STORAGE AND GEOLOGICAL DISPOSAL OF HIGHER ACTIVITY RADIOACTIVE WASTES, AND MANAGEMENT OF NUCLEAR MATERIALS

OCTOBER 2009

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INTRODUCTION BY THE CHAIR

This is one of three CoRWM reports to Government in 2009. The reports are about:

- interim storage of higher activity wastes (including waste conditioning, packaging and transport, and the management of materials that may be declared to be wastes)
- the implementation of geological disposal of higher activity wastes
- research and development for interim storage and geological disposal (this report).

The reports cover the three strands of the UK Government's *Managing Radioactive Waste Safely* programme. They contain the results of CoRWM's scrutiny, during 2008 and much of 2009, of the work of the Government, the Nuclear Decommissioning Authority, other nuclear industry organisations, the regulators, local authorities and various organisations that carry out research. The recommendations in the reports are to Government but also affect others.

Robert Pickard
30 October 2009

EXECUTIVE SUMMARY

1. CoRWM's remit is to provide independent scrutiny and advice to Government on the long-term management, including storage and disposal, of higher activity radioactive wastes and materials that may be declared to be wastes. This is the last of three reports produced in 2009 that describe the results of the Committee's scrutiny and provide advice to Government.

Scope of Report

2. This report is about CoRWM's work during 2008 and much of 2009 on:

   - the UK's process for providing research and development (R&D) in the management of higher activity wastes
   - the skills requirements to support R&D in the Managing Radioactive Waste Safely (MRWS) programme, in particular those R&D skills to enable implementation of geological disposal
   - the infrastructure requirements, in particular those facilities supporting R&D on highly radioactive materials and R&D that will need to be carried out underground
   - public and stakeholder engagement on the above topics.

3. For each topic, the current position is summarised and advice is given for use in making plans for the R&D to be carried out over several decades and beyond. CoRWM intends to monitor whether and how this advice has been acted on by Government and others.

How CoRWM Worked

4. CoRWM worked by gathering information from the Nuclear Decommissioning Authority (NDA), its Site Licence Companies (SLCs), other nuclear site licensees, the Research Councils, Learned Societies and other organisations in the UK involved in R&D of relevance to the MRWS programme. It looked at the processes used to define R&D strategies in other countries. It held meetings with all the major organisations and it helped to organise meetings on the current state of national R&D in storage and geological disposal with the Radioactive Waste Immobilisation Network. It also sought the views of stakeholders and the public *via* its website and at CoRWM stakeholder events in October 2008, February 2009 and September 2009. A draft of this report (without conclusions and recommendations) was sent to key stakeholders for comment and a full draft placed on the CoRWM website for public comment. Responses to all the requests for comments were taken into account in preparing the final version of the report.

Overall Conclusions and Recommendations

5. This report sets out the information CoRWM gathered on each topic, references CoRWM and other documents for more details, and gives CoRWM's conclusions on each topic. The overall conclusions and recommendations are as follows.

Strategic Co-ordination of UK Radioactive Waste Management R&D

6. CoRWM considers that there is a need for more strategic co-ordination of R&D for the management of higher activity wastes throughout the UK. This strategic co-ordination is required within NDA (including its SLCs), between NDA and other parts of the nuclear industry (including the Ministry of Defence), amongst the Research Councils, and between the nuclear industry, its regulators and the Research Councils.

7. Within NDA, the need is for more strategic co-ordination of R&D carried out by its SLCs, its Radioactive Waste Management Directorate (RWMD) and within its Direct Research Portfolio (DRP). It is particularly important to co-ordinate RWMD's R&D for implementation of geological disposal with SLC and DRP R&D for waste conditioning, packaging and storage and for the management of spent fuels, plutonium and uranium that may be declared to be wastes. The lack of such co-ordination would lead to a poor use of NDA's resources (effort, time and money).

8. Between NDA and the nuclear industry there is a need for strategic co-ordination of R&D and agreement on national priorities. As well as enabling better use to be made of resources, this would ensure that key issues are tackled in a timely way.

9. Of the five Research Councils that could potentially fund research relevant to the management of higher activity radioactive wastes, only two are doing so at present and only one at a substantial level. Research Councils do not seem to have recognised the need to come together to identify the fundamental research required to underpin the MRWS programme. They should work together in an open and transparent way and involve prospective researchers in all the relevant fields, as well as the nuclear industry and its regulators. All these stakeholders should agree national priorities for the research to be funded by the Councils. This will maximise the benefits of the Research Councils' resources to the MRWS programme.

10. CoRWM does not wish to be prescriptive about the co-ordination mechanisms to be used in any of these cases. However, it has identified a number of attributes it thinks that the mechanisms should have in all cases. The mechanisms should:

    - cover the R&D needs of all the relevant UK organisations
    - be open and transparent
    - involve researchers, the nuclear industry, its regulators and other stakeholders
    - agree national priorities for R&D
    - encourage innovation
    - foster collaboration with other countries
    - ensure R&D is carried out in a timely manner
    - involve independent national and international review
    - ensure R&D results are disseminated and acted upon.

11. In CoRWM's view no single existing body, as presently constituted, is capable of overseeing the necessary strategic co-ordination mechanisms. Either several

bodies would need to work together or an existing body would need to be augmented in order to fulfil the oversight role.

12. It is essential that future UK R&D programmes for the management of higher activity wastes contain sufficient fundamental research, as well as applied research and development. In deciding which R&D to fund and when, account should be taken of the needs of the overall programme for the management of higher activity wastes, the needs for safety case development and the lead times and durations of R&D projects.

Recommendation 1

CoRWM recommends to Government that it ensures that there is strategic co-ordination of UK R&D for the management of higher activity wastes. Such co-ordination is required within the NDA, between the NDA and the rest of the nuclear industry, amongst the Research Councils and between the whole of the nuclear industry, its regulators and the Research Councils.

Regulatory Research

13. The Health and Safety Executive (HSE) has a responsibility to ensure that appropriate nuclear safety research programmes are carried out, including nuclear safety research related to the management of higher activity waste. It has a well-established mechanism for fulfilling this responsibility. HSE commissions its own research and sets out the research topics that nuclear site licensees should address.

14. The Environment Agency (EA) and the Scottish Environment Protection Agency (SEPA) have relatively modest research programmes on topics of regulatory interest in the areas of radioactive waste management and related health and environmental protection issues. CoRWM believes that EA will need to commission more independent research as the MRWS programme proceeds in order to carry out its role as a regulator of geological disposal of higher activity wastes. CoRWM also expects that SEPA will need to commission research to assist it in the regulation of the management of higher activity wastes in Scotland.

Recommendation 2

CoRWM recommends to Government that it ensures that the Environment Agency and the Scottish Environment Protection Agency obtain the resources that they need to access and commission the additional independent research required to support them fully in their regulation of the management of higher activity wastes.

R&D Skills to Support the MRWS Programme

15. The importance of maintaining nuclear skills in the UK was recognised some years ago and steps have been taken to reverse the decline that was occurring. In recent years there has been a significant improvement but there is some way to go, particularly for R&D skills.

16. CoRWM has found that responsibility for the provision of R&D skills is split between many organisations. Although each organisation is playing its part, there

seems to be a lack of national leadership and strategic direction. CoRWM thinks that this would be best rectified by assigning a single organisation the responsibility for providing this leadership and direction. This organisation should be capable of taking a clear overview of the R&D skills needs of the whole of the nuclear industry, existing and new, civil and defence. CoRWM believes that the Cogent Sector Skills Council, with additional expertise, could fulfil this role.

Recommendation 3

CoRWM recommends to Government that it assigns to a single organisation the responsibility for providing national leadership and strategic direction for provision of R&D skills relevant to the long-term management of radioactive wastes.

Infrastructure Required for R&D – Facilities for Research with Highly Radioactive Materials

17. CoRWM considers that the UK's existing civil facilities for research with highly radioactive materials are inadequate and in need of improvement. In addition, new facilities need to be established in order to support the full spectrum of research relevant to the management of higher activity wastes, including geological disposal.

18. Almost all of the existing facilities for research with highly radioactive materials are operated by the National Nuclear Laboratory (NNL). There are plans to widen access but at present the only R&D that can be performed in these facilities is that funded by NNL customers, primarily the NDA and other nuclear industry organisations. It is essential that funders and providers of fundamental research can access the facilities they need in order to contribute to R&D for the management of higher activity wastes, both now and in the future.

Recommendation 4

CoRWM recommends to Government that it ensures that facilities for research with highly radioactive materials are improved and their capability enhanced so that they can be used for the full spectrum of research relevant to the long-term management of higher activity wastes. These facilities should be accessible to all researchers who need them.

Infrastructure Required for R&D – Underground Research Facility

19. Underground investigations will be needed at the site of any proposed geological disposal facility (GDF) in the UK. These investigations need to include both underground site characterisation work and underground R&D if they are to provide sufficient input to GDF design and safety case development. CoRWM is of the view that this R&D should be carried out in an underground research facility (URF) at any site where it is proposed to construct a GDF.

20. An R&D programme should be carried out in the URF prior to the decision as to whether or not to proceed with GDF construction. This programme should be discussed with a range of stakeholders, including the community local to the site and independent scientists, and agreed with regulators. The geological disposal programme should allow time to carry out the required underground R&D and to

disseminate and assimilate its results. It should be recognised that this underground R&D may take decades. The URF should continue to be used for as long as is necessary while the GDF is open.

21. Until a URF is available in the UK, generic R&D should be carried out in underground facilities in other countries. This would allow UK researchers to gain the necessary experience, as well as providing information and techniques to be used in the UK geological disposal programme.

Recommendation 5

CoRWM recommends to Government that an underground research facility be constructed at any site where it is proposed to construct a geological disposal facility.

Public and Stakeholder Engagement for R&D

22. At present, as in the past, stakeholders who are outside the organisations that fund and carry out R&D have little opportunity to influence UK R&D programmes on radioactive waste management. There is a general lack of transparency in establishing R&D requirements and commercial reasons are often cited as a reason for not publishing results.

23. CoRWM believes that this situation must change. As implied in Recommendation 1, a wider range of stakeholders should be involved in establishing R&D requirements. It is also necessary to make accessible information available to the public about R&D needs, progress and plans.

Recommendation 6

CoRWM recommends to Government that mechanisms are put in place to ensure that a wider range of stakeholders than to date will be involved in establishing R&D requirements for the long-term management of higher activity wastes and that accessible information will be made available to the public about R&D needs, plans and progress.

Specific R&D Issues

24. In addition to arrangements for providing R&D and the skills and infrastructure needed for it, CoRWM also considered some of the topics on which further R&D is likely to be required for the long-term management of the UK's higher activity wastes. In doing so, it recognised that future R&D programmes will need to build on the substantial body of knowledge that already exists as a result of past R&D in the UK and other countries. This current knowledge base is sufficient to be confident that geological disposal is the right way forward. In future R&D it will be necessary to focus on knowledge gaps and uncertainties that are important for UK wastes and, in the case of geological disposal, for the types of rocks in which a GDF may be located. The results of CoRWM's consideration of specific topics are in Section 6 and Appendix A of this report. CoRWM did not attempt to identify, consider or prioritise every topic on which R&D may be needed. The material in Section 6 and this appendix is only intended to illustrate the range of R&D that could be required over the next few decades.

1. INTRODUCTION

Scope of the Report

1.1 This report describes CoRWM's scrutiny of current provision and future research and development (R&D) needs for interim storage and geological disposal of higher activity radioactive wastes, and management of nuclear materials that may be declared to be wastes. It covers a number of tasks in CoRWM's work programme for 2008-09 (CoRWM doc. 2266) and much of 2009-10 (CoRWM doc. 2515.2). These tasks can be grouped into the following areas.

Development of a UK R&D programme

- Advising on mechanisms for developing a UK R&D programme on interim storage and geological disposal.
- Scrutinising mechanisms for oversight, review and peer review of R&D.
- Contributing directly to the identification of key technical areas that have fundamental research requirements.

Provision of the skills and infrastructure required for R&D

- Scrutinising current proposals for acquiring and maintaining the skills needed for R&D on storage and geological disposal, over decades.
- Evaluating existing capabilities for R&D, including facilities for work on radioactive materials and capability for investigation of potential sites for a disposal facility.

1.2 In June 2008, as part of the Managing Radioactive Waste Safely (MRWS) programme, the Government published a White Paper on the framework for implementing geological disposal and an invitation to communities to participate in discussions to host a geological disposal facility (GDF) (Defra *et al.*, 2008). The White Paper highlights the need for more R&D to support both storage and implementation of geological disposal and describes the role of the Nuclear Decommissioning Authority (NDA) in carrying out R&D:

> *"The NDA has statutory responsibility under the Energy Act 2004 for carrying out research to support the activities for which it is responsible. The UK Government believes, in the light of CoRWM's work and wider international experience, that there is already sufficient research work available to be confident that geological disposal is technically achievable. In line with CoRWM's recommendation 4 (CoRWM doc. 700) and responses to the MRWS consultation, the NDA will undertake further research during the geological disposal facility development process in order to refine concepts, improve understanding of chemical and physical interactions in a disposal facility, address specific issues raised by regulators, support development of site-specific safety cases and to optimise facility design and delivery.*
>
> *Whilst Government policy is to pursue the geological disposal of higher activity radioactive waste, Government recognises the need to take account of developments in storage and disposal options, as well as possible new technologies and solutions. Future R&D may identify new options for dealing with some wastes, which under application of the waste hierarchy could reduce the amounts of waste requiring disposal…."*.

1.3 CoRWM's Work Programme for 2008-09 (CoRWM doc. 2266) and the R&D Working Group's work plan (CoRWM doc. 2323), stated that CoRWM would be seeking to reassure itself that the R&D carried out would be:

- of appropriate scope and breadth to underpin the MRWS programme
- at the forefront of innovation and international developments in the field
- performed by the most appropriate people and institutions
- cost-effective
- aligned with the needs of the MRWS programme
- able to access the specialised infrastructure needed to work safely with radioactive materials
- of quality at least comparable to that in countries with similar waste inventories and demonstrated through a well-defined independent peer review process
- integrated into skills development activities as an essential component in developing high level skills
- funded openly and transparently, and performance monitored objectively
- appropriately resourced
- an appropriate mix of applications-focused applied and underpinning fundamental science programmes
- conducted in a manner that ensures effective co-ordination between different funding bodies (*e.g.* NDA, nuclear site licensees, Research Councils) and activities (waste conditioning, packaging, storage, disposal).

1.4 CoRWM's 2006 report also stated (CoRWM doc. 700):

> *"If the public is to have confidence in the proposals for the long-term management of radioactive waste, it is essential that the areas of uncertainty and the plans for addressing them are clearly identified from the outset. Wherever possible, uncertainties should be reduced through further research. Where this is not possible, the implications for the success of the programme should be explained along with proposals for managing the programme in the face of these uncertainties."*.

1.5 It was evident at the outset that, to achieve all these requirements, the UK needs co-ordinated R&D that facilitates strategic planning, is open to independent scrutiny, and encourages engagement of talented researchers from a diverse range of fields across fundamental research and applied R&D. The report focuses on these aspects. It covers the UK's current programme and future R&D needs across all research providers and funding bodies; it is not restricted to the NDA.

1.6 CoRWM emphasises that this report is not intended to be exhaustive in the sense of identifying each and every topic on which R&D may be required or describing every R&D project that is in progress or planned. Its focus is the mechanisms and arrangements for specifying R&D needs, carrying out R&D and ensuring the results are utilised fully in managing higher activity wastes and nuclear materials that may be declared to be wastes. Where R&D on specific topics is discussed this is solely for illustration of the breadth and depth of the work required in future;

the omission of any topic does not imply that CoRWM is unaware of it or that it is unimportant.

1.7 Technical topics that are outside the scope of this report include wastes from new build reactors, which CoRWM is addressing in its 2009-10 work programme, and transport of higher activity wastes, which CoRWM plans to address in future. A further omission is the effects of radiation on the health of human beings and other living organisms. The report does not deal in any detail with research in the social sciences that is relevant to radioactive waste management. This was because there was insufficient time to do so. CoRWM intends to return to this topic in future.

1.8 Issues associated with the provision of interim storage and implementation of geological disposal are addressed in two other CoRWM reports published in 2009 (CoRWM docs. 2500, 2550). A position paper (CoRWM doc. 2389) on R&D for conditioning, packaging and storage of higher activity wastes, and the management of nuclear materials, formed the core of sections on these topics in this report.

Context

1.9 In 2006, CoRWM (CoRWM doc. 700) recommended geological disposal as the long-term management option, the provision of safe and secure interim storage, an intensified programme of R&D to support both disposal and storage and a site selection process that is based on the willingness of communities to participate. Government accepted the bulk of CoRWM's recommendations and gave the responsibility for implementing geological disposal to the NDA (UK Government *et al*., 2006). The positions of the Devolved Administrations are given below.

- In June 2007, the Scottish Government rejected geological disposal, opting instead for long-term, near-site, near-surface storage. At the time of publication of this report the Scottish Government is developing a policy framework to take this forward.
- The Welsh Assembly Government reserves its position on geological disposal; it attaches particular importance to ensuring safe and secure interim storage and to carrying out R&D to support the optimised management of higher activity wastes.
- The Department of the Environment in Northern Ireland supports the MRWS programme.

1.10 Many organisations have an interest in, or obligation to, carry out R&D relevant to the management of higher activity wastes. Specifically, under the Energy Act 2004, NDA must ensure that R&D relevant to its remit for decommissioning and clean up is carried out. When the NDA was additionally given responsibility for implementing geological disposal, this included commissioning appropriate R&D. NDA was also required to engage with, and learn from, relevant overseas R&D programmes (UK Government *et al*., 2006). R&D on waste conditioning, packaging and interim storage is largely the responsibility of nuclear site licensees; NDA has a strategic role for its sites.

1.11 The R&D requirements for the long-term management of higher activity wastes are complex and cover the full spectrum from fundamental underpinning scientific research to highly focused applied research. An example of the former is determining the local atomic co-ordination around uranium in particular crystals, an example of the latter is defining the size, shape and manufacturing route of waste containers. NDA's R&D programme is extensive, ranging from techniques to separate and sort contaminated materials during decommissioning to computer model development to simulate the migration of gases through the rocks surrounding a GDF. It necessarily consists of R&D targeted to fulfil specific needs in support of NDA's mission and objectives. More fundamental research in the UK is generally performed by universities and national research centres and is funded mainly through the UK Research Councils.

1.12 This report provides a summary of the current R&D situation. There will undoubtedly be changes in future.

Approach to the Work

1.13 The work described in this report has focused on the provision of technical R&D for support of interim storage and geological disposal of existing and committed UK higher activity wastes. In particular, at this early stage in the MRWS programme, it is critical that the R&D programme includes:

- a system for identifying, prioritising and meeting key R&D needs for interim storage of radioactive wastes
- a robust process of R&D strategy development to identify and prioritise R&D requirements for geological disposal
- a robust and independent peer review process for all R&D
- a long-term programme of skills and infrastructure development that will meet the requirements for long-term waste management including eventual implementation of geological disposal.

1.14 Much of the information required by CoRWM to assess the current extent of R&D programmes, the provision of existing infrastructure and the existing skills development programme was not readily available in any documented form. Consequently, a substantial amount of investigation, conducted by individual members of CoRWM, has proved necessary. This has taken a number of forms, as described in our position paper on storage R&D (CoRWM doc. 2389), including meetings with relevant stakeholders and the interrogation of on-line databases.

1.15 Drafts of this report and of the position paper on storage R&D were issued to stakeholders for comment, placed on CoRWM's website for public comment and discussed at stakeholder workshops (CoRWM docs. 2563, 2581, 2630, 2677). All the comments received have been considered in finalising this report.

Report Layout

1.16 The following sections address each of the topics listed below in turn:

- establishing R&D requirements (Section 2)

- the UK R&D programme relevant to the management of higher activity wastes (Section 3)
- R&D skills (Section 4)
- infrastructure required for R&D (Section 5)
- some specific R&D issues (Section 6 and Appendix A).

1.17 The overall conclusions and CoRWM's recommendations are in Section 7.

2. ESTABLISHING R&D REQUIREMENTS

What is meant by R&D?

2.1 R&D activities for the management of higher activity radioactive waste are diverse. They range from experiments in a small laboratory or development of mathematical and computational methods to design and operation of multi-million pound pilot plants or the construction of underground research laboratories (URLs). Defining exactly what is meant by research and development in diverse fields is difficult. CoRWM has had extensive discussions with NDA and others over these terms and has not been able to reach agreement on definitions.

2.2 CoRWM has devised its own definitions for use in the context of radioactive waste management and these are stated in the Glossary (Appendix C). Key definitions are as follows.

- *Applied Research*: investigation directed primarily towards a specific practical aim or objective, which can involve using existing knowledge and understanding or acquiring new knowledge.
- *Fundamental Research*: original, exploratory investigation involving experimental or theoretical work undertaken primarily to acquire new knowledge and understanding of phenomena and observable facts without necessarily having any immediate application or use in view.
- *Development*: progressive, systematic use of knowledge and understanding gained from research directed towards the production or improvement of materials, devices, systems or methods.

2.3 CoRWM believes strongly that a full range of fundamental and applied research is required for the management of higher activity wastes. The requirement for applied research is the more obvious and it is on this that current R&D programmes in the UK tend to focus. Fundamental research is essential for long-term radioactive waste management, where an ability to demonstrate good understanding of underlying mechanisms and processes is required to provide sound inputs to decisions and make a robust defence of a proposed course of action.

2.4 In particular, CoRWM believes that fundamental research is important for geological disposal, where the safety case must demonstrate to the satisfaction of regulators, the host community, other stakeholders and the public that it is very unlikely that significant quantities of radionuclides will be released from a GDF and travel to the surface over periods of tens of thousands of years or more. Uncertainties over such long times can only be addressed if there is a sound understanding of the processes that underlie potential release and transport of radionuclides. Fundamental research may also reveal unknown issues or phenomena that have not yet been considered but which may be of crucial importance.

2.5 It is clear to CoRWM that the UK needs an R&D programme on the management of higher activity waste that contains fundamental research, applied research and development, with an appropriate amount of effort on each.

2.6 Other terms that are often used to describe different types of research are "needs-driven" and "curiosity-driven". CoRWM has not found these terms to be useful. "Needs-driven" is too general a term in the context of management of higher activity wastes. It covers both applied and fundamental research but says nothing about the balance between them. "Curiosity-driven" is an ambiguous term. In one sense it can be used instead of "fundamental". However, it is often used to refer to research that appears to have no relevance at the time to any practical application (also called "blue skies" research).

Scope of R&D Required

2.7 Radioactive waste management is usually taken to cover a wide range of topics in addition to *conditioning*, *packaging*, *storage* and *disposal*, which are addressed in paragraph 2.14 *et seq.*. Management activities include:

- minimising arisings of all radioactive wastes (solids, liquids and gases), *e.g.* through appropriate designs of nuclear facilities and appropriate operating and decommissioning procedures
- waste characterisation, *i.e.* determining the radionuclide content of waste, its non-radioactive content, and the physical and chemical forms in which radionuclides and other potentially harmful constituents are present
- minimising arisings of each type of solid radioactive waste (low, intermediate and high level), *e.g.* through sorting, segregation, decontamination and allowing radioactive decay
- treatment of liquid and gaseous effluents prior to discharge to the environment
- retrieval of wastes from legacy facilities
- transport of wastes, *e.g.* between stores and disposal facilities
- near-surface disposal
- geological disposal.

2.8 Wastes will follow a sequence of conditioning, packaging, storage, transport and disposal. R&D can be used to provide confidence that the waste packages will be storable, transportable and disposable. This sequence, from the initial processing of raw waste to final sealing into a closed disposal facility, is likely to take many decades, so the durability of the packaged wastes is critical. The waste packages must retain sufficient integrity during interim storage to allow them to be transported to a GDF and emplaced. They then may have to remain intact during a period before the disposal facility is backfilled and sealed. Lastly, they may fulfil important safety functions in the long-term, post-closure safety of the disposal facility. R&D related to many of these topics is covered in this report. In particular, CoRWM has investigated how research requirements related to these topics are established and prioritised, how R&D is co-ordinated and how the R&D results are used in radioactive waste management programmes.

2.9 R&D relevant to radioactive waste management is also carried out in two other technical contexts: nuclear safety, and health and environmental protection. Nuclear safety R&D is mainly about preventing accidents, minimising their consequences, and protecting workers and the public, during the construction, commissioning, operation and decommissioning of nuclear facilities, including

radioactive waste management facilities. In the UK nuclear safety research is co-ordinated by the Health and Safety Executive (HSE); this is discussed further in Section 3. Health and environmental protection research related to radioactive waste management is about the movement of radionuclides through the surface and near-surface environments, and the effects of radiation on people and other living systems. This research was briefly discussed in CoRWM's position paper on storage R&D (CoRWM doc. 2389). For both nuclear safety research and health and environmental protection research, CoRWM's concern is with links and overlaps with radioactive waste management research, and gaps that may need to be filled.

2.10 It should also be mentioned that OCNS (Office for Civil Nuclear Security), which regulates the security of civil licensed nuclear sites, nuclear materials and sensitive nuclear information, is connected into national groups considering R&D on wider security issues, such as those led by the Home Office Scientific Development Branch (CoRWM doc. 2414).

2.11 R&D in support of the management of higher activity wastes is both multi-disciplinary and inter-disciplinary. The disciplines involved include chemistry, geology, materials science, biology and engineering. When establishing R&D requirements it is essential to take a holistic view within each discipline and across the boundaries of disciplines.

The Context for R&D – UK Higher Activity Wastes

2.12 The UK has a vast array of various types of radioactive waste, a legacy of its early lead in military and civil power generation nuclear programmes. In this respect, it is similar to the USA, Russia and France, but it is unlike countries such as Sweden, Finland and Switzerland. Higher activity wastes currently being stored (Defra & NDA, 2008a, b) include vitrified high level waste (HLW) in over 4,300 1.34m high x 0.43m diameter steel canisters in a specialist store at Sellafield. There are also about 40,000 packages of conditioned intermediate level waste (ILW) in store, mostly at Sellafield. These include several thousand 500 litre drums of Magnox Encapsulation Plant (MEP) wastes containing reactive metals such as Magnox (a magnesium-aluminium alloy used to clad uranium metal fuel in Magnox reactors) and some uranium. Other ILW includes ion exchange resins, graphite, steels, plutonium contaminated materials (PCM) and some soils. In addition, there are some ill-characterised legacy wastes (predominantly at Sellafield), many as sludges for which immobilisation routes are being developed. In due course some spent fuels, plutonium and uranium may be declared to be waste.

2.13 The diversity, complexity and, in some cases, poor level of characterisation of the UK's higher activity wastes mean that fundamental and applied research, specific to the complex UK inventory, is required to support waste conditioning, packaging, storage and disposal programmes. R&D must be directed to those UK-specific wastes for which other countries are unlikely to develop appropriate treatment processes. The effects of these unusually diverse waste streams on R&D needs are discussed in more detail below and in Section 6 and Appendix A.

Waste Conditioning and Packaging R&D Requirements

2.14 Less than 10% (in terms of volume) of the total predicted UK arisings of ILW have been conditioned to date (CoRWM doc. 2459; NDA, 2008a). The volume of conditioned ILW in store is about 21,000m^3; this is in about 40,000 packages. The volume of raw ILW in store is about 71,500m^3 (Defra & NDA, 2008a). Conditioning and packaging options have been identified for many of the remaining wastes but R&D is needed to choose between the options and to enable the chosen option to be implemented in the most appropriate way. There are also some wastes for which no appropriate conditioning method has yet been developed and for which, research of a more fundamental nature is needed to develop options. Examples of the issues on which R&D is in progress are as follows.

2.15 Most of the ILW that has been conditioned so far has been encapsulated in cement. This matrix could also be used for many other types of ILW but there are other conditioning options that may be better. For example, in the case of ion exchange resins and so-called "wet wastes" (*e.g.* sludges), techniques that involve dewatering and/or high temperature processes may be able to produce more durable wasteforms with lower volumes, and hence lower storage and disposal costs. These techniques are being investigated by several waste producers, who are evaluating their technical advantages and disadvantages and their development, capital and operating costs. There are also wastes such as reactive metals for which many formulations of cement are not ideal and for which alternative treatment and encapsulation methods are being sought.

2.16 To date, most waste containers have been made of various types of stainless steel. There are questions as to whether more corrosion-resistant steels should be used in future for some ILW containers. There are also proposals to use thicker steel containers, which would have a longer life simply through their size. The various possibilities are under investigation at a number of nuclear sites. For vitrified HLW, a number of potential over-pack canister materials for disposal have been proposed and will be investigated by the NDA.

2.17 A further area of research is into the behaviour of some waste packages that are already in store. This is needed to improve understanding of the evolution of the wasteforms and their containers, and hence both to predict their likely performance and to learn lessons for future conditioning and packaging.

2.18 A related area is R&D on the remediation of waste packages, either because they have deteriorated in some way during storage, or because they were not manufactured to the correct specifications. Remedial actions could range from a simple repair of a waste container (*e.g.* re-sealing a lid), to placing the container in a new one (overpacking), to removing the waste, reconditioning it and placing it in a new container (sometimes called "reworking").

2.19 Much of the above R&D informs the drawing up and the review of waste package specifications. These are set by the NDA, which operates the "Letter of Compliance" system (CoRWM docs. 2459, 2688; NDA, 2008b). This system is designed to make sure that wastes are conditioned and packaged in ways that enable them to be stored and disposed of. It does not provide guarantees but

should mitigate the risks of finding in the future that packages are unsuitable in some way (CoRWM docs. 2389, 2500).

Waste Storage System R&D Requirements

2.20 It is necessary to ensure the whole storage system is stable for a long enough period (including any potential delays in the geological disposal programme) so that, when desired, the waste packages can be transported and emplaced in a GDF and remain stable until closure and beyond. CoRWM defines the storage system as encompassing the wasteform, its container, the building or other structure in which the packaged waste is housed, the environment in the building, the means of controlling that environment, other equipment in the building such as cranes and other handling equipment, and the monitoring, inspection and maintenance regime. The reason for defining the storage system in this holistic way is that all these factors interact to govern the safety, security and robustness of storage (CoRWM doc. 2500).

2.21 The most modern purpose-built stores are the new ILW stores at Trawsfynydd and Hunterston A. These are large concrete buildings that are designed to hold ILW in steel drums or boxes. The stores are seismically qualified and designed for ease of maintenance over their entire lifetimes (100-150 years). The Trawsfynydd store uses passive environmental control (natural ventilation *etc*.) while the Hunterston store is actively controlled. The stores also have good arrangements for the monitoring and inspection of waste packages. R&D requirements for such stores include improving predictions of the lifetime of the concrete structure.

2.22 Some future ILW stores will be similar to those at Trawsfynydd and Hunterston. However, various nuclear sites are considering other types of storage system in which wastes are placed in very robust containers that are then housed in relatively simple buildings (Section 6 and Appendix A). Such systems are being developed to the point where a safety case could be made for them.

2.23 Existing stores vary from the relatively modern and purpose-built to older facilities, some of which were only intended as temporary. There are a number of topics on which applied research or development is required to improve these facilities or predict or extend their lives. These topics include atmospheric control systems, monitoring and inspection regimes, means of recladding buildings, and means of replacing cranes, ventilation systems and other equipment.

Geological Disposal R&D Requirements

2.24 R&D is required to support the siting, design, construction, operation and closure of geological disposal facilities and the preparation of safety cases for all these stages and for the long post-closure period. The UK has carried out research on geological disposal since the late 1970s. This initially focused on HLW and was largely funded by the Government and by the European Commission. After Nirex was established in 1982, the focus moved to ILW. Research on geological disposal of ILW was funded by Nirex and also by Her Majesty's Inspectorate of Pollution (which became part of the Environment Agency in 1996) (EA, 2003). Since the failure to acquire planning permission for a Rock Characterisation Facility (RCF) at Sellafield in 1997, relatively little geological research specific to

radioactive waste disposal has been conducted in the UK. It has continued to participate in European Commission R&D programmes, but at a relatively low level of effort compared to other countries. It has also followed developments in countries outside the European Union and participated in some work in such countries.

2.25 There is a need now to have a UK R&D programme to support geological disposal that has the appropriate amounts of fundamental research, applied research and development. This will involve making use of past UK R&D, carrying out new R&D and applying relevant overseas knowledge to UK wastes and geologies.

2.26 Much of the new R&D will be site specific and can only begin once one or more candidate sites have been identified. There are, however, a number of areas where generic (*i.e.* not site specific) research would be useful. Examples of these areas are: temporal changes (both transient and permanent) to the hydraulic, chemical and mechanical properties of a rock mass; sorption processes on likely surfaces; microbial interactions with wasteforms; and the transport and fate of waste-emitted gases in the geosphere (including from chemical and microbial reactions). Such research 'grand challenges' have been highlighted in the US (USA) Department of Energy (USDOE) Workshops (USDOE, 2006, 2008a).

2.27 Preparation of a post-closure safety case for a GDF will require numerical models to describe a range of processes over the lifespan of the facility. Applied research will be needed to develop state-of-the-art models, at a range of spatial and temporal scales, leaving sufficient time within the geological disposal programme for these models to be robustly tested. Fundamental research will be required to understand, for example, chemical and microbial interactions over long timescales between the backfill material, wasteform containers, the surrounding geosphere and contaminant plumes migrating from different wasteforms; and coupled thermal-hydraulic-chemical-mechanical behaviour of any GDF and surrounding geosphere over time. Research will also be required to develop and validate up-scaling methodologies over space and time, to relate detailed process-based model predictions to simplified probabilistic calculations within the framework of a post-closure safety case (EA & NIEA, 2009).

2.28 Once candidate sites have been identified, and the desk study and site investigation stages begin, a range of fundamental and applied research will be required to support site characterisation, engineering design and the development of site specific safety cases. Site characterisation will relate both to design and construction of the GDF (including depth, construction techniques and waste emplacement geometry) and to characterising the heterogeneous physical, chemical, hydraulic and mechanical properties of the surrounding geosphere. Much of this research will have to be carried out underground (Section 5).

Knowledge Management

2.29 Knowledge management is an important aspect of establishing R&D requirements. Effective knowledge management entails making full use of existing information so that R&D can be planned to advance knowledge and

there is no unwarranted repetition of previous work. It also includes ensuring that the results of R&D feed through into the design, construction and operation of radioactive waste management facilities, and into the development of safety cases for facilities and operations.

2.30 UK knowledge management needs to encompass relevant radioactive waste management work worldwide. The activities and publications of international organisations have a useful role to play. The United Nations International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency (NEA) of the Organisation for Economic Co-operation and Development (OECD) organise meetings and compile information and experience. The European Commission funds projects that provide overviews of past R&D on particular topics. Some countries seem to be much more advanced than the UK in developing and using knowledge management procedures and systems in the context of radioactive waste management. For example, Japan has developed a knowledge management system specifically for geological disposal of HLW [1].

2.31 CoRWM will return to the topic of knowledge management in its future work programme. For the present, it notes that there are several issues that need to be addressed with some urgency. These are (CoRWM doc. 2630):

- preservation of documents that describe past R&D (so that knowledge is not completely lost and work has to be repeated)
- declassification of as many existing R&D documents as possible, including documents that are marked “restricted” or “commercial” (so that R&D results are widely available)
- capturing the tacit knowledge of senior experts who are approaching retirement
- development of a suitable knowledge management system for all radioactive waste management R&D in the UK (so that understanding from past and future R&D can be shared, used and passed on to subsequent generations).

Timescales and Priorities for R&D

2.32 It is clear that R&D needs to be timed so that it fits in with the overall programme for the management of higher activity wastes. For example, it is unnecessary to begin R&D on methods for conditioning a particular waste if that waste will not arise for several decades. On the other hand, if facilities for storage of existing raw wastes are reaching the end of their useful lives, R&D is needed in the near future on methods for conditioning and packaging those wastes for further storage and eventual disposal.

2.33 In the case of geological disposal, there should be a progression from generic to site specific R&D. For example, generic R&D on site characterisation techniques must precede the start of investigations of prospective sites for a GDF. However, site specific underground R&D can only begin once a site for detailed investigation has been selected.

[1] *http://www.jaea.go.jp/04/tisou/english/forum/forum_index.html*

2.34 It is also necessary to consider the durations of the R&D projects needed for the management of higher activity wastes. These range from a few months to several years and in some instances to a few decades. Some projects can begin almost immediately while others have long lead times, for example because of the need to build up the skills base or to develop new facilities.

2.35 A further very important issue in setting research priorities is safety case development. This is an iterative process. An initial design for a facility is devised and a safety case is developed for that design. Then an analysis of that safety case is carried out to identify those areas of uncertainty that have most impact on the safety of the GDF. R&D is then performed to investigate these areas of uncertainty, with a view to reducing them or producing a better quantification of them. The design is then improved and the safety case revised accordingly. The iterations continue until the safety case is sufficiently robust to satisfy regulators and other stakeholders. For a GDF, the R&D includes site investigation, from the surface and underground, and the analysis of safety case results helps to guide the site investigations. Throughout the iterative process, time needs to be allowed for R&D results to be promulgated, assimilated and discussed.

2.36 In the current economic climate, it is particularly important to set clear R&D priorities. CoRWM believes that this is best done in an open and transparent way, involving the people who will do the R&D as well as those who will use the results.

Key Points on Establishing Research Requirements

2.37 Both applied R&D and fundamental research are needed to support the management of higher activity radioactive wastes. The applied research addresses practical safety and design issues in the development and operation of facilities for waste conditioning, packaging, storage and disposal. The fundamental research provides the detailed understanding that underpins safety cases and facility designs. It can also reveal hitherto unknown issues that need to be considered. It is essential that future UK R&D programmes for management of higher activity wastes contain the full spectrum of fundamental research, applied research and development, with appropriate amounts of effort devoted to each.

2.38 Research requirements for the management of higher activity wastes span a large number of disciplines. These include engineering disciplines as well as physics, chemistry, biology and earth sciences. The research needed is both multi-disciplinary and inter-disciplinary.

2.39 There are a number of knowledge management issues that should be addressed in the near future. These include the preservation and declassification of documents describing past R&D for higher activity wastes and the development of a UK knowledge management system for all radioactive waste management R&D.

2.40 Priorities for R&D to support the management of higher activity wastes should be set in an open and transparent way, involving researchers themselves as well as programme managers and users of results. It is also important to involve a wide range of stakeholders, including local communities (Section 3). The needs of

safety case development, the overall programme for the management of higher activity wastes, project lead times and project durations should all be taken into account in deciding which R&D to fund and when.

3. UK R&D FOR MANAGEMENT OF HIGHER ACTIVITY WASTES

3.1 In this section of the report, the organisations that provide R&D for the management of higher activity wastes are identified and their roles described. There is then a description of the mechanisms used in the past to co-ordinate UK radioactive waste management R&D and a discussion of public and stakeholder engagement in past and current UK R&D programmes. This is followed by some examples of how other countries organise their radioactive waste management R&D. The section ends with CoRWM's conclusions about future UK R&D for the long-term management of higher activity wastes.

Overview of Organisations Responsible for Providing R&D

3.2 Figure 1 shows the organisations responsible for providing R&D relevant to the long-term management of higher activity wastes and the links between these organisations. The organisations that fund R&D are:

- NDA, including its Site Licence Companies (SLCs)
- other civil and defence nuclear industry organisations (*e.g.* British Energy, AWE plc)
- regulators of the nuclear industry (HSE, Environment Agency (EA), Scottish Environment Protection Agency (SEPA))
- Research Councils
- the European Commission.

3.3 The organisations that carry out R&D are:

- universities
- the National Nuclear Laboratory (NNL)
- research institutes (*e.g.* the British Geological Survey)
- nuclear industry organisations
- consultants and contractors.

3.4 As an indication of the current scale of R&D and the contributions of the various organisations, Table 1 shows approximate annual funding levels for the organisations for which CoRWM has been able to obtain figures.

NDA

R&D on Waste Conditioning, Packaging and Interim Storage

3.5 The NDA is required by the Energy Act 2004 to undertake R&D relevant to its mission. It funds research directly *via* its Direct Research Portfolio (DRP) and other means. However, most of its funding for R&D is indirect, *via* its SLCs. It is difficult for NDA to estimate its indirect expenditure on R&D because R&D spend is included in SLC project costs rather than being recorded as separate items. NDA's Annual Report and Accounts for 2008-09 state that it spent about £101M in total on R&D, of which £11M was direct spend and £90M was the estimated SLC spend. For perspective, NDA's total operating expenditure in 2008-09 was £2.7B (NDA, 2009a).

Table 1. Approximate annual levels of funding for R&D on management of higher activity wastes

Funding provider	Approximate maximum annual spend (£M)
NDA Radioactive Waste Management Directorate	3*
NDA Direct Research Portfolio	4**
NDA Site Licence Companies	60***
Engineering and Physical Sciences Research Council	2
Natural Environment Research Council	0.25
British Geological Survey (non-NERC)	0.6
European Commission	2
Total	Less than 72

*The NDA RWMD and DRP figures are its spend on contractors. They exclude costs associated with NDA R&D staff and support functions.
**Total DRP budget is £6M; CoRWM estimates the proportion relevant to higher activity wastes and materials that may be declared to be wastes to be this amount.
***Total SLC R&D budget is about £90M; CoRWM estimates the proportion relevant to higher activity wastes and materials that may be declared to be wastes to be this amount.

3.6 The figures for NDA shown in Table 1 were derived from CoRWM's estimates of the proportion of NDA's spend that was for R&D specifically to support the implementation of geological disposal. All of the SLC spend shown in Table 1 is for R&D on waste conditioning, packaging and storage, as is much of the DRP spend. CoRWM estimates that less than 5% of NDA's £101M R&D expenditure in 2008-09 was for geological-disposal-related R&D.

3.7 The SLCs are responsible for decisions on their own radioactive waste management R&D. They have their own programmes of work; these are driven by the task in hand, including meeting regulatory requirements for safety and environmental protection. The SLCs' R&D programmes are defined in Technical Baseline and underpinning R&D documents (TBuRDs) linked to the SLC Life Time Plans (LTPs). The TBuRDs set out the technical baselines for the site, describe the technical challenges that the SLCs face and summarise the R&D that is deemed necessary to meet them. For each NDA site, it is the contractual responsibility of the SLC to develop an LTP and assess the associated timescales and costs. The LTP includes the reference means of conditioning, packaging and storing wastes. Where there are unknowns or significant uncertainties, the need for R&D is identified. The R&D requirements are compiled in the TBuRD, which is updated annually (NuSAC, 2008).

3.8 The "NDA Research and Development Needs, Risks and Opportunities" (NDA, 2006a) document is a compilation produced before the development of the

TBuRD system in its current form. It states that "Historically, the short-term benefits gained from carrying risks associated with the technical underpinning of projects led to significant cost implications and delays to projects and programmes. Today, we believe the technical baselines and identification of R&D requirements will help the SLCs to focus on overall programme delivery and not just short-term activities". This document is being revised to reflect the creation of the NDA's Radioactive Waste Management Directorate (para. 3.17) and provide an updated description of NDA's non-site R&D.

3.9 The NDA role is primarily one of strategic and contract management, helping to avoid duplication of similar work over its seven SLCs. The NDA Research Board on Nuclear Decommissioning and Waste Clean Up (NDARB) is an advisory body which provides high-level oversight, and has members from government departments, regulators and Research Councils. It also has two independent members including one from HSE's Nuclear Safety Research Review Group (previously a sub-committee of the Nuclear Safety Advisory Committee (NuSAC), which has been disbanded). The primary objective of NDARB, which meets every four months (see NDARB Terms of Reference [2]), is to:

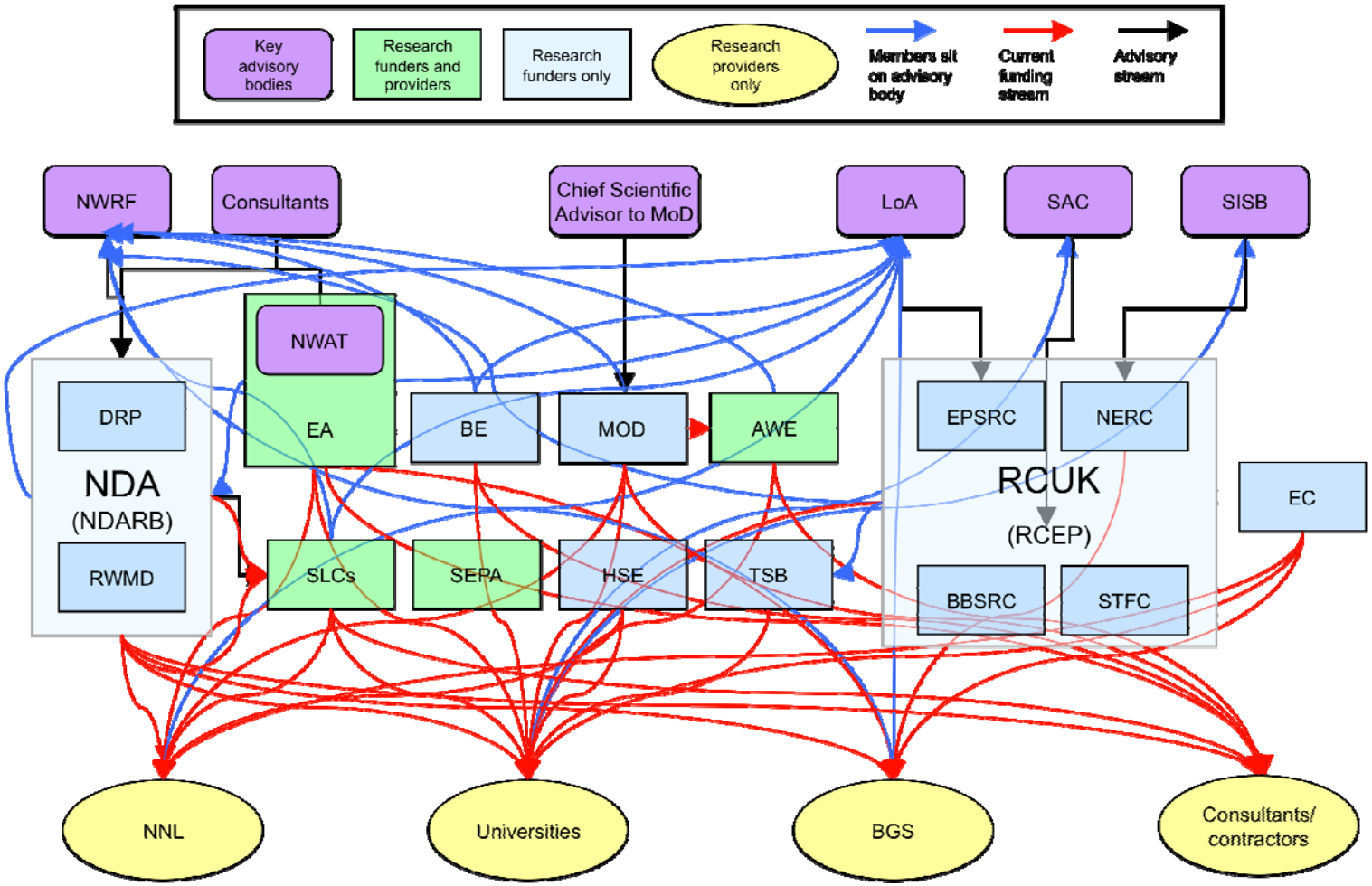
> *"promote a common understanding and collaboration between relevant bodies across the UK about respective R&D needs, risks and opportunities required to enable the delivery of the NDA mission. Where appropriate these activities will be linked to long term skills and capability requirements*.".

3.10 At the operational level, the Nuclear Waste Research Forum (NWRF) was set up to share information and create networks between SLCs. It reports to NDARB. NWRF includes representatives from NDA, its SLCs, RWMD, AWE and the regulators (NII, EA, SEPA and the Department for Transport (DfT)), the Ministry of Defence (MoD) and British Energy. It meets every three months. A number of NWRF sub-groups have been established to look at generic topics common across SLCs and other waste producers. These topics include waste packaging, wet wastes, sludges and heels characterisation, remote size reduction and dismantling, categorisation and re-categorisation of wastes, decontamination, high temperature processes, orphan wastes, and contaminated land and site end states. A new sub-group on interim storage held its first meeting in June 2009.

3.11 From feedback CoRWM has received at meetings with regulators and the SLCs involved, the NWRF is perceived to be generally working effectively. NWRF is recognised as a good meeting point to share ideas and identify areas of common interest. Progress has been made where it is possible to find simple pragmatic solutions to short-term operational problems, and to put in hand R&D which addresses specific problem areas and delivers solutions. However, CoRWM understands that there have been some difficulties caused by lack of technical personnel to do the work or by limited access to funding for longer-term R&D because of competition with short-term operational claims (CoRWM docs. 2386, 2519, 2464).

[2] *http://www.nda.gov.uk/*

Figure 1. Structure of UK R&D provision for management of higher activity wastes



Acronym Legend

AWE Atomic Weapons Establishment
BBSRC - Biotechnology and Biological Sciences Research Council
BE - British Energy
BGS - British Geological Survey
DRP - Direct Research Portfolio
EA - Environment Agency
EC - European Commission
EPSRC - Engineering and Physical Sciences Research Council
ESRC - Economic and Social Research Council
GDRF - Geological Disposal Research Forum
HSE - Health and Safety Executive
LoA - Letter of Arrangement group
MoD - Ministry of Defence
NDA - Nuclear Decommissioning Authority
NERC - Natural Environment Research Council
NNL - National Nuclear Laboratory
NWAT - Environment Agency's Nuclear Waste Assessment Team
NWRF - Nuclear Waste Research Forum
RCEP - Research Council Energy Programme
RCUK - Research Councils UK
RWMD - Radioactive Waste Management Directorate
SAC - RCEP's Scientific Advisory Committee
SEPA - Scottish Environment Protection Agency
SISB - Science and Innovation Strategy Board
SLCs - Site Licensing Companies
STFC - Science and Technology Facilities Council
TSB - Technology Strategy Board

3.12 NDA's DRP process was developed to support strategic and national R&D issues that are not funded directly by SLCs. It is a component of the broader R&D portfolio and has an annual budget of £6M. It started in 2005 as a single research contract with Nexia Solutions but has since been opened out and a tranche of DRP research was awarded to various organisations in 2008. The programme was determined from a review of the SLC TBuRDs. It is split into four lots covering support for University Interactions (Lot 1, awarded to NNL/Serco), Waste Processing (Lot 2 awarded to NNL/UKAEA/Hyder), Materials Characterisation (Lot 3, awarded to UKAEA/NNL/Serco) and Actinide/Strategic Material Investigation (Lot 4, awarded to NNL/UKAEA). NWRF contributed to a prioritisation of proposed DRP work areas. While this is intended to be a more open process than that used previously, where NDA staff reviewed the proposals of Nexia Solutions (now NNL), research providers have expressed concern about the complexity and opacity of the current DRP process (CoRWM doc. 2630).

R&D in the Letter of Compliance Process

3.13 Waste conditioning and packaging is overseen by NDA through the Letter of Compliance (LoC) process, which is described in CoRWM's Interim Storage report (CoRWM doc. 2500). LoC is a process designed to make sure that, as far as practicable, waste conditioning methods will produce waste packages that can be safely stored, transported and disposed of. The system was started by Nirex and was originally called the Letter of Comfort (because it was designed to give comfort to waste producers that Nirex would accept their packages for geological disposal). It is now operated by RWMD (para. 3.17).

3.14 To obtain an LoC, the waste owner has to provide evidence that the waste package will be compliant with the NDA specifications (Nirex, 2007). This often requires the owner to conduct R&D, the results of which are scrutinised to support the LoC application. For a typical cemented waste, factors such as the rate of setting, amount of free water, mechanical strength, heat production and fracturing are taken into account. For difficult wastes, the size of the R&D programmes required to develop and implement conditioning and packaging processes can be substantial in money and time (from hundreds of thousands to millions of pounds and over many years). NDA agreed to allow CoRWM to investigate the R&D underpinning some example LoC applications in order to explore this area more fully (CoRWM doc. 2688).

3.15 Nirex/NDA waste package specifications have changed with time and it is possible that they will change again. Thus by the time a GDF comes into operation, the UK will have several categories of ILW packages: older packages that were prepared to meet the earlier specifications, newer packages designed to meet the current specifications and possibly also packages designed to meet future, different specifications.

3.16 The NDA is undertaking a review of earlier LoCs and this will either provide reassurance that "old specification" waste packages will meet the more recent standards, or will identify the need for remedial action to ensure that packages will meet these standards. R&D will be necessary to determine the types of remedial actions required.

NDA R&D for Geological Disposal

3.17 RWMD was established in 2007 when Nirex was subsumed into NDA. It will be developed into a delivery organisation to implement geological disposal. The plan is for RWMD to become a wholly-owned subsidiary of NDA and then to become an SLC at a late stage in the process of GDF siting. RWMD has 70 employees and a total annual budget of £15-20M, of which the R&D components are 10 employees and about £3M. The RWMD Head of Research sits on NDARB. RWMD is also represented on NWRF. CoRWM understands that NDA is setting up an independent geological disposal advisory panel answering to NDARB and the RWMD Executive. The terms of reference and membership of the panel have not yet been made public. The panel will publish an annual report of its findings (CoRWM doc.2630).

3.18 In June 2008, RWMD put forward a Proposed R&D Strategy (NDA, 2008c) for consultation. Feedback from CoRWM (CoRWM doc. 2408), stakeholder meetings and other written responses led to a revised strategy, which is being produced as two separate documents. The first document, issued in March 2009, details the high level strategy and structures within the NDA for geological disposal R&D (NDA, 2009b). The second document will detail the planned R&D programme. It has not yet been published by RWMD, so scrutiny of it will form part of CoRWM's future work programme. In its response to the 2008 NDA R&D strategy document, CoRWM identified a number of areas where substantive research will be required (CoRWM doc. 2408) and some of these are described in Section 6 and Appendix A of this report.

3.19 RWMD's high level R&D strategy document defines its remit as (NDA, 2009b):

> *"to carry out R&D to support a national strategic need to support safe and secure geological disposal. We therefore commission applied research and development, targeted to fulfil specific needs in support of RWMD's objectives. We call this needs-driven R&D."*

3.20 RWMD will define an applied R&D programme that is needs-driven and focused on construction of the GDF and preparation of an accompanying safety case. RWMD expects to fund any applied research required to underpin implementation of its programme. Certain aspects of this may be supported through the DRP, where skills development is a primary driver. This is similar to the approach for other NDA R&D, which is split between the DRP and the SLCs.

3.21 RWMD recognises the importance of external review of its R&D and is developing a process to ensure this is carried out. CoRWM has had the opportunity to comment on RWMD's developing proposals, and understands RWMD is now augmenting its management system arrangements for review of deliverables to ensure the related guidance is sufficiently robust.

R&D in the NDA's Strategy Management System

3.22 The NDA's Strategy Management System (SMS) was set up in 2008. It will be used to build up the next NDA Strategy from a series of "topic strategies", and to ensure consistency with the strategies of each of the NDA's sites (CoRWM doc. 2418; NDA, 2009c). There will be several topic strategies for higher activity

wastes, for nuclear materials management and for spent fuels management [3]. There is one topic strategy for R&D, which is described as a "critical enabler" for the other topics. CoRWM understands that R&D needs will be identified for radioactive waste management and for site restoration topics, while the R&D topic strategy will be a set of high level principles. However, the current SMS documents (NDA, 2009c) show little about how R&D will be treated and NDARB does not appear on the block diagram describing the SMS.

3.23 There is a Higher Activity Wastes Strategy (HAWS) Group, with representatives from the regulators, NDA, British Energy, MoD and SLCs, which oversees the development of the higher activity wastes topic strategies and which reports into the NDA SMS. There is also a UK Spent Fuels and Nuclear Materials Topic Overview Group, which includes representatives of Government, regulators and NDA, where R&D on the management of spent fuels, plutonium and uranium can be discussed at a strategic level. There will be no geological disposal topic strategy because the intention is that RWMD will become an SLC, with its own site strategy and TBuRD.

Other Nuclear Industry Organisations

3.24 Civil nuclear industry organisations such as British Energy and Urenco UK Ltd. (which enriches uranium) also fund R&D but, unlike the NDA, do not have major R&D programmes on radioactive waste management. Their approach is to carry out R&D as and when it is required to solve particular waste management problems. Typically, these organisations will do R&D as an input to "optioneering studies" (*i.e.* studies to identify and evaluate options for managing a particular type of waste). Their studies increasingly involve identifying techniques used in other countries, with the aim of buying "off the shelf" solutions, rather than carrying out any in-house R&D. An example of this is the R&D that British Energy carried out when evaluating options for conditioning and packaging the spent water treatment ion exchange resins from the Sizewell B PWR.

3.25 The situation is similar for MoD sites that are nuclear licensed sites and are run by contractors (*e.g.* Aldermaston, Devonport, Rosyth). None of these sites, nor MoD itself, has major R&D programmes on radioactive waste management. They carry out or commission R&D as and when it is needed. There is increasing co-operation between defence and civil sites through groups such as the NWRF (para. 3.10).

Role of the National Nuclear Laboratory

3.26 The NNL was launched in 2008. It is based on Nexia Solutions, a former subsidiary of BNFL. In April 2009 it became a government-owned, contractor operated organisation (GOCO). The management and operations contractor is a consortium of Battelle, Serco and the University of Manchester. The role of the contractor is to provide strategic vision and management to NNL and to develop it as a stand-alone business. The contract is for an initial three-year period with options to extend by up to two years.

[3] *http://www.nda.gov.uk/strategy/overview.cfm*

3.27 The purpose of NNL can be summarised as being to:[4]

- identify and preserve key nuclear scientific and technical skills and facilities
- lead and integrate UK strategic technology programmes
- provide independent technical advice to the UK Government and its agencies
- operate world class facilities for research
- assist in the development of the market for the provision of nuclear research.

3.28 The areas of business of NNL include nuclear science, waste management, plant process support, modelling, materials and corrosion, specialist analytical services and environmental management. It operates at six locations in the UK: Sellafield, Workington, Preston, Risley, Harwell and Stonehouse. Its active facilities (Section 5) are owned by the NDA and leased by NNL, which operates them under the nuclear site licences of the relevant SLCs. They can be used for long-term, large-scale experiments with highly radioactive materials.

3.29 NNL has about 750 personnel, of whom about 400 are technical and a further 150 provide facilities support. Key personnel in the NNL structure are the seven Technical Authorities, each of which has overall responsibility for defining the technical strategy and maintaining quality within a defined technical area, and the eight Senior Research Fellows, who are NNL's leading technical experts with a responsibility for engaging with universities and other stakeholders and for quality publications within their area of expertise. NNL plays a key role in the maintenance and development of R&D skills (Section 4).

3.30 NNL delivers R&D using these facilities but currently for a fairly narrow "customer base". 75% of its business is from the NDA and SLCs with a further 20% from British Energy and MoD. Its customer base is expected to expand in the future. It receives no subsidy from Government but operates as a fully commercial organisation. If the NNL is to meet UK strategic needs for R&D then it will require customers that recognise those needs and fund projects accordingly.

Nuclear Safety Research and the Role of HSE

3.31 The management of the UK nuclear safety research programme was transferred from the Department for Trade and Industry to the Health and Safety Commission (now combined with HSE) in 1990. The Government set three primary objectives for the programme (HSE, 2009a):

- to ensure that adequate and balanced programmes of nuclear safety research continue to be carried out, based on a view of the issues likely to emerge in both the short and long term
- to ensure that, as far as reasonably practicable, the potential contribution which such research can make to securing higher standards of nuclear safety is maximised

[4] *http://www.nnl.co.uk/*

- to ensure that the results of any such research having implications for nuclear safety are disseminated as appropriate.

3.32 There were also supporting objectives, namely maintaining a sufficient range of independent capability and taking advantage of international collaboration (HSE, 2009a). The legal context for the programme is provided by the Health and Safety at Work … Act 1974, which places duties on HSE to make arrangements for carrying out research and to encourage research by others, and the Nuclear Installations Act 1965, which states that HSE may recover the costs of nuclear safety research from nuclear site licensees (and applicants for licences).

3.33 The latest edition of the HSE Nuclear Safety Research Strategy (HSE, 2009a) is published as part of the Nuclear Research Index (NRI). It covers the research that HSE will do and the research that it expects nuclear licensees to carry out. Within the NRI there is also an HSE Nuclear Directorate Research Strategy Statement for Waste and Decommissioning Research (HSE, 2009b). This statement is to ensure that nuclear sites consider HSE's needs and concerns in the waste and decommissioning technical area when they are establishing their research requirements (*e.g. via* TBuRDs in the case of NDA SLCs and *via* Nuclear Safety Research Schedules in the case of British Energy). The Statement applies to both operating and shutdown reactor plant. It is not prescriptive but is intended to list the topics on which, in HSE's view, R&D will be needed to support safety cases. It gives the regulatory and research goals as being:

> *"to ensure a sound technical basis for the safe and timely retrieval, passivation, immobilisation, containment and interim storage of radioactive wastes on both operating and shutdown reactor plant"*.

3.34 Much of the research by licensees will fit into a project programme and be funded by that project, rather than being part of an R&D programme as such.

3.35 NuSAC had the responsibility to inform HSE each year whether the nuclear safety research programmes of the industry and its regulators were adequate and balanced in supporting nuclear safety in the UK. Based on its sampling in 2007-08, NuSAC concluded that good progress had been made to define and develop topics requiring research. It judged the nuclear safety research situation to be satisfactory but, in the longer term, in need of continuing encouragement and scrutiny. The 2008 NuSAC review of the NDA SLCs' TBuRDs stated:

> "*We formed a favourable impression during our review of TBuRDs (2008). Standardisation of format has helped to ensure that all sites are addressing relevant issues, and some topics have yielded results that have been implemented. We did advise where further improvements might still be beneficial*.".

3.36 HSE's Nuclear Directorate (ND) reported in early 2009 that the 2008-09 nuclear safety research programme for radioactive waste management and decommissioning was being commissioned to plan by ND and the nuclear site licensees (HSE, 2009c). The programme focused on Magnox sites, Sellafield and Dounreay. ND identified the key areas and topics for research. The licensees

identified the research required and told ND that it was being progressed (HSE, 2009c).

3.37 Since NuSAC was disbanded, its Research Review Group (RRG) has continued to advise HSE. In 2009, the RRG commented (CoRWM doc. 2630):

> *"(R&D) would benefit from a more transparent presentation of all the aims, in some detail, so that the adequacy of progress could be judged against a programme. Critically, there are many areas where solutions are still sought, and they must be provided on an acceptable timescale."*.

The Environment Agencies

3.38 EA and SEPA have relatively modest research programmes on topics of regulatory interest in the areas of radioactive waste management and related health and environmental protection issues (CoRWM doc. 2464). Both agencies aim primarily to influence others to carry out research and can require nuclear site licensees to do research *via* conditions in authorisations issued under the Radioactive Substances Act.

3.39 The research programme of EA's Nuclear Waste Assessment Team (NWAT), while small, is highly focused and makes good use of its resources. EA has a limited R&D budget, including around £1M over the next 5 years for in-house (2 scientists) and commissioned work, supplemented by industry charges levied by NWAT. This budget covers radioactive waste management and radioactive substances risk assessment, including new-build. It is partly used to "lever" EA into joint projects and programmes involving NII, industry and international bodies (such as the NEA Radioactive Waste Management Committee's Integrated Group for the Safety Case, para. 3.134). This approach gives the EA wider influence and greater access to knowledge to help it to underpin its regulatory decisions. Current EA projects include:

- HLW / spent fuel safety cases: how different elements including the waste form, container and disposal facility design contribute to the safety functions
- remediation of ILW packages, including non-intrusive techniques for monitoring the condition of packages in store, and guidance on choosing remediation options so as to minimise health and environmental impacts.

EA plans further projects in:

- chemical speciation of radionuclides and non-radioactive elements in the environment
- site issues such as appropriate characterisation techniques and managing graphite wastes.

3.40 SEPA commissions research mainly *via* the Scotland and Northern Ireland Forum for Environmental Research (SNIFFER). To date SEPA has funded little R&D on the management of higher activity waste.

The Research Councils

3.41 Support for research is available from the Research Councils, which are the UK Government agencies responsible for funding research and training. They

disburse about £2.8B per annum to universities and research centres across the UK. The strategic partnership of the UK's seven Research Councils is Research Councils UK (RCUK), based in Swindon. Many activities are undertaken collectively and *via* cross-council initiatives. The research requirements for management of higher activity wastes encompass a wide range of disciplines (social science, ethics, radiochemistry, hydrogeology, engineering, microbiology, *inter alia*) and hence are relevant to several Research Councils. The Research Councils of most relevance to this report are the Engineering and Physical Sciences Research Council (EPSRC), the Natural Environment Research Council (NERC), the Biotechnology and Biological Sciences Research Council (BBSRC), the Economic and Social Research Council (ESRC) and the Science and Technology Facilities Council (STFC).

3.42 RCUK funds a wide range of fundamental research and training across the full spectrum of science, engineering and social sciences. Summarising RCUK's whole funding portfolio is well beyond the scope of this report but CoRWM recognises that some of this investment may, in future, lead to direct or indirect benefits to R&D relevant to higher activity wastes. The focus, here, is on describing funding programmes that are of direct relevance to R&D for interim storage and geological disposal of radioactive wastes, and management of nuclear materials.

3.43 The Research Councils work together in energy projects through the Research Councils' Energy Programme (RCEP), which brings together all facets of energy research, knowledge transfer, engagement and training across the Councils in a programme which includes nuclear fission and fusion. The EPSRC is the co-ordinating lead for the RCEP. Activities are developed through a Programme Co-ordination Group (PCG) comprising members of each of the Research Councils (budget holders and individuals responsible for research themes), with observers from the Department for Business, Innovation and Skills (BIS) [5] although not from the Department of Energy and Climate Change (DECC), which is responsible for nuclear and radioactive waste management policy. The PCG meets approximately once a month. A Scientific Advisory Committee (SAC), which does have DECC representation, is used to advise the RCEP on its balance of programmes and development of activities. It is an independent strategic committee which meets at least quarterly. In response to an RCEP paper, the SAC agreed that geological disposal is an area of interest and plans are underway to develop a managed activity with relevant stakeholders (CoRWM doc. 2524).

3.44 The majority of RCEP research funds are placed through 'managed calls'. Managed calls are generally in the form of a call for research proposals within a pre-specified topic (or topics). Industry is often involved in specifying the topics in such managed calls (para. 3.50). Each call has a pre-defined sum of funding available from the Research Councils, often with additional funds from industry. Research bids are invited from groupings typically comprising more than one university, together with allied organisations (each bidding team is termed a 'consortium'). Review of bids is usually a 2-stage process. Firstly, all proposals

[5] BIS was derived from two separate departments, the Department for Innovation, Universities and Skills (DIUS) and the Department for Business, Enterprise and Regulatory Reform (BERR).

submitted to RCEP are subjected to peer and merit review. Secondly, an awards panel comprising academics and industry members ranks the proposals.

3.45 In addition to the managed activities supported through the Energy Programme, the Councils also support research through their responsive mode schemes in which individuals or groups of researchers submit research proposals in any area of their choosing. The current level of funding directly related to the management of higher activity wastes *via* Research Council responsive mode schemes is discussed in the sections for individual Research Councils below.

3.46 The Research Councils also work closely with the Technology Strategy Board (TSB), an executive non-departmental public body established by Government in 2007 and sponsored by BIS, other Government Departments, the Devolved Administrations, Regional Development Authorities and other national and supranational bodies. The TSB funds applied research and development of products and processes that are near to market rather than fundamental research, which is the domain of RCUK. There are no currently funded TSB R&D programmes directly relevant to the management of higher activity wastes although it has highlighted nuclear energy as a possible area for future funding and is currently undergoing a review exercise.

EPSRC

3.47 EPSRC funds research and training in engineering and the physical sciences, investing about £740M per annum in a broad range of subjects from mathematics to materials science and from information technology to structural engineering. Almost all the EPSRC-funded R&D relevant to radioactive waste management is funded *via* managed calls in the form of consortia. These managed calls can either be solely EPSRC funded or funded through the joint RCEP led by EPSRC.

3.48 Current EPSRC-funded consortia relevant to waste conditioning, packaging, storage and geological disposal fall under the RCEP. EPSRC funds just over £26M of research under the 'Nuclear Energy' stream of RCEP. The majority of this is directed into research on power generation, and so is not relevant to the management of higher activity wastes. Existing EPSRC-funded consortia relevant to radioactive waste management are: Keeping the Nuclear Option Open (KNOO); Decommissioning, Immobilisation And Management Of Nuclear wastes for Disposal (DIAMOND) (EPSRC, 2009); and 'Biogeochemical Applications in Nuclear Decommissioning and Waste Disposal'. These consortia, all funded through the RCEP, are described briefly in Box 1. EPSRC held a scoping workshop on Future Activities in Nuclear Power Research and Training in June 2009 and it has up to £5M funds to support consortia in this area. A similar workshop is planned to consider geological disposal research.

3.49 The EPSRC also funds two research Chairs in the nuclear field at the Dalton Nuclear Institute, University of Manchester. One, in Radiation Chemistry, supports the development of generic knowledge in this field. The other, in Decommissioning Engineering, supports the development of generic knowledge in the field of decommissioning engineering that can be used to solve problems associated with nuclear decommissioning.

3.50 Existing EPSRC-funded research is principally supported through managed calls. The scope of each call is at the discretion of EPSRC, which has advisory input from a variety of sources, including the Letter of Arrangement (LoA) group. The EPSRC set up the LoA group in 2005 with members from nuclear companies and the regulators (EPSRC, HSE, BNFL, AWE, MoD, British Energy and NDA). The LoA group is a forum for research funders to share strategic priorities and potentially to identify areas for collaborative activities. The decision whether to proceed with proposed areas and the exact scope of an activity rests with EPSRC.

3.51 In April 2009, EPSRC held a workshop on "Nuclear Engineering" jointly with the USDOE and the National Science Foundation. The aim was to "identify opportunities in areas where UK-USA collaborations make sense and fill the needs for one or both countries", and nuclear engineering was defined very broadly. Topics discussed relevant to interim storage and geological disposal of higher activity wastes were largely within the *Spent Nuclear Fuel and Waste Management and/or Post Operation* theme, which encompassed:

a. reprocessing
b. waste forms
c. permanent storage
d. disposal
e. transmutation of waste (reduction of volumes and waste recycling)
f. environmental waste management and legacy waste
g. advanced fuel cycles.

3.52 In the context of the UK's MRWS programme, questions of interest were essentially restricted to four topics within this theme (wasteforms, permanent storage, disposal, and 'environmental waste management and legacy waste') out of a total of 34 topics identified across the six themes. Topics related to life extension, new build, future reactor systems and reprocessing dominated the workshop output. At the time the workshop was held, there was much uncertainty over the USA Yucca Mountain programme, so it was difficult to discuss geological disposal and interim storage did not appear to have attracted much USA research activity.

NERC

3.53 NERC funds research *via* universities and its own research centres with a remit to increase knowledge and understanding of the natural world and to tackle major environmental issues including climate change, biodiversity and natural hazards. It also provides independent research and training in the environmental sciences. NERC supports research totalling about £400M annually.

3.54 In 2007, NERC launched its new science strategy, following a 2-year consultation period with the UK's environmental research users, funders and providers. The strategy, Next Generation Science for Planet Earth, sets out an overview of how NERC, in partnership with others, will respond to the critical issue of the 21st century - the sustainability of life on Earth. The strategy defines the funding priorities for 2007-2012 and was developed with strong inputs from the Science and Innovation Strategy Board (SISB), NERC's principal advisory committee.

Box 1. Research Council Funded University Research Consortia

The KNOO consortium is a 4-year, ~£6M, RCUK initiative which started in 2005 and is funded through the multidisciplinary research consortia programme, Towards a Sustainable Energy Economy, to support nuclear-related research. KNOO is led by Imperial College and is a consortium of 7 universities; it comprises 4 work packages, only one of which is relevant to radioactive waste issues (WP-3: An Integrated Approach to Waste Immobilisation and Management). In developing KNOO, geological disposal was specifically excluded from the programme scope because it was not, at that time, Government policy. The KNOO programme ended in September 2009 and the Research Councils have announced a follow-up managed call in the nuclear area, predominantly aimed at reactor lifetime extension and new build.

The DIAMOND consortium (2008-2012, £4.28M) is led by the University of Leeds. It involves 6 universities and is divided into three areas - Environment, Migration and Risk; Decommissioning, the Historic Legacy and Site Termination; and Materials - Design, Development and Performance. Two areas focus on work relevant to waste management: Decommissioning, the Historic Legacy and Site Termination is centred on the improved and accurate characterisation of stored legacy wastes (particularly "Orphan wastes" for which no clear management route exists) and the development of novel technologies for retrieval and treatment; Materials - Design, Development and Performance aims to address key knowledge gaps in the conditioning, storage and disposal of wastes in order to underpin future decision-making in waste management.

The 'Biogeochemical Applications in Nuclear Decommissioning and Waste Disposal' consortium (2009-2013, £1.9M) involves 5 universities and the British Geological Survey. The consortium will explore the use of microbial technologies to reduce the risk of radionuclide migration from decommissioning and disposal sites by 'microbially engineering' precipitates to seal fractures in the surrounding rock/soil mass and by immobilising radionuclides within these precipitates.

Three other EPSRC research grants, awarded under RCEP over the period 2005-2012, are directly relevant to the MRWS programme. These awards, amounting to £2.16M, are focused either on the properties and behaviour of borosilicate glass or on the potential for micro-organisms in near-surface media to retard radionuclide migration.

In July 2009, the EPSRC, under its High End Computing programme, funded a further relevant research project, 'Understanding the Chemistry of Ceramic Materials Under Irradiation'. This project, involving 3 universities and awarded a total of £756K over the period 2010-2014, will investigate the mechanisms by which radioactive elements are incorporated into possible host matrices, how radiation damage changes the host properties (in particular, dissolution), and how radioactive species may escape from such host matrices.

3.55 The NERC science strategy is delivered *via* seven science themes: climate system, biodiversity, earth science system, natural hazards, sustainable use of natural resources, environment pollution and human health (EPHH), and technologies. The themes most relevant to MRWS-related R&D are EPHH and Technologies.

3.56 EPHH examines the interactions of humans with the environment, how man-made changes may affect the health of humans and how adverse effects may be prevented. NERC is currently setting up an Expert Group, under the most recent EPHH theme action plan, to identify research gaps in the area of Radioactivity and the Environment, covering all aspects of radioactivity from atmospheric

dispersion modelling to geological disposal. The group will be used to inform the development of the next round of NERC's Theme Action Plans during 2009, which will set out the actions to be taken to deliver the NERC science strategy.

3.57 The Technologies theme develops capabilities to detect hazardous species in the environment *via* novel instruments and sensors. The theme is mostly concerned with pathogens and toxins; radionuclides are not specifically mentioned.

3.58 NERC has four main avenues for the direct funding of radioactive waste management R&D:

- responsive mode funding of research that falls within its remit under the topic of 'environmental radioactivity'
- directed thematic grant programmes (managed calls)
- British Geological Survey (BGS) research centre funding
- Centre for Ecology and Hydrology (CEH) research centre funding.

3.59 The total direct and dedicated support *via* NERC responsive mode funding over the period from 1998-2012 for nuclear topics, including geological disposal, amounts to just over £1.4M. The research falls into three topic areas: 'abiotic' considerations on waste immobilisation and geosphere character; organic complexation of uranium and related elements; and biogeochemical interactions and radionuclide mobility in near-surface environments.

3.60 On behalf of MoD, NERC has managed a depleted uranium (DU) thematic research programme, which awarded £928K of funding over the period 2004-2008 in support of research aimed at characterising and understanding DU behaviour in the environment. The results are of relevance to the decommissioning and surface soil contamination aspects of NDA and nuclear site licensee work, but are of very limited applicability to the long-term management of radioactive wastes.

3.61 BGS provides NERC's main contribution to research that is relevant to the MRWS programme. Founded in 1835, BGS is the world's longest-established national geological survey and the UK's national centre for earth science information and expertise. It is a NERC Research Centre, deriving approximately half of its annual income (£40M) from NERC. The remainder comes from commissioned research from the public and private sectors. In line with this mixed-funding model, the BGS carries out research into geological disposal as part of its NERC-funded science programme and also in the context of commissioned research funded by third parties. Three BGS staff who work on radioactive waste disposal issues, full time, form the core of its Radioactive Waste Team. These are complemented by a further 37 BGS scientists who currently work on projects relating to radioactive waste disposal on a part-time basis, leading to a total BGS commitment of 13 man years of effort per year. This compares with an estimate of 25 man years of radioactive-waste-related research in 1995, with about 20 man years at that time on the service and advice component of work.

3.62 BGS is conducting three projects relevant to geological disposal within its NERC Science Programme remit. These are: *Bio-Tran*, investigating microbial transport and microbial indicators of mass transport through geological media; *Geosphere Containment*, developing fundamental understanding of the mass transport properties and hydromechanical behaviour of low permeability media (anthropogenic and natural) with application to radioactive waste disposal, carbon dioxide sequestration, gas storage and contaminant transport; and *Paleohydrogeology,* developing paleohydrogeology techniques to support geological disposal. Direct support from NERC for these programmes was about £470K over a seven-year period from 2003-2010.

3.63 BGS is involved in, and in some instances leads, research programmes directed at understanding the behaviour of the engineered components of a GDF in the sub-surface and characterising host rock masses and their fracture systems. The areas include projects on bentonite, the engineering disturbed zone (EDZ) fracture transmissivity and near-field chemical containment. A series of geological disposal-related research studies have been carried out by BGS for Japanese contractors. These focused on the characterisation of fluid pathways and fluid-rock interactions in the Mizunami URL site, Honshu, Japan.

3.64 NERC also has the ability to fund research through CEH, which is a NERC-funded institute for integrated research in terrestrial and freshwater ecosystems and their interaction with the atmosphere. In recent years, no research of direct relevance to the management of higher activity wastes has been funded by NERC *via* the CEH.

Other Research Councils

3.65 BBSRC funds research relating to the understanding and exploitation of biological systems. Its remit includes research at all levels of biological systems, from molecules and cells through tissues to whole populations and their interactions; it covers plants, animals and microbes. It also supports a number of important industrial stakeholders, including the agriculture, food, chemical, healthcare and pharmaceutical sectors. Its current budget is about £420M per annum. Its current strategic priorities include global security, living with environmental change and bionanotechnology. BBSRC does not have any current grants in the area of radioactive waste management or remediation of radioactively contaminated land. This contrasts markedly with the USA programme, where biological effects on radioactive contamination, and bioremediation, have been strongly supported over many years, initially through the dedicated Natural and Accelerated Bioremediation Program (NABIR) and subsequently within the wider Environmental Remediation Sciences Program (ERSP). [6] Similarly, the Swedish Deep Biosphere Laboratory [7] has existed for over 20 years, conducting a biological research programme in support of geological disposal.

3.66 ESRC is the UK's leading agency for research funding and training in economic and social sciences. It receives most of its funding (about £203M per annum) from BIS. It has recently reviewed its strategic plan which now includes a

[6] *http://esd.lbl.gov/research/projects/ersp/generalinfo/intro.html*
[7] *http://www.gmm.gu.se/groups/pedersen/index.php*

strategic challenge on Environment, Energy and Resilience, one of only seven. CoRWM asked RCEP representatives, specifically, whether or not ESRC was funding work into the public understanding of the scientific, social and ethical issues surrounding long-term radioactive waste management and, in particular, issues relating to management in the face of considerable scientific uncertainty and issues of intergenerational equity. In addition, since public and stakeholder engagement (PSE) is regarded as a given in many radioactive waste programmes today, CoRWM asked ESRC whether or not it was funding research into the impact of PSE on the decision-making process and/or on the most appropriate ways to undertake PSE in this area. In its response, made prior to the revision of its strategic plan, ESRC noted (CoRWM doc. 2524) that "current investment in this area is limited, but there may be greater opportunities to explore new agenda in the near future".

3.67 STFC was formed in 2007 by merging the Particle Physics & Astronomy Research Council and the Council for the Central Laboratory of the Research Councils. With an annual budget of around £500M, STFC funds research in astronomy and nuclear and particle physics. It also provides the research community with access to large facilities at two principal UK sites, the Daresbury and Harwell Science and Innovation Campuses, as well as at the Institute Laue Langevin (ILL) and the European Synchrotron Radiation Facility (ESRF) in Grenoble. Harwell is home to ISIS, the world's most powerful pulsed neutron and muon source, which is used to study the atomic structure of materials; Vulcan, the world's highest intensity focused laser; and the Diamond synchrotron, in which STFC has an 86% share. The Cockcroft Institute at Daresbury focuses on designing the next generation of particle accelerators.

3.68 There is a long history of experiments using small quantities of transuranic materials at ISIS and ILL. ISIS is currently working with EPSRC grant holders to support their experimental programme in radioactive waste management. Diamond currently permits experimental work with samples with low levels of radioactivity. It is reviewing what needs to be done to respond to future demands of the scientific community, whether this be with transuranic materials or higher activity levels (Section 5).

EU Research Funding

3.69 All aspects of nuclear fission R&D, including work on wasteforms and geological disposal, have been supported over many years at the European Union (EU) level. There have been eight European Atomic Energy Community programmes since 1975, and since 1984 these have been integrated into the broader EU Framework Programmes (FPs), of which there have been seven. Historically, the UK was an active participant in EU programmes, particularly through BGS and the United Kingdom Atomic Energy Authority (UKAEA). Following the shift in UK focus to ILW, including the formation of Nirex, and organisational changes in UKAEA in the 1980s, then the hiatus in UK work on disposal of higher activity wastes after 1997, UK involvement in FPs declined significantly. Reports from the FPs, especially FP4 to FP6, contain research results and overviews that could now be useful to the UK.

3.70 In the current FP7 programme (2007-2011) fusion is dominant, but a budget of €287M has been allocated to fission research. The stated priority for fission is establishment of a sound scientific and technical basis for better management (safer and more resource-efficient, competitive and environment-friendly) of energy and waste and the impact thereof. A further €517M has been allocated for the EU's Joint Research Centre (JRC) activities in the nuclear sphere, which are intended to support co-operative international activities in nuclear waste management, environmental impact, nuclear security and nuclear safety.[8] European research activities are co-ordinated through the Sustainable Nuclear Energy Technology Platform.[9] An EU Implementing Geological Disposal Technology Platform (IGD-TP) is also being set up to provide a framework led by industry to define R&D priorities, timeframes and action plans in this area. CoRWM members made informal comments on the draft "vision document" for the platform.

3.71 Only one FP7 Euratom project is led by a UK institution: BGS was recently awarded the ~£2M Fate of Repository Gases (FORGE) project on gas migration (para. A.59). The FORGE project is designed to characterise and quantify the conditions during geological disposal under which gas formation will occur with sufficient pressure increase to result in radionuclide migration from the GDF into the surrounding host rock. The project will include model development to underpin GDF designs that lie within a safe gas generation envelope.

3.72 A number of other FP7 Euratom research projects relevant to the management of higher activity wastes include one or more UK partners. These include:

- Actinide Recycling by Separation and Transmutation (ACSEPT) - 34 European partners including the Universities of Reading and Edinburgh, and the NNL with a technical focus on separation and transmutation of actinide elements. The total budget for this programme is €24M, of which €9M will be funded by the EU. Approximately €4.5M will be spent in the UK (€3.9M by NNL and €600K by universities), of which €1.6M will be funded by the EU.
- Treatment and Disposal of Irradiated Graphite and other Carbonaceous Wastes (Carbowaste) - 27 partners including Amec, Bradtec, Doosan Babcock, NDA, NNL and University of Manchester in the UK. This project aims to develop an integrated waste management approach for existing stocks of irradiated graphite and carbonaceous waste and for future ones such as graphite-based Generation IV reactor systems (€3.4M to be spent by UK organisations with EU contribution of €1.9M).
- Redox Phenomena Controlling Systems (RECOSY) - 32 partners, with Loughborough and Manchester Universities and BGS in the UK as associate partners. The objectives of RECOSY are the development of a sound understanding of redox phenomena controlling the long-term release/retention of radionuclides in nuclear waste disposal and the provision of tools to apply the results to performance assessment and safety cases.

3.73 Other EU projects include Fundamental Processes of Radionuclide Migration (FUNMIG) and Near Field Processes (NF-Pro) (both run in FP6 and recently

[8] *http://www.europa.eu/*
[9] *http://www.snetp.eu/*

completed). NDA has current commitments in support of UK elements of EU projects (which are typically of 3-5 years duration) in excess of £1M.

The Learned Societies

3.74 The Learned Societies provide invaluable communication resources to their membership *via* journals, websites and meetings, workshops and conferences. Several (in particular, the Geological Society of London, the Institute of Physics (IoP) and the Institute of Materials, Minerals and Mining (IOMMM)) have been particularly helpful to CoRWM during the preparation of this report (*e.g.* CoRWM docs. 2455, 2519) by hosting meetings and surveying their membership. Radioactive waste management is a topic in which the Royal Society (RS) has a long-standing interest. The Royal Society funds Policy Reviews which influence research, such as the report on Strategy Options for the UK's Separated Plutonium (Royal Society, 2007). Representatives of the British Nuclear Energy Society (BNES), the Geological Society of London, IoP, IOMMM and the Royal Society of Chemistry (RSC) contributed to the planning and format of the NDA RWMD's R&D Strategy Workshop to support geological disposal, held in Loughborough in November 2008. In addition, there have been joint learned society meetings involving, for example, IoP, RS, RSC, the Mineralogical Society, the Geological Society of London and the British Geophysical Society. A group of the Learned Societies has agreed, in principle, to set up a joint website to provide independent scientific information to the public on higher activity waste issues, although they are still discussing a funding route.

3.75 The Royal Academy of Engineering, like the Royal Society, has encouraged debate on radioactive waste issues. It held a meeting in December 2006 to discuss Future Developments in the Management of Nuclear Waste: Building on CoRWM. It also held a workshop in December 2008 on skills for the nuclear industries and defence, which brought together stakeholders from civil and defence nuclear engineering, representatives of the engineering educational providers and others interested in the provision of engineering skills across the nuclear industries. This meeting agreed that there is a requirement for a truly planned and co-ordinated approach to the identification, quantification, development and delivery of the engineering skills base at every level. Further work to take this forward is being scoped.

Past UK Co-ordination of Provision of R&D

1970s

3.76 UK R&D on the long-term management of higher activity wastes expanded in the late 1970s following the publication of the sixth report of the Royal Commission on Environmental Pollution (the "Flowers report") (RCEP, 1976). This report recommended that there should be no commitment to a large nuclear power programme until:

> *"it has been demonstrated beyond reasonable doubt that a method exists to ensure the safe containment of long-lived highly radioactive waste for the indefinite future."*.

3.77 RCEP noted that there was a lack of clarity about who had the responsibility for determining the best waste management strategy. It recommended that the Department of the Environment (DoE) be given this responsibility. RCEP also saw a need for a national disposal facility, developed and managed by a Nuclear Waste Disposal Corporation, and for a Nuclear Waste Management Advisory Committee to sponsor research (RCEP, 1976).

3.78 In its response to the Flowers report, Government gave DoE the responsibility for radioactive waste management policy, increased research on HLW disposal and recognised the need for a national disposal facility for ILW (UK Government, 1977). Also, in 1978, Government established the Radioactive Waste Management Advisory Committee (RWMAC). The terms of reference for RWMAC were:

> *"To advise the Secretaries of State for the Environment, Scotland and Wales on major issues relating to the development and implementation of an overall policy for the management of civil radioactive waste, including the waste management implications of nuclear policy, of the design of nuclear systems and of research and development, and the environmental aspects of the handling and treatment of wastes."*.

3.79 RWMAC defined its role in relation to R&D as:

> *"assessing the overall scale, balance and priorities of the Government's radioactive waste management research programme, and the adequacy of the total resources devoted to research activities, whether by Government or by the industry"* (RWMAC, 1982).

3.80 In 1979, drilling started at Altnabreac as part of research on geological disposal of HLW. UK expenditure on R&D for radioactive waste management in 1978-9 was £13.3M and in 1979-80 it was £19.8M. About 50% of the expenditure was by BNFL and about 25% by DoE (RWMAC, 1982).

1980s

3.81 The main players in radioactive waste management R&D in the 1980s were:

- DoE, which included the environmental regulator for England and Wales, Her Majesty's Inspectorate of Pollution (HMIP), so had both policy and regulatory responsibilities
- the Ministry of Agriculture, Fisheries and Food (MAFF), which had regulatory responsibilities under the Radioactive Substances Act; for land, the relevant part of MAFF was the Food Science Division (FSD) and for sea, the Directorate of Fisheries Research (DFR)
- the Nuclear Installations Inspectorate, for nuclear safety aspects
- UK Nirex Ltd, which was formed in 1983 for disposal of low and intermediate level wastes and was funded by the nuclear industry
- UKAEA, which was funded by the Department of Energy
- BNFL, which recovered most of its R&D costs from its customers in the UK and overseas
- CEGB and SSEB, the generating companies

- MoD
- the National Radiological Protection Board (NRPB), which carried out work under contract to other UK organisations and to the European Commission, but which received funding for research related to its statutory role from the Department of Health and Social Security.

3.82 DoE, MAFF and others funded work at the NERC institutes, *i.e.* BGS, the Institute of Oceanographic Sciences (mainly for research related to sub-seabed disposal of HLW) and the Institute for Terrestrial Ecology (ITE). The Building Research Establishment (BRE) was funded by DoE and Nirex for design work on land disposal facilities (near-surface and deep).

3.83 The research programmes covered all types of radioactive wastes: gaseous effluents, liquid effluents, and solid LLW, ILW and HLW. In 1981, there was a major change of direction in R&D when the Government decided that the research drilling programme for geological disposal of HLW should cease. R&D on ocean disposal of HLW continued until about 1987, by which time the Government policy was to store HLW for a minimum of 50 years. R&D on ILW disposal increased after the establishment of Nirex.

3.84 RWMAC scrutinised the R&D programmes of the various organisations throughout the 1980s. It published a major review of HLW disposal research in 1983 and considered the options for long-term management of spent fuel in 1985 (RWMAC, 1983, 1985). In 1987 RWMAC noted in its 8th Report that:

> *"Research and development is needed in the field of radioactive waste management to provide a suitable information base for proper development of general policies and specific strategies. We consider that it is important to have a co-ordinated and balanced programme making the best use of resources to meet the waste management objectives of the various Departments. Suitable arrangements are also required for peer review of results and for competent assessments of the quality of work."*.

3.85 There was a DoE symposium on research objectives in 1986, to review research management procedures and strategic objectives. Participants included those responsible for sponsoring and undertaking research, Government Departments and advisory bodies such as RWMAC. The symposium identified several issues that required clarification or strengthening of procedures. These included programme co-ordination, programme review and peer review of results. It was also considered that more attention should be given to presentation of research results to the general public (RWMAC, 1987).

3.86 After the symposium, DoE reviewed the inter-departmental committee structure for liaison on monitoring and allocation of research resources. There were two overall liaison committees, each with a sub-committee, one for the interests of the regulators and one for industry and regulators together (RWMAC, 1987).

3.87 In 1987-88, DoE employed consultants to carry out a review of national research requirements for radioactive waste management. This identified gaps and overlaps and enabled the liaison committees to consider the balance of R&D programmes and the use of resources. RWMAC continued to review R&D in five

sectors: land disposal, ocean disposal, environmental studies, waste conditioning and strategy and systems studies (RWMAC, 1988, 1989).

3.88 Throughout the 1980s, RWMAC collected information on planned expenditure on radioactive waste management R&D and included it in its annual reports. Data were presented by sector and by funding organisation (RWMAC, 1987, 1988, 1989). Total expenditure rose from £28.6M in 1980-81 to £46.66M in 1989-90. Table 2 summarises the expenditure breakdown for 1989-90 (RWMAC, 1989).

Table 2. UK Radioactive Waste Management R&D Expenditure in 1989-90

Sector	*Planned UK R&D expenditure (£M)*	*Major funders*
Land disposal	13.92	Nirex (£6M), DoE (£4.9M)
Ocean disposal	0.47	MAFF DFR (£0.45M)
Environmental studies	7.1	DoE (£1.9M), BNFL (£1.7M), MAFF DFR (£1.6M), MAFF FSD (£1.2M),
Waste conditioning	23.92	BNFL (£16M), DoE (£3.5M), UKAEA (£2.42M), CEGB (£2M)
Strategy and system studies	1.25	DoE (£0.5M), BNFL (£0.3M), CEGB (£0.2M)
Total	46.66	

1990s

3.89 At the time of the reconstitution of the committee in 1991, the relevant Minister asked RWMAC to review the DoE radioactive substances research programme. By this time, HMIP (Her Majesty's Inspectorate of Pollution) had its own research programme, which was focused on its regulatory role, and the DoE research programme for radioactive waste management focused on policy issues. RWMAC completed and published its review in 1993 (RWMAC, 1993).

3.90 In its review, RWMAC expressed concern about the scope for overlap of the research programmes of DoE, other Government Departments, Research Councils and non-Government organisations. It recommended that DoE create a unit to track research overlaps. DoE responded that its Radioactivity Research and Environment Monitoring committee (RADREM), which had members from Government Departments and industry, provided an effective liaison mechanism. The committee met bi-annually and had four sub-committees, each for a specific area, to identify and report developments, gaps and overlaps (RWMAC, 1994).

3.91 RWMAC also recommended that DoE develop expertise so that it could manage its research programme in-house. DoE responded that it secured technical support for management of its research programme by means of a consultancy.

It considered this to be both an effective and a flexible arrangement (RWMAC, 1994).

3.92 Although RWMAC continued to review the DoE (subsequently the Department for Environment, Transport and the Regions (DETR)) radioactive substances research programme during the 1990s, the committee no longer reviewed UK radioactive waste management R&D as a whole. RWMAC reviewed the results of the DETR HLW and Spent Fuel Research Strategy Project. It also considered the Nirex-proposed work programme following the 1997 RCF decision (RWMAC, 1998). RADREM operated until 1995 but produced no published reports on co-ordination of R&D.

3.93 After the RCF decision, the need for strategic co-ordination was recognised by the House of Lords Science and Technology Committee (Lords, 1998) who concluded:

> *"When there is agreement on the national strategy (for long-lived waste management) a comprehensive research programme should be set out, linked to milestones in the development of the facilities. The Commission should be responsible for co-ordinating all UK research on the long-term management of nuclear waste…."*.

Public and Stakeholder Engagement for R&D Programmes

3.94 In the past, there was little opportunity for stakeholders outside the R&D funding and providing organisations to influence UK R&D programmes on radioactive waste management. For example, NGOs were not invited to sit on the various committees or to take part in reviews of research requirements. While some organisations published all the results of their research (*e.g.* Nirex, Her Majesty's Inspectorate of Pollution), others published very little. On the whole, little attention was paid to providing information about R&D to the public in an easily accessible form.

3.95 CoRWM has found that the situation is much the same today. Most of the fora at which R&D requirements are discussed are closed and do not issue publicly available documents. TBuRDs are not publicly available, in full, for most SLCs and are, in any case, only suitable for use by those with considerable expertise. Considerable amounts of R&D are viewed as "commercial" and the results are not published. This is particularly the case for waste conditioning and packaging research.

3.96 There are signs that the situation will be better for geological disposal research. For example, there was stakeholder consultation about the proposed RWMD R&D Strategy (para. 3.18) and RWMD plans to consult about the R&D programme to implement the strategy (CoRWM doc. 2677). However, none of the organisations involved in radioactive waste management R&D routinely produce documents that explain in accessible language what they think the key uncertainties are and what R&D is in hand or planned to address those uncertainties. This is despite the importance that the public and stakeholders attach to R&D (CoRWM doc. 2488). There is a specific need for an accessible summary of what is known about geological disposal and of R&D requirements

beyond those that RWMD intends to tackle in the near future (CoRWM doc. 2677).

International Experience in Defining R&D Programmes

3.97 A number of countries are conducting R&D programmes to support long-term management of higher activity wastes. It is not the intention to review or summarise all of these here. Instead, this section contains examples of how R&D programmes are organised, drawn from six countries that CoRWM has visited or has good knowledge of, to provide comparison with the UK situation. It also considers the role of international organisations in assisting countries to define their research programmes and in international co-ordination of R&D.

USA – Yucca Mountain

3.98 USDOE has been investigating Yucca Mountain as a site for geological disposal of spent nuclear reactor fuel and other radioactive waste in the USA since 1987. The site is located within unsaturated ignimbrites (pyroclastic volcanic rocks) above the contemporary water table on federal land adjacent to the Nevada Test Site in Nye County, Nevada. USDOE submitted a licence application to the Nuclear Regulatory Commission (NRC) for construction at Yucca Mountain in June 2008; the preliminary process of checking over and 'docketing' the application was completed in September 2008. In early 2009, the new USA Secretary of Energy stated that the Yucca Mountain project would be terminated and a “blue ribbon panel” would be convened to study alternatives, including new potential GDF locations and management options for spent fuel other than geological disposal.[10] USDOE work related to the Yucca Mountain licence application continues but all other work on the project has stopped.

3.99 To date, all relevant R&D to support the Yucca Mountain disposal site has been controlled and commissioned by USDOE. The DOE does not have in-house expertise across all the required subject areas; consequently, it hires project Management and Operations (M&O) contractors. The organisations conducting the R&D, until recently, were termed the ‘Participants’. These are the National Laboratories and the US Geological Survey (USGS). Each year, all participants submit plans to DOE on the research they believe to be required. Universities can only become actively involved in conducting research for DOE *via* collaboration with the national laboratories. Academics are, however, supported by independent funding provided by the State of Nevada and Nye County, who are currently contesting the DOE licence application for Yucca Mountain.

3.100 This "Program Plan (PP)" is DOE’s overarching planning document. The PP describes the work to be carried out over the following five years. It is updated every year, so the plans for the "out years" (*i.e.* years beyond the upcoming years) change regularly. Input for the PP is provided by "assistant program managers", who are responsible for particular topics, with the help of the M&O contractors and participants. The plans for each topic area are compiled into one document, the PP, which then goes through an internal DOE approval procedure. Much of what is contained in the PP is for the purposes of budgeting, so that the DOE can see what the technical implications are of reducing research plans to

[10] *http://www.nrc.gov/*

match a given budget. None of the PP is available for public comment (*i.e.* there is no consultation process), although it is a public document and copies are sent to other branches of government. The PP is primarily an internal DOE document rather than a mechanism for obtaining feedback on the planning and research prioritisation strategy.

3.101 All research reports are subject to internal review but this process is more geared towards quality assurance than a review of research quality. Most fundamental research is published in the academic literature and hence subject to independent peer review. Some of the published research, including a book (Ewing & Macfarlane, 2006), has identified technical problems with the Yucca Mountain GDF design.

3.102 Independent review of the research programme, as a whole, is provided by the Nuclear Waste Technical Review Board (NWTRB). The NWTRB is an independent agency of the USA Federal Government whose purpose is to provide independent scientific and technical oversight of the DOE's programme for managing and disposing of high-level radioactive waste and spent nuclear fuel. It reports to Congress and the Secretary of Energy at least twice a year. The Government appoints well-respected experts to act as independent members of the Board, based on recommendations from the National Academy of Sciences.[11] Meetings of the Board are convened once or twice a year. For the past 20 years, NWTRB has focused on the DOE's Yucca Mountain programme. Now that this programme has effectively ended, NWTRB is developing and compiling technical information to inform the USA evaluation of waste management alternatives, while monitoring any new DOE work related to the management of HLW and spent fuel.

3.103 The United States Nuclear Regulatory Commission provides independent guidance on regulation and licensing for development of the GDF.

3.104 In 2001, the Office of Basic Energy Sciences (BES) in USDOE's Office of Science commissioned a "Basic Research Needs" series of workshops to identify the fundamental research needed to assure a secure energy future. These workshops have engaged academic researchers in defining fundamental research priorities toward a sustainable USA energy policy. In 2006, a 4-day workshop was held entitled 'Basic Research Needs for Advanced Nuclear Energy Systems'. A major component of this workshop was to identify fundamental research issues for geological disposal (USDOE, 2006). Research challenges and priorities identified in the workshop included those in Box 2.

3.105 The workshop involved a total of 235 invited experts from 31 universities, 11 national laboratories, 6 industries, 3 government agencies, and 11 foreign countries and exemplifies the USA practice of engaging the wider R&D community in the major research programmes such as for geological disposal.

[11] *http://www.nwtrb.gov/*

Box 2. USDOE 2006 Workshop R&D Issues

Grand Challenges

- computational thermodynamics of complex fluids and solids
- integrated characterisation, modelling and monitoring of geological systems
- simulation of multiscale systems for ultra-long times

Priority Research Directions

- mineral-water interface complexity and dynamics
- nanoparticle and colloid physics and chemistry
- dynamic imaging of flow and transport
- transport properties and *in-situ* characterisation of fluid trapping, isolation and immobilisation
- fluid-induced rock deformation
- biogeochemistry in extreme subsurface environments

Cross-Cutting Issues

- the microscopic basis of macroscopic complexity
- highly reactive subsurface materials and environments
- thermodynamics of the solute-to-solid continuum

Japan

3.106 Geological disposal of Japanese HLW was set out as the end point of a process embodied in the 2000 Act, "Specified Radioactive Waste Final Disposal Act", which also set up the Nuclear Waste Management Organisation, NUMO. The 2002 report, "Requirements of Geological Environment to select Preliminary Investigation Areas (PIAs) of HLW Disposal", set out the basis for site exclusion following a voluntarism approach, and led to the Open Solicitation in December 2002. NUMO was set up as the organisation responsible for delivery of a repository system, and as implementer it was made responsible for site selection and characterisation, the licensing of applications and organisation of the programme of repository development, and overseeing the construction, operation and closure of any repository. NUMO is supervised by the Ministry of Economy, Trade and Industry (METI) and funded by owners of the nuclear power reactors. The fund is managed by the Radioactive Waste Management funding and research Centre (RWMC – see below).

3.107 In the Japanese nuclear waste disposal programme, the term '*Research and Development*' is used to include all work aimed at building fundamental scientific understanding and establishing necessary technology. '*Demonstration and Validation'* (D&V) refers to work which confirms that the resultant tools, models and engineering concepts are practical, and builds the confidence needed for implementation, licensing and public acceptance.

3.108 There are several organisations in Japan involved in carrying out or sponsoring R&D aimed directly at supporting the nuclear waste disposal programme. These R&D organizations include, amongst others the Japan Atomic Energy Agency (JAEA), RWMC, the Central Research Institute of Electric Power Industry (CRIEPI), National Institute of Advanced Industrial Science and Technology (AIST), National Institute of Radiological Sciences (NIRS), and NUMO itself. The

sponsoring organisations include the Agency for Natural Resources and Energy (ANRE) of METI and the Ministry of Education, Culture, Sports, Science and Technology (MEXT).

3.109 Co-ordination of this research infrastructure is provided through a Geological Disposal R&D Co-ordination Council, which was established in July 2005 under supervision of ANRE and involves NUMO and the other R&D providers. This co-ordination resulted in production, by March 2007, of a framework for database integration and 'roadmap' for research into the implementation of geological disposal that is being followed today. This co-ordination is regarded as an essential feature of the R&D programmes, and has been put in place to optimise the research efforts and strategies in Japan. JAEA is the main technical support organisation which has been promoting R&D activities such as two URLs, and development of an advanced Knowledge Management System.

Sweden

3.110 Figure 2 shows how geological disposal work is co-ordinated in Sweden. Disposal of wastes is the responsibility of the nuclear power utilities and a fee, supporting the Swedish Nuclear Waste Fund (SNWF), is levied by Government on each power generating company. The nuclear power utilities have formed a jointly owned company, SKB, the Swedish nuclear fuel and waste management company[12] which is responsible for management, storage and geological disposal of Swedish nuclear and radioactive waste. The SNWF is used to fund SKB, but is also open to bids from other agencies such as Authorities, Municipalities and Non Governmental Organisations (NGOs). Investigations toward deep geological disposal in Sweden have been ongoing for almost 30 years and are at an advanced stage. Site investigations focused on two prospective sites in fractured hard rock: Forsmark (municipality of Östhammar) and Laxemar (municipality of Oskarshamn), both of which were volunteer communities. SKB selected Forsmark as the site in May 2009. Spent fuel intended for the geological facility is held at an SKB interim storage facility in Oskarshamn.

Figure 2. Co-ordination of Geological Disposal Issues in Sweden

[12] *http://www.skb.se*

3.111 Fundamental and applied research in support of geological disposal is principally conducted within SKB; a small amount of additional independent R&D is conducted *via* the Swedish Radiation Safety Authority (SSM)[13], university PhD students and outside consultants. Every 3 years, SKB submits a research, development and demonstration programme (the FUD programme) to SSM which describes SKB's planned scientific and sociological research. The programme is reviewed by SSM, the National Council for Nuclear Waste (the Swedish equivalent to CoRWM) and independent overseas experts. It is also posted on the web for public consultation. SSM takes all the comments made into account before making a recommendation to Government about the programme. The Council's review of the 2007 SKB programme is available.[14] The Swedish NGO Office for Nuclear Waste Review (MKG) has formally requested the Government to scrutinise carefully SKB's proposed FUD-07 programme on the grounds that new research on copper corrosion calls into question aspects of the KBS-3 concept (MKG 2008).

3.112 Much of the R&D into final storage of spent nuclear fuel has taken place underground in the Äspö Hard Rock Laboratory, north of Oskarshamn. The Äspö research facility has been the focus of much fundamental geosphere research activity as well as supporting the development and testing of technological disposal solutions. Experiments are carried out at a depth of about 500 metres in collaboration with Swedish and international experts; Äspö has played a central role in a large number of EU nuclear-related research programmes.

3.113 Results of Swedish R&D are published in a series of reports, all of which are independently peer reviewed, often by international experts including some from the UK, freely available and downloadable from SKB's website. Some research is also published in academic journals.

Finland

3.114 In 1994, the Nuclear Energy Act came into force in Finland, according to which all nuclear waste must be treated, stored and disposed of in Finland. Detailed site investigations began at four sites in 1993, resulting in the recommendation and selection of a single site, in the bedrock of Eurajoki's Olkiluoto island, in December 2000.

3.115 Since 1994, research, development and planning work for geological disposal in Finland has been carried out by Posiva Oy, a company jointly formed by the nuclear power companies Teollisuuden Voima Oy (TVO) and Imatran Voima Oy (IVO). R&D is principally supported by the excavation of the underground rock characterisation facility, ONKALO, as part of the site investigations carried out in Olkiluoto. At depth investigations in the Olkiluoto rock characterisation facility are underway. The R&D programme reports in 3-year periods and is reviewed by the regulator (STUK).

3.116 Finland also has a Public Sector Research Programme aimed at supporting the regulatory activities and maintaining expertise in national research institutes;

[13] The Swedish Radiation Safety Authority (SSM) was formed in July 2008 by merging the Swedish Radiation Protection Institute (SSI) and the Swedish Nuclear Power Inspectorate (SKI).
[14] *http://www.karnavfallsradet.se/Uploads/Files/337.pdf*

funded at €1.5m per annum collected from licence holders. Several national research institutes participate in the programme which is focused on disposal of spent nuclear fuel.

Canada

3.117 Canada has been investigating geological disposal since the 1970s. Until 2002, Atomic Energy of Canada Ltd (AECL) was responsible for the programme, which focused on the rocks of the Canadian shield. Much of the research was undertaken at Whiteshell Laboratories, near Winnipeg. A URL was built in the 1980s at a site that would not be used for a GDF. There was an extensive review of policy for the long-term management of highly active wastes in the late 1990s, which concluded that the technical feasibility of geological disposal had been demonstrated but its public acceptability had not.

3.118 Canada's Nuclear Waste Management Organization (NWMO) was established in 2002 to investigate approaches for managing Canada's spent nuclear fuel. NWMO made recommendations to Government in 2005. In June 2007, the Canadian Government selected Adaptive Phased Management (APM) as the approach for long-term management of spent fuel, which has at its end-point, geological disposal. NWMO is currently consulting on a siting process that is based on communities volunteering to host a GDF. The geological disposal project will involve the creation of a "centre of expertise" for technical, environmental and community studies related to the design and operation of GDFs. This centre will "become the hub for national and international scientific collaboration for many decades".[15]

3.119 NWMO's technical R&D programme is currently focused on developing and evaluating conceptual designs for a deep geological repository, improving the readiness for site evaluations, used fuel transportation, and preliminary safety assessments of potential candidate host sites for long-term management of spent fuel.

3.120 To ensure independent review of Canadian R&D for APM, the Independent Technical Review Group (ITRG) has been established. ITRG annually assesses the appropriateness of NWMO's scientific and technical approaches and methodologies, and compares them with international best practice. The group is also required to assess the resources NWMO has to address technical issues which may arise during the siting process. Current ITRG members are from Canada, Sweden, Switzerland and the UK and members are either academics or have significant experience in international work on radioactive waste disposal.

3.121 In early 2009, NWMO became responsible for the development and construction of the GDF for ILW and LLW that is to be established beneath the Bruce nuclear power station. Another recent development is that AECL is constructing a new dry storage facility for legacy wastes and spent fuels at its Chalk River site, to be used until a GDF is available.[16]

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[15] *http://www.nwmo.ca/*
[16] *http://www.aecl.ca/Development/SD-WMD/FPSP.htm*

France

3.122 There are six major groups that contribute to nuclear R&D in France. These are the utilities, Electricité de France (EDF), Areva and GdF-Suez; the Atomic Energy Commission (CEA); the national waste management organisation (ANDRA); the National Research Agency (CNRS); the regulatory body, the Nuclear Safety Authority (ASN); the Government *via* its Ministry for Economy and Industry; and Parliament, through its commissioning of the National Evaluation Commission (CNE) to provide independent assessment of R&D.

3.123 France has investigated the geological disposal of higher activity radioactive waste since the 1970s. Throughout the 1970s and 1980s, disposal R&D was carried out by ANDRA, which was then a division of the CEA. There was a major step-change in organisation and co-ordination in 1991 when Law 91-1381 was passed. This specified that there was to be R&D on three major topics:

- partitioning and transmutation (P&T)
- waste packaging and the effects of long-term surface storage
- geological disposal.

3.124 The geological disposal programme was to include the development of at least two URLs in different types of rock. The law made ANDRA a public service company, separate from the CEA. ANDRA was given responsibility for co-ordination of R&D related to interim storage and geological disposal. CEA was given responsibility for co-ordination of R&D into P&T, mostly performed by the CEA and CNRS (Niel, 1996). The law stipulated that by 2006 the government had to submit to Parliament an overall assessment of the research concerning high level, long-lived waste, with a draft law authorising, if appropriate, the creation of a disposal facility for these wastes.

3.125 The 1991 law also established the CNE to monitor the R&D work carried out by, or on behalf of, ANDRA and CEA, and report to parliament on progress. The annual reports produced by the CNE on ANDRA and CEA activities are reviewed by the Parliamentary Office on the Assessment of Scientific and Technological Options (OPECST). In 2006, OPECST produced a report on the state of radioactive waste management in France, following a major review of ANDRA and CEA progress by the CNE in 2005. On the basis of this review and report, in June 2006 a parliamentary Act was passed in which phased deep geological disposal was selected as the preferred option for HLW, at a site to be selected by 2015, following conditioning and interim surface storage. This Act also required that R&D would continue in the URL in the claystone / mudrocks at Bure, in north-eastern France, and that any facility should incorporate 'reversibility' at every stage.

3.126 Recent and on-going R&D programmes in France continue to be divided into three thematic areas consistent with the 1991 Law and 2006 Act (CNE, 2006; Flocard, 2006). CEA deals with P&T, packaging and interim storage. ANDRA deals with geological disposal and longer term storage (including underground storage).

3.127 The radioactive waste management research being conducted by ANDRA principally takes the form of joint programmes at a national, European or international level (Landais, 2008). ANDRA is strongly involved in FP6 and FP7 European research initiatives, and acts as both a contributor (*e.g.* FORGE) and co-ordinator in these. It also acts as the co-ordinating body for French contributions to wider international programmes, such as the 'development of coupled THCM models and their validation against experiments' (DECOVALEX). At national level, the public sector research partners are the government-funded CNRS (National Centre for Scientific Research), which supports a number of national centres and institutes in various technical areas, and the universities, which have co-ordinated their actions in this area through the PACE programme (*Programme sur l'aval du cycle électronucléaire*) organised around research consortia on important research themes. Organisations from within the nuclear industry (*e.g.* EDF, Areva), and also the CEA, participate in many of the research consortia. Some examples of recent consortia include:

Forpro (*FORmation géologique PROfonde*) [Deep Geological Formation], which covers research into and within underground laboratories and involves ANDRA and CEA;
Gedeon (*GEstion des DEchets par des Options Nouvelles*) [Waste Management through New Options], which has focused on sub-critical accelerator driven systems and thorium-based fuel, and has involved CEA, CNRS, EDF and Areva;
Nomade (*NOuvelles MAtrices DEchets*) [New Waste Matrices], which is focused on the study of new conditioning matrices, and involves CEA and CNRS;
MoMaS (*MOdélisation MAthématique et Simulations numériques*) [Mathematical Modeling and Digital Simulations], which aims to develop advanced models to simulate radioactive waste management problems and involves CEA, CNRS, ANDRA, BRGM, and EDF;
Practis (*Physico-chimie de Radioéléments, des ACTinides, aux Interfaces et en Solutions*) [Physical-chemistry of Radioelements, Actinides, Interfaces and Solutions], which involves CEA, CNRS, EDF and ANDRA.

3.128 The CNRS maintains research institutes, for example the National Institute for Earth Sciences and Astronomy (INSU) and the Institute National de Physique Nucléaire et de Physique des Particules (IN2P3), which contribute to R&D programmes on radioactive waste or are likely to in the future. The current CNRS interdisciplinary theme, 'Energy', appears to be geared, to some extent, towards facilitating R&D in radioactive waste disposal through co-operative programmes linked into the ANDRA and CEA research themes.

3.129 The CNRS follow-on programme after PACE covering 2006-2011 is PACEN (*Programme pour l'Aval du Cycle Electro-Nucleaire*). The theme areas in PACEN cover the following subjects.

- Transmutation, which is largely related to energy development.
- Partitioning, including both pyrochemical and hydrometallurgical technologies.
- Geological characterisation *via* ongoing research under Forpro and PARIS. The latter research consortium is focused on deep drilling of the Paris Basin

and in concert with Forpro is designed to advance understanding of water and gas reactions, monitoring, underground chemistry, and the importance of interactions and feedbacks on scales from microns to metres. The MoMaS consortium continues to 2011 to develop modelling simulations that incorporate multiphase flows and coupled behaviour, quantification of uncertainties and establishment of benchmark models and modelling tools.

- Near-field issues including waste matrices, container-clay interactions and interfaces.

3.130 R&D in nuclear safety, transport and security is co-ordinated separately from that relating to radioactive waste disposal. A combined independent agency, known as the '*Institut de Radioprotection et de Sûreté Nucléaire*' (IRSN), was established in 2002 with the role of advising and briefing the regulators on issues relating to radiological risk and nuclear safety. IRSN was given responsibility for research in:

- nuclear safety
- safe transport of radioactive materials
- health and environment radiation protection
- physical protection and control of nuclear materials
- protection of nuclear facilities and nuclear materials transport against possible attacks or sabotage.

3.131 IRSN has also been placed in charge of preparing reviews of ANDRA documentation (*e.g.* the Dossier Argile, 2005) for the French regulator, ASN.

Role of International Organisations

3.132 The three international organisations that have a role in helping countries to define and co-ordinate their R&D programmes on radioactive waste management are the EU, the NEA of OECD and the IAEA. These organisations are discussed in turn below.

3.133 While the financial contribution from the EU (paras. 3.69-3.73) is useful, much of the value of EU research projects is in bringing participants together to exchange ideas and information. This helps EU member countries to make the best use of their resources, for example by each concentrating its R&D on a particular aspect of a common problem and then pooling their results.

3.134 The NEA's general objective in its radioactive waste management work is to contribute to the adoption of safe and efficient policies and practices in its member countries. It focuses on geological disposal of HLW and spent fuel. Its work is supervised by its Radioactive Waste Management Committee (RWMC), which is assisted by three working parties:[17]

- Forum on Stakeholder Confidence
- Integration Group for the Safety Case (IGSC)
- Working Party on Management of Materials from Decommissioning and Dismantling.

[17] *http://www.nea.fr/html/rwm/*

3.135 RWMC and its working parties provide the overall forum for exchange of information, which is achieved through meetings and the production of reports. Detailed technical work is carried out by means of working groups, topical sessions, workshops, symposia and technical reviews. NEA also organises international peer reviews of national studies and projects. For example, it organised a peer review of the Dossier Argile 2005 (para. 3.131) by a team of independent specialists from various countries. The review covered research and safety assessment. Two of the aims of the review were to determine whether the future research needs identified in the Dossier were consistent with the existing knowledge base and whether the stated research priorities were appropriate.

3.136 RWMC is currently carrying out a project on reversibility and retrievability in geological disposal. Current IGSC activities include:

- a working group on the characterisation, understanding and performance of argillaceous rocks for geological disposal (the "Clay Club")
- a project on approaches and methods for integrating geological information in GDF safety cases
- a project on sorption of radionuclides on geological media
- a project on engineered barrier systems
- maintaining a database of features, events and processes (FEPs) that need to be considered in GDF post-closure safety cases
- a thermodynamic database project.

3.137 IAEA's work on radioactive waste management is carried out by its Department of Nuclear Safety and Security. It includes establishing safety standards, producing guidance on the application of safety standards and sending teams of experts to developing countries to assist them in policy, regulatory and practical aspects of waste management.

3.138 IAEA also organises Co-ordinated Research Projects (CRPs) that are designed to encourage the acquisition and dissemination of new knowledge.[18] CRPs involve developed countries, which pay for their own research and participation, and developing countries, which are funded by IAEA. The results of CRPs are published by IAEA. A CRP on the use of numerical models in support of site characterisation and performance assessment studies for GDFs has been running since 2005 and is due to end in 2010.

3.139 In addition, IAEA runs knowledge transfer networks. There is a "Network of Centres of Excellence" in training and demonstration of radioactive waste underground research facilities, the "URF Network".[19] This has been running since 2001. Its "members" are countries that have URFs and associated laboratories that they offer for training, demonstration and research activities by "participants", that is countries that do not have such facilities. The URF Network has 9 members and 21 participants. The UK is a member and the Geoenvironmental Research Centre, Cardiff University, is its centre of excellence. The objectives of the URF Network are to:

[18] *http://www-crp.iaea.org/*
[19] *http://www.iaea.org/OurWork/ST/NE/NEFW/wts_URF_homepage.html*

- encourage the transfer and preservation of knowledge and technologies
- work on solutions for countries that at present do not have URFs
- supplement national efforts and promote public confidence in radioactive waste disposal schemes
- contribute to the resolution of key technical issues.

Conclusions on UK R&D Programme

3.140 Many organisations in the UK are involved in funding and carrying out R&D relevant to the management of higher activity wastes. These include NDA and its SLCs, other nuclear industry organisations (civil and defence), the NNL, the regulators, the Research Councils, universities, and consultants and contractors. CoRWM's conclusions on UK R&D programmes relate mainly to co-ordination within and between these organisations.

NDA and Other Nuclear Industry Organisations

3.141 NDA has made a good start in some respects. The TBuRD system is designed to ensure SLCs identify R&D requirements and the NWRF aims to ensure R&D needs are discussed between SLCs, British Energy and regulators at a technical level. RWMD has developed its R&D Strategy for geological disposal and will produce a more detailed document setting out its forward programme of R&D. CoRWM understands that RWMD is in the process of setting up an advisory panel to assist it in developing its programme. NDA also funds R&D relevant to its mission directly, for example, through its DRP.

3.142 However, there seems to be little strategic co-ordination of SLC, RWMD and DRP R&D within NDA. In particular, it is not clear how RWMD R&D on geological disposal will be co-ordinated with the R&D by NDA and its SLCs on waste conditioning, packaging and storage, or on the management of spent fuels, plutonium and uranium. NDA seems to see R&D only as an adjunct to its strategy work, not something to which it should also have a strategic approach.

3.143 Various groups set up by NDA, for example the NWRF, involve other nuclear industry organisations and the regulators. As far as CoRWM has been able to determine, these groups are useful for identifying gaps and overlaps in R&D. However, they are not set up to provide strategic co-ordination of R&D nor to agree nuclear industry R&D priorities at a national level. As a result, they cannot ensure that key issues are addressed in a timely way or that the best use is made of resources.

Regulators

3.144 HSE has a responsibility to ensure that appropriate nuclear safety research programmes are carried out and that the results are disseminated. This includes nuclear safety research related to the management of higher activity wastes. HSE publishes a Nuclear Safety Research Strategy that covers both research that it will commission and research that it expects nuclear site licensees to undertake. The mechanism for deriving national nuclear safety research requirements is well-established and has input from an independent expert group. HSE can recover the costs of its own research from licensees.

3.145 EA and SEPA commission research in support of their regulatory roles and influence nuclear industry organisations to carry out research on the management of radioactive wastes. They recover some of their costs from the industry. The EA research budget is small compared to the expenditure of the corresponding regulator in the 1980s and 1990s. In CoRWM's view, the EA will need to commission more research in the later stages of the MRWS programme to support it in its role as a regulator of geological disposal. CoRWM also thinks that, as Scottish Government policy is developed and implemented, SEPA will need to commission research related to its regulation of the management of higher activity wastes.

Research Councils

3.146 The UK has seven Research Councils. Five of these are relevant to R&D on the management of higher activity wastes. These Research Councils support research in their own institutes and provide research grants to universities. They are the main funders of fundamental research, while the nuclear industry focuses on applied research and on development.

3.147 At present there is no process for identifying where fundamental research is needed to underpin and complement applied research on the management of higher activity wastes. Only the EPSRC has a clear mechanism for obtaining input from the nuclear industry to its programmes. This mechanism is not focused on fundamental research, nor does it involve contact between the prospective researchers, who should be providing the ideas, and the industry, who will use the results. CoRWM believes that, in general, there is an over-emphasis on applied research within the Research Councils, to the detriment of the MRWS programme.

3.148 CoRWM has found that there is insufficient co-ordination between the various Research Councils at a strategic level on radioactive waste-management-related issues. There is also insufficient co-ordination between the Research Councils, the nuclear industry and the regulators.

3.149 In addition, CoRWM has some concerns about specific Research Councils. These can be summarised as follows.

- EPSRC makes too little use of funding strategies other than managed calls; these calls are perceived to be heavily influenced by the nuclear industry.
- NERC has been slow to respond to the needs of the MRWS programme.
- BBSRC is not currently funding any research specific to radioactive waste management, unlike its counterparts in other countries.
- As far as CoRWM is aware, STFC is not taking any steps to ensure that independent research can be carried out in the active facilities operated by the NNL.

EU Research Funding

3.150 The UK does participate in EU Framework Programmes but to a lesser extent than in the past. Several EU colleagues have commented to CoRWM members about the limited participation of UK universities in Framework Programmes in

comparison to other countries with similar sized nuclear industries. One reason for this may be that UK participants have difficulty in obtaining funding to match the EU contribution and to cover the full economic costs of participation.

3.151 In CoRWM's view, the UK should make increased efforts not only to participate in but also to influence Framework Programmes on R&D for the management of higher activity wastes. It is also important that effective use is made of knowledge gained in past Framework Programmes.

Learned Societies

3.152 There is good co-ordination emerging among the Learned Societies and good communication with their members on radioactive waste management issues, including geological disposal. As well-respected and independent institutions they should prove very useful in helping to inform a technical and wider public audience about the MRWS programme, as well as developing the skills base through their members. However, CoRWM does not believe the Learned Societies are in a position to provide strategic co-ordination of R&D.

Past UK Co-ordination of R&D

3.153 In the past, there were mechanisms for strategic co-ordination of UK waste management R&D. These were Government-led because at that time Government departments funded a considerable amount of R&D to support policy development. The co-ordination mechanisms ceased to exist in the 1990s, after Government departments had scaled back their R&D on HLW disposal. After the RCF decision in 1997, there was further scaling back by Nirex and by the regulators. Nuclear industry R&D increasingly focused on immediate needs, rather than long-term waste management issues and the Research Councils and academic communities reduced their programmes as Government and industry funding diminished.

3.154 CoRWM considered whether the co-ordination mechanisms used in the past could be applied today. It concluded that they could not. Although the number of key players now is similar to what it was, the players' roles and responsibilities are very different. In particular, Government neither directly funds nor leads R&D programmes. Further, past co-ordination mechanisms relied largely on discussions behind closed doors and standards of openness and transparency are much higher today.

Public and Stakeholder Engagement

3.155 There is little opportunity for stakeholders outside the R&D funding and providing organisations to influence UK R&D programmes on radioactive waste management. Most fora at which R&D requirements are discussed are closed and much R&D is regarded as "commercial" so the results are not published.

3.156 CoRWM believes that this situation must change if a wide range of stakeholders and the public are to have confidence that higher activity wastes will be managed safely in the long term. More stakeholders should be involved in establishing R&D requirements. Accessible information should be made available to the public about R&D needs, plans and progress.

International Experience

3.157 Countries such as Sweden and Finland have good mechanisms for co-ordinating R&D but the waste inventories they have to deal with are orders of magnitude smaller and simpler than in the UK, and their Government, regulatory and nuclear industry structures are less complex. The Swedish scheme of submission of the forward R&D programme to the regulators every 3 years, wide consultation, and subsequent recommendation to the Government by the regulator (SSM) is commendable. The French system with a national commission evaluating the R&D and producing annual reports that are reviewed by a parliamentary commission also has much merit. The USA has mechanisms for co-ordinating geological disposal research but does not appear to have good mechanisms for co-ordinating other radioactive waste management research. The workshops organised by DOE in the USA are very good for discussing R&D requirements. CoRWM believes that similar workshops should be held in the UK, with participants from the European Union and other countries.

4. R&D SKILLS TO SUPPORT THE MRWS PROGRAMME

4.1 In keeping with its terms of reference and as part of its scrutiny of the R&D undertaken, CoRWM is seeking to reassure itself that an appropriate skills base is, or will be, available to the UK to undertake R&D and that R&D is integrated into skills development activities as an essential component in developing high-level skills (Section 1). R&D skills to support the MRWS programme have to be viewed as part of a wider nuclear industry skills issue although some 'new' skills, particularly those associated with geological disposal, will be required. As with many existing skills, some of these new skills are available, and should be transferable, from non-nuclear areas such as the hydrocarbon and civil engineering industries. This section focuses on R&D skills relevant to MRWS but against the wider nuclear industry background.

4.2 R&D skills cannot be considered in isolation from the basic training of personnel and the two are considered in this report as integral components of the same issue. Although an attempt is made in this section to separate basic skills training from research training, the boundaries are inevitably diffuse.

4.3 Any attempt to review a continuously changing situation must inevitably date quite quickly. The information below has been updated to the end of summer 2009 as far as possible, except for those data lists where a partial update would destroy the comparative basis.

Skills Requirements

4.4 A wide range of skills will be required for the long-term management of higher activity wastes, spread across many disciplines. Among the more obvious in the contexts of interim storage and geological disposal are nuclear science (including nuclear physics and radiochemistry), the geosciences (including geochemistry, geophysics and hydrogeology), materials science and civil and mechanical engineering (including geotechnics and underground construction). Many specialised skills will be required for the different phases of implementation of geological disposal such as site characterisation, construction, operation and closure of the GDF and significant R&D will be required to remove, reduce, or quantify the underlying uncertainties so as to produce a satisfactory site-specific safety case.

4.5 While the emphasis in this section is on the skills required for R&D, the wider skills and training issues are also considered and it is CoRWM's intention to deal more fully with the specialist skills required for site characterisation and other aspects of geological disposal in its future work programme. In discussing the skills issue across the range of disciplines, it is appropriate to focus on those aspects that are primarily nuclear related. However, there are many non-nuclear aspects of, for example, the geological, materials and engineering sciences, that are particularly relevant and these are dealt with in paragraph 4.35 *et seq.*.

Nuclear Skills – Current UK Situation

4.6 Since 2000, a succession of reports on nuclear skills and training (*e.g.* OECD/NEA, 2000; HSE-NII, 2002; NSG, 2002; Cogent, 2008) has identified a number of concerns including:

- a shortage of skilled manpower in the UK that could affect the defence, nuclear power and health sectors and have serious implications for the long-term management of radioactive wastes;
- a projected requirement for 15,000 to 19,000 trained personnel to be recruited to the nuclear sector by around 2017;
- a nuclear industry that has become heavily dependent on generic provision, *i.e.* recruitment of good quality graduates from non-nuclear specific degree courses;
- a fragile specialised post-graduate training sector in the nuclear area;
- a top priority of increasing vocational and technical skills, with a recommendation to quadruple the number of apprentices by 2013.

4.7 The most recent report, a more detailed analysis by Cogent (Cogent, 2009), forecasts a skills gap of up to 14,000 by 2025, which equates to a need for 1,000 new recruits a year, with the main drivers being:

- an ageing workforce that retires earlier than the UK workforce in general
- a shift in skills from electricity generation to decommissioning
- a demand for skills to operate a new batch of nuclear power stations.

4.8 It is clear from all of these reports that the situation had declined to the point of grave concern and, although this has been recognised and measures begun to address it, arrangements are not yet adequately rebuilt for the future. This is especially the case for the decommissioning and radioactive waste management programmes and there will be competition between these areas and the expected new build programme.

Nuclear Skills - Training

4.9 Many bodies and organisations are involved in the provision of nuclear skills in the UK and the relationships between them are complex (Figure 3).

4.10 The current approach to training is based on a “skills pyramid” (Figure 4) in which the sizes of the sections approximate to the relative numbers required. In keeping with the main conclusions of a Cogent report (Cogent, 2008), most of the initial efforts were concentrated on the lower part of the skills pyramid. This emphasised the skills needed at these levels and demanded by employers but, with this being addressed, attention is now turning also to the upper areas of the pyramid.

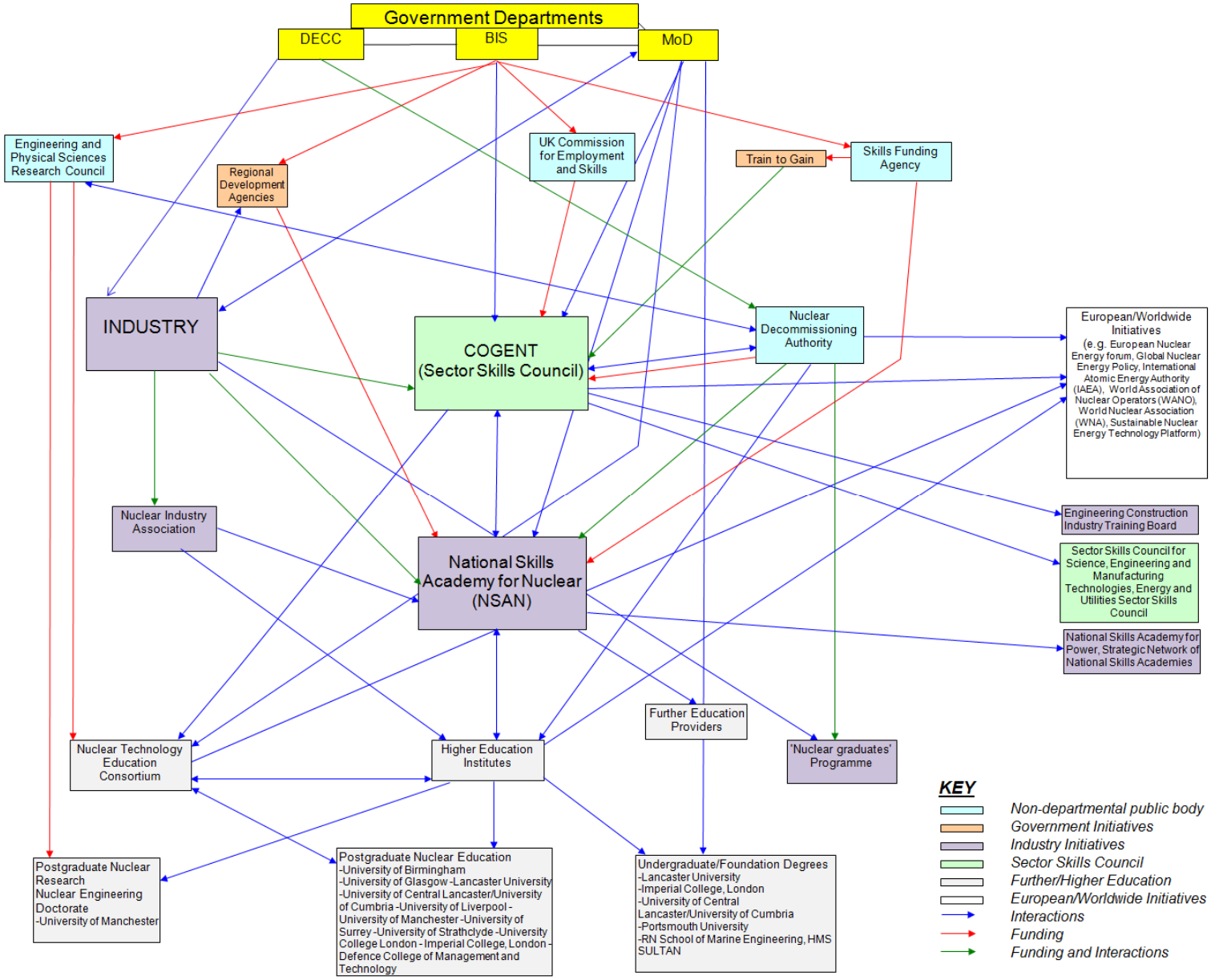


Figure 3. UK Nuclear Skills Map
Source: DECC

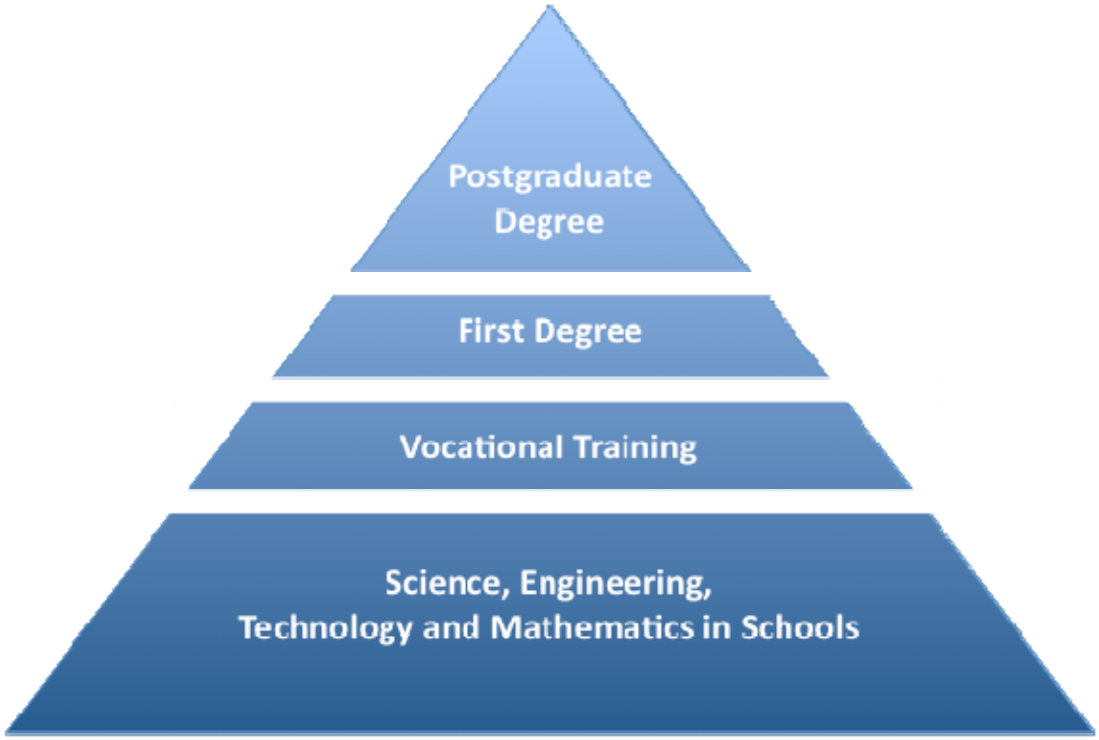


Figure 4. Skills Pyramid

4.11 The principal 'players' in the provision of nuclear skills in the UK are the Cogent Sector Skills Council, the National Skills Academy for Nuclear (NSAN), NDA, NNL and the universities. However, the significant contribution made by the industry through 'on the job' training (*e.g.* the Nuclear Power Academy run by British Energy at Barnwood) should not be underestimated. It is encouraging that all of these bodies are now taking steps to redress the situation. The roles and contributions of some of the key providers are outlined below. Training in the specialised skills required for R&D is at the top of the pyramid and the current situation is described in paragraph 4.21 *et seq.*.

Cogent

4.12 The Cogent Sector Skills Council has recently been relicensed by Government, through the UK Commission on Employment and Skills, to take an overview of a wide range of science-based industries. It is an employer-led organisation that produces education and training standards and qualifications for industries such as oil and gas, petrochemical and nuclear. For the nuclear industry, it works to deliver these through NSAN. Cogent is required to conduct Labour Market Intelligence (LMI) research across its industrial remit and is currently undertaking this for the civil and defence nuclear programmes, including waste management and new build (Cogent, 2009).

National Skills Academy for Nuclear

4.13 NSAN began operating in January 2008 as a wholly owned subsidiary of Cogent and is led and directed by its nuclear industry employer boards. Its remit is to address the key skills and training challenges facing the nuclear industry and

ensure the availability of a skilled workforce to meet future demands. These include defence and new build in addition to decommissioning and the MRWS programme.

4.14 NSAN is not a direct provider of training. It is an enabling organisation which sets up and funds training schemes and initiatives through partnerships with training providers (schools, universities and employer organisations). It is funded half by employers and half by BIS but after its first three years it is expected to be self-sustaining. It is still developing its work programme and training infrastructure. Its current approach is mainly focused on the lower levels of the skills pyramid (Figure 4), particularly vocational training and foundation degrees but it is now also turning its attention to higher level skills. For example, it is currently developing a post-graduate Certificate of Nuclear Professionalism. NSAN is also trying to encourage mobility within the industry with initiatives like its Nuclear Skills Passport, a basic skills qualification that would be accepted by all employers. HSE has stated that NSAN is "a lynchpin in providing the nuclear industry with a sustainable approach to meeting the nuclear skills shortage" (HSE, 2009c).

4.15 NSAN is a small, flexible organisation that can respond quickly to identified needs but its remit requires it to focus on employer requirements. Many employers, such as SLCs, have Lifetime Plans that run well into the next century but questions of prioritisation necessitate concentration of limited resources on short-term issues. For NSAN to focus exclusively on employer requirements, therefore, runs the risk of skills needs not becoming evident in a timely manner owing to the relatively short time horizon of most employers (CoRWM doc. 2444). For example, developing the skills related to geological disposal, which require long lead times, may not yet be 'on the radar' of many nuclear industry employers. Exercises, such as Cogent's LMI, which looks ahead to 2025 will help but, since this too is led by employer-identified needs, it is by no means certain to do so.

Nuclear Decommissioning Authority

4.16 The NDA's "Skills and Capability Strategy" (NDA, 2008d) reports progress on its initiatives in this area since 2005. Its approach to skills and training covers all four levels of the skills pyramid, namely, the science, engineering, mathematics and technical curriculum in schools; vocational training; first degrees and higher degrees. The latter are more appropriate to skills for research and are covered in paragraph 4.21 *et seq.*.

4.17 At the schools level, NDA supports the Energy Foresight programme, led by NSAN, which aims to improve understanding of nuclear power and nuclear technology. NDA provides instructional and other material in support of the national curriculum to over 400 schools. Vocational training initiatives are supported through NVQs in nuclear technology and decommissioning, and the funding of apprenticeships, both within NDA and its supply chain. Around 100 apprentices a year are recruited, mainly within NDA and its SLCs (CoRWM doc. 2373). The Energus facility in Cumbria opened in June 2009. It is funded by NDA, NSAN and industry employers among others and will train up to 150 apprentices, mainly in support of the operational skills requirements for Sellafield. It also hosts higher education students in nuclear-related subjects through a link

with the University of Cumbria. The supply chain tends to find recruitment of apprentices more difficult, largely because of the short-term nature of most of its contracts.

4.18 At the next level of the pyramid, there is support for foundation degrees offering a mix of academic learning and on-the-job training. Working through its SLCs and the supply chain, NDA attempts to identify the skills that will be required and looks to NSAN as a key enabler of these up to the foundation degree level. For training and skills beyond the foundation degree, NDA sponsors first degrees at various universities.

Universities

4.19 The UK situation with regard to the provision of nuclear skills through first degrees has improved only marginally since the HSE-NII report (HSE-NII 2002). Two universities (Imperial College and Lancaster) now offer a total of four courses with significant nuclear content leading to an MEng degree. Details of university provision are given in Box 3.

Box 3. Nuclear-related Undergraduate Courses

Any attempt to outline the provision of courses (and research activities) in higher education can only be a snapshot at the time of writing. The data on first degree courses given below (and on higher degree courses in Box 4) are based largely on information in the Cogent gap analysis ("A gap analysis for the nuclear industry. An investigation into gaps in provision based on current and predicted future skill needs" - www.cogent-ssc.com), on the Nuclear Liaison website (www.nuclearliaison.com) and from a presentation to a Geological Society of London meeting by JW Roberts of the University of Sheffield's Immobilisation Science Laboratory ("The storage and disposal of radioactive waste", Geological Society of London, 21 May 2008).

For almost 20 years prior to 2006, there were no first degree courses in nuclear engineering or waste management in the UK but there are now two institutions offering nuclear degrees, namely:

- Imperial College, London
  - MEng in Mechanical and Nuclear Engineering
  - MEng in Chemical and Nuclear Engineering
  - MEng in Materials and Nuclear Engineering
- Lancaster University
- MEng in Nuclear Engineering.

In addition to these, the University of Central Lancashire (John Tyndall Institute for Nuclear Research) runs a variety of nuclear-related Foundation Degrees as part of the NSAN portfolio.

4.20 Against this, much of the nuclear industry currently does not seek to recruit specifically nuclear-trained graduates, opting instead for good quality graduates in the physical and engineering sciences. This appears to be a preference, rather than an enforced situation, although we understand that AWE is currently trying to increase its recruitment of nuclear-trained graduates. In recent years, the annual recruitment to the industry has been around 500 science, engineering and technology graduates but this is likely to rise as decommissioning and new build proceed. Industry is keen to strengthen links with universities on skills development but notes that the timescales for achieving this are 5-10 years,

which is longer than the competition-based contract arrangements that tend to be used for many projects.

Nuclear Skills – Higher Level Skills for R&D

4.21 Figure 5 illustrates the decline in numbers employed in UK nuclear fission-related R&D from nearly 9,000 in 1980 to around 1,000 in 2004. Over the last 5 years, the number has remained at about this level, of which, around 750 are employed by the NNL. The closure of many R&D facilities and the associated decline in personnel has left the UK's capability for nuclear R&D significantly depleted.

4.22 The principal organisations providing training in the nuclear-related research skills needed for the R&D to underpin the MRWS programme are the universities, NDA (and some of its SLCs) and NNL. Other nuclear industry organisations and the industry's supply chain also provide training, but the latter often have difficulties planning and supporting high-level training over 3 years or more owing to the short-term nature of their contracts. Although not providers of training, Cogent and NSAN are working to develop "products" to help to sustain this important resource and NSAN has recently announced a round of bursaries to support training all the way up the pyramid. There is clear evidence that the situation is improving gradually but there is still some way to go.

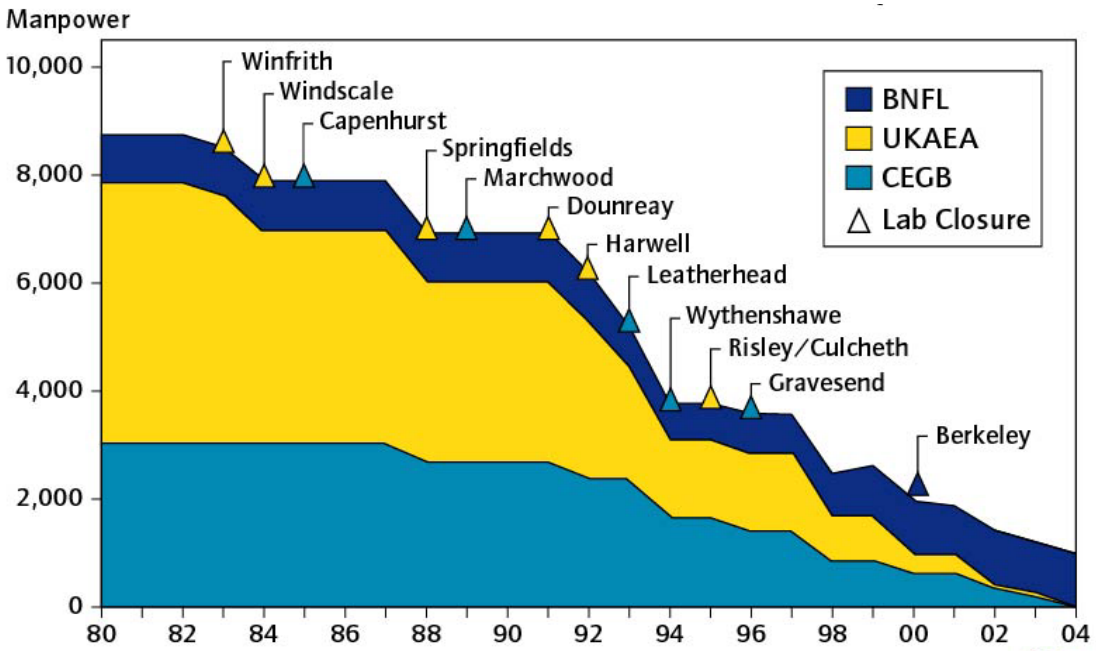


Figure 5. Illustrative decline in manpower employed in nuclear fission related R&D
Source: NNL

Universities

4.23 Research skills appropriate to nuclear R&D activities are provided in the higher education sector over a range of levels and disciplines. Starting with taught Master degrees, most of which involve research projects, these opportunities

advance through research-based Master degrees to Doctorates (PhDs) and post-doctoral research.

4.24 There are fourteen taught Master courses in the nuclear-related technical and scientific disciplines currently available in the UK. These are listed in Box 4. Decommissioning and clean-up are reasonably well represented but there are few of direct relevance to interim storage or geological disposal. The principal exceptions are the MSc degree offered by the NTEC consortium and the MSc in Nuclear Environmental Science and Technology offered by the University of Sheffield (Box 4).

4.25 A range of PhD research training is available in universities, with PhD provision particularly relevant to the MRWS programme concentrated in: the University Research Alliances (URAs); the nuclear research consortia; and a number of other smaller university research groups undertaking research and providing training in nuclear-related areas (see Box 4).

4.26 The four BNFL URAs were established in 1999-2001 as a response to the decline in the UK research skills base as described in Box 4. Following their initial 5 years of funding from BNFL these have become largely self-sustaining (with partial funding from NDA) and have proved very effective sources of skilled people. They have produced over 100 PhDs and trained more than 80 post-doctoral research associates (PDRAs) and, although not all are in the nuclear area (a consequence of the need for self-funding), many are now employed in the nuclear industry.

4.27 The Research Councils, principally EPSRC, have funded a small number of large research and training consortia (Box 4), among the functions of which is to provide PhD training in areas pertinent to their research brief.

4.28 There are at least a dozen other university groups providing research training in relevant areas spread across eight English and Welsh universities. Details of the URAs, nuclear research and training consortia and other nuclear-related research groups are given in Box 4. Scrutiny of the published details of research activities in the URAs, groups and consortia reveals that, while many relate to waste conditioning and other pre-disposal aspects of waste management, very few are orientated towards geological disposal.

NDA High Level Skills Training for R&D

4.29 Although the NDA's Skills and Capability Strategy is focused mainly on the lower parts of the skills pyramid, NDA does sponsor PhD studentships in universities, through its PhD Bursaries Scheme, recently incorporated into its DRP, which typically supports 5 students per year, and through SLCs *via* CASE (Co-operative Awards in Science and Engineering) studentships. There is, however, concern in some quarters (CoRWM doc. 2630) that the DRP is not conducive to graduate-level skills development, which is best achieved through PhD research training in universities. Typical DRP projects are on a much shorter timescale than a PhD project, which can require a commitment of up to 4 years.

Box 4. Postgraduate University Provision

There are several nuclear-related post-graduate taught courses in UK universities, of which, those in italics below are most likely to be potentially relevant to the decommissioning, clean up and waste management programmes.

- University of Birmingham
  - MSc in Physics and Technology of Nuclear Reactors
  - *Certificate & Diploma in Radioactive Waste Management & Decommissioning*
- Imperial College
  - MEng in Chemical and Nuclear Engineering
  - *MEng in Materials and Nuclear Engineering*
  - MEng in Mechanical and Nuclear Engineering
- Lancaster University
  - MEng in Nuclear Engineering
  - *MSc in Decommissioning & Clean-Up*
  - MSc in Safety Engineering
- University of Central Lancashire
  - *MSc, Diploma, Certificate in Energy and Environmental Engineering (Nuclear Decommissioning)*
  - *Certificate in English for Nuclear Decommissioning*
- University of Liverpool
  - MSc in Radiometrics: Instrumentation & Modelling
  - *Certificate in Radioactive Waste Monitoring & Decommissioning*
- University of Sheffield
  - *MSc in Nuclear Environmental Science & Technology*
  - *MSc in Nuclear Science and Technology*
- University of Surrey
  - MSc in Radiation & Environmental Protection
  - MSc in Radiation Detection & Measurement

The Nuclear Technology Education Consortium (NTEC), collaboration between 11 universities and research institutes, offers programmes leading to MSc, Diploma, Certificate or Continuing Professional Development (CPD) qualifications. The MSc combines the best elements from each of the institutions by allowing selection of 8 modules from a total of 31 available across the partnership, combined with a project. Four of the core modules relate specifically to decommissioning and the management, processing, storage and disposal of wastes.

Undoubtedly the major sources of high-level research skills from the university sector are PhD graduates and post-doctoral research assistants/fellows. Increasing numbers of these are becoming available across a wide range of scientific and engineering disciplines and among the most appropriate for the R&D needed to underpin the MRWS programme will be those from the nuclear-related University Research Alliances (URAs), research & training consortia and specialised research groups described below.

A drop in public funding of nuclear R&D from over £450M in the 1970s to less than £10M in the mid-1990s combined with a rapid decline in the UK skills base created grave concerns about the future of nuclear-related research. In response to this, BNFL established four URAs with initial core funding of £2M each. These were set up from 1999-2001 as follows, with staff (as of January 2009) in square brackets.

- Centre for Radiochemistry Research (CRR) – University of Manchester [4 academic staff]
- Institute for Particle Science & Engineering (IPSE) – University of Leeds [3 academic staff and a technology manager]
- Immobilisation Science Laboratory (ISL) – University of Sheffield [11 academic staff and a technical manager]
- Materials Performance Centre (MPC) – UMIST/University of Manchester [10 academic staff]

These have proved very effective in terms of the numbers of PhD students attracted and degrees awarded; post-doctoral research assistants (PDRAs) employed and trained; research projects undertaken and papers published (data in table below as of October 2008).

Box 4. (*continued*)

URA	PhDs	PDRAs	Papers
CRR	49	29	104
IPSE	14	17	78
ISL	11	13	75
MPC	35	24	60

Each of the URAs has generated several million pounds of research funding in addition to their initial core funding and they are clearly an invaluable component of the research and high-level skills bases. After their 5-year, start-up period, BNFL intended the URAs to be self-sufficient and all have achieved this. However, they have all had to diversify their funding sources and as a result, a substantial part of their activities are directed to areas other than storage and disposal. In some cases, their research portfolios now include significant non-nuclear activities.

There are a number of other university groups undertaking nuclear-related research and providing PhD training in areas relevant to the management of higher activity wastes. These are:

- University of Birmingham
  - Nuclear Power Technology Group, Department of Physics
  - Radiation Biophysics Group, Department of Physics
- University of Cardiff
  - Geotechnical Research Centre, School of Engineering
- University of Cambridge
  - Various groups, Department of Earth Sciences
- Hull University
  - Design, Materials & Process Performance, Department of Engineering
- Imperial College
  - Centre for Nuclear Engineering
- Lancaster University
  - Control & Instrumentation Research Group, Department of Engineering
- Loughborough University
  - Environmental Radiochemistry Research Group, Department of Chemistry
  - Radiation Damage Prediction Group, Department of Mathematics
- University of Manchester
  - School of Earth, Atmospheric and Environmental Science
  - School of Mechanical, Aeronautical and Civil Engineering
  - School of Chemistry.

A number of consortia have been funded by the research councils (notably EPSRC) to undertake research and provide doctoral-level research training in the nuclear area. These include:

- The Nuclear Engineering Doctorate (EngD) programme. This is a collaboration between six universities: Manchester, Imperial College, Sheffield, Leeds, Strathclyde and Bristol. It provides a 4-year PhD programme that includes taught modules and research projects on the management, immobilisation, storage and disposal of radioactive wastes.
- Keeping the Nuclear Option Open (KNOO - see Box 1) has been established to maintain and develop PhD level skills relevant to nuclear power generation.
- DIAMOND (Box 1) funded mainly by EPSRC, is a 4-year programme which also seeks to address a growing EU-wide skills gap in the decommissioning and waste field and offers PhD and post-doctoral training.
- The Biogeochemical Applications in Nuclear Decommissioning and Waste Disposal Consortium (Box 1), A 4-year programme involving 5 universities and BGS.

4.30 The NDA also operates a graduate recruitment scheme, which covers a wide range of disciplines and involves over 20 companies. The scheme currently attracts over 1,000 applicants a year, of which, about 10 are recruited annually (CoRWM doc. 2373). During the three-year scheme, the recruits receive two years of post-graduate training and are placed with SLCs and supply chain companies on a rotational basis to gain practical and industrial experience. This is an excellent scheme and, although relatively new, appears to be working well (CoRWM doc. 2373). There is, however, some concern that without any guarantee of, or commitment to, employment upon completion (as was the case with the first cohort recruited) these people could subsequently be lost to non-nuclear careers (CoRWM doc. 2630).

4.31 NDA is a partner with the University of Manchester in the Dalton Cumbria Facility. Although small (3 academic posts), this aims to undertake nuclear-related research and provide research training and post-graduate level education in radiation sciences and in decommissioning engineering.

The National Nuclear Laboratory

4.32 NNL has a specific responsibility to maintain the critical skills required to support civil nuclear R&D. Arising from a skills review in which 72 essential areas were identified, it now maintains an R&D skills risk register. A key function of this register is to suggest actions to mitigate the risks, such as initiating recruitment before a skills gap appears. The NNL governance process will enable it to raise skills issues and this should ensure that skills are not lost by chance.

4.33 One of NNL's concerns is that NDA's tendering process has led to the need for nuclear skills to become spread across a much larger number of organisations than previously, with potential problems in maintaining appropriate technical standards.

4.34 In the view of NNL (CoRWM doc. 2630), in order to deliver its commitment on training, NNL needs to ensure that it has access to a wide range of R&D skills. It plans to pursue a growth strategy that increases staff numbers.

Relevant Non-Nuclear Skills

4.35 A substantial range of non-nuclear skills will be required for the successful implementation of the MRWS programme, particularly in the geological, materials and engineering sciences. It is beyond the scope of this report to assess the level of skills provision in these areas, as each is a substantial sector in its own right. Consequently, text here is limited to comment on the geosciences sector where serious concerns have been directly expressed to CoRWM through bilateral meetings (CoRWM docs. 2455, 2456). It is noted, however, that it has also been drawn to CoRWM's attention that fewer than ten UK universities have "full capability" first degree courses in materials science, despite the demand for graduates (CoRWM doc. 2630).

4.36 At present, there are 25 university departments teaching first degrees in geological sciences or environmental geosciences in the UK. The universities listed in Box 5 produce about 1,000 graduates a year, with around half staying in earth-sciences-related employment. Of these, many are recruited by overseas

employers (especially in the mining, hydrocarbon, water and civil engineering industries in which geosciences skills shortages are worldwide).

4.37 Undergraduate geophysics courses are offered by 13 universities. Owing to the high standards required from school leavers in maths and physics, these courses traditionally have far lower student numbers than geological sciences degrees.

4.38 The geological disposal R&D programme will also require specialist sub-disciplines like engineering geology and hydrogeology (Box 5). Taught MSc degrees in engineering geology are available at 22 UK universities but the levels of recruitment are such that many of them do not run. Only six universities offer a taught MSc in hydrogeology and again, the number of students taking these is small.

4.39 Nationally and internationally, graduates in geophysics, engineering geology and hydrogeology are currently all in short supply; the nuclear industry will need to compete strongly with the mining, hydrocarbon, water and civil engineering industries to attract highly-qualified researchers to work in the nuclear sector. Concerns about this were raised during meetings between CoRWM and the Learned Societies (including the Geological Society of London and the International Association of Hydrogeologists) (CoRWM docs. 2484, 2455). These discussed the availability of geosciences graduates and postgraduates to enter the nuclear industry and to proceed to PhDs in key sub-disciplines of particular relevance to R&D for the geological disposal programme, *e.g.* hydrogeology: NDA estimates that the maximum number of hydrogeologists required at the peak of site characterisation activity will be around 100 and it hopes to exploit the experience gained by hydrogeologists who have been involved in delivering geological disposal overseas rather than relying on UK-based experts.

4.40 A specific concern was also raised by BGS (CoRWM doc. 2456) about the increasing shortage of geosciences graduates who are also highly numerate. This arises because A-level mathematics is not a prerequisite for most geosciences degree courses and so graduates from these programmes have limited mathematical and modelling ability. Numerate geoscientists are essential for numerical modelling of radionuclide migration through the geosphere that surrounds a GDF. Numerate geoscientists are also highly sought after by the oil and gas industry, and for the development of potential carbon capture and storage capability and a national shortage will inevitably impact on R&D related to geological disposal.

4.41 Bilateral meetings between CoRWM and a range of learned societies, industry organisations and Research Councils have not identified any other particular concerns regarding skills provision in the materials and engineering (other than engineering geology) disciplines beyond the more general national concern regarding shortages of well-qualified recruits with suitable backgrounds in mathematics and the physical sciences.

NDA Skills Requirements for Implementation of Geological Disposal

4.42 NDA's Skills and Capability strategy was written before Nirex was fully incorporated into NDA (NDA, 2008d) and does not identify any substantive need

for NDA to acquire additional or specialised skills to implement geological disposal. When CoRWM met with NDA in April 2008 (CoRWM doc. 2373), it was informed that NDA's skills development was being extended to the geological disposal programme with input to the NDA Skills and Capability Strategy from RWMD.

4.43 CoRWM questioned (CoRWM doc. 2456) whether NDA has the necessary level of in-house geosciences expertise to enable external work (*e.g.*, in site characterisation and geosphere studies) to be integrated effectively into its overall programme. It was assured that NDA recognises this issue and is actively recruiting to match programme needs. CoRWM understands two senior staff members have recently been recruited in this area (CoRWM doc. 2630).

4.44 Of particular importance to the geological disposal programme is the need to understand the interactions that will occur over very long periods between emplaced wastes, containers and buffer materials and the geosphere. The geosphere components include not only the rocks within which a GDF is constructed, but also the fracture systems in these rocks, the groundwater fluids percolating through the rocks and GDF, and any introduced micro-organisms. Understanding and predicting these interactions in enough detail to develop a safety case requires a combination of sophisticated mathematical modelling and high quality experimental data that, for geological systems, are often extremely difficult to obtain.

4.45 There is evidence that the UK needs more skills capability in the area of 'coupled thermal-hydraulic-chemical-mechanical' (THCM) processes. Study of these processes is a major feature of the leading international R&D programmes (CoRWM docs 2455, 2484).

4.46 There is also the issue of experience in underground R&D. Many countries that are implementing geological disposal have had URLs for many years and have built up considerable experience (Section 5). Some UK researchers have worked in URLs in other countries but the numbers of people involved are small and some of the experience was gained many years ago by people who are now close to retirement. It is important that UK-based personnel are trained in underground R&D skills and working practices through active participation in overseas URL programmes to ensure the UK has a suitably experienced workforce when required (Section 5).

Consultant and Contractor based R&D Skills

4.47 An important pool of UK geoscience experience relevant to the geological disposal of radioactive waste currently resides in consulting organisations and among independent consultants. A large amount of commissioned work has been (and is still being) done by UK-based consultants for overseas WMOs, most notably in Sweden, Finland, the USA, France and Japan. Many of these scientists have 20-30 years of experience but, as with much of the nuclear industry, they are approaching retirement, and in many cases are working beyond retirement.

Box 5. Skills to Support the Geological Disposal Programme

In terms of the skills required to support the geological disposal programme, the three areas most likely to be called upon for provision are the geological and materials sciences, and civil engineering. At a meeting with the learned societies and NERC (CoRWM doc. 2455), concern was expressed about the supply of geosciences graduates both for entry to radioactive waste management in the nuclear industry and to go on to higher degree programmes in key sub-disciplines relevant to R&D for geological disposal such as geochemistry, hydrogeology, engineering geology and mining.

At present there are 25 university departments teaching first degrees in geological sciences or environmental geosciences in the UK. These are at the following universities:

Aberdeen	Cardiff	Leeds	Oxford	University College
Aberystwyth	Durham	Leicester	Plymouth	
Birmingham	Edinburgh	Liverpool	Portsmouth	
Bristol	Imperial	Manchester	Royal Holloway	
Camborne	Keele	Newcastle	Southampton	
Cambridge	Lancaster	Open	St Andrews	

The universities listed produce about 1,000 graduates a year, of which, around half stay in earth sciences related employment. Of these many are recruited by overseas employers (especially the mining, hydrocarbon, water and civil engineering industries in which geosciences skills shortages are worldwide).

BGS has told CoRWM (CoRWM doc. 2456) that, while it can still recruit satisfactory numbers of good geosciences graduates, it is becoming increasingly concerned about the shortage of highly numerate recruits who will be needed in ever greater numbers for modelling and other work. This is probably part of a wider problem in the numbers of students doing mathematics and physical sciences in the secondary and tertiary education systems. It could impact on the implementation of geological disposal in the UK, including the ability to learn from, and contribute to, international programmes.

There is also concern from the geological disposal perspective about the situation regarding taught Master degrees in the relevant specialist sub-disciplines like engineering geology and hydrogeology.

Within the broader definition of engineering geology (*i.e.*, including soil/rock mechanics and mining) 22 institutions offer a taught MSc, namely the following universities –

Bangor	Durham	Leeds	Reading
Birmingham	Glasgow	Manchester	Sheffield
Camborne	Greenwich	Newcastle	South Bank
Cambridge	Herriot-Watt	Nottingham	Southampton
Cardiff	Imperial	Nottingham Trent	
Dundee	Kingston	Portsmouth	

while only six universities have a taught MSc in hydrogeology, namely –

Birmingham	Imperial	Newcastle
Cardiff	Leeds	Sheffield

Given the relatively small numbers of students involved, the latter is of particular concern in view of the likely requirements for expertise in hydrogeology throughout the geological disposal programme.

Worthy of mention in this context is the Empower programme. This is a scheme whereby students taking a Master's course in earth sciences or environmental geology (at any university) are given exposure to the nuclear sector through research project placements or other activities. A pilot scheme ran in 2008 and the full programme, funded by the NDA, EA, AWE and British Energy, commenced in 2009. It is hoped this will lead to greater recruitment of geoscientists to the industry at a critical time.

Retention of Skills

4.48 It has been brought to CoRWM's attention that the radioactive waste management side of the industry will face severe competition for its skilled staff (CoRWM doc. 2677), not only from existing industries like hydrocarbons, water and civil engineering but also from emerging activities such as nuclear new build and carbon capture and sequestration. Also, a proportion of the R&D skilled staff would be expected to move into other roles in the nuclear industry and its regulators, rather than remaining in R&D roles (CoRWM doc. 2630).

Conclusions on Skills

4.49 For nuclear skills in general, but R&D in particular, the picture in the UK has been one of decline since the 1980s, largely a result of research laboratory closures but not helped by the "unfashionable" perception of careers in the nuclear industry. By 2000, this was giving grounds for serious concern. It is therefore encouraging that recently there have been significant improvements in the skills and training area. These are partly a consequence of the setting up of NDA and the "skills alliance" formed between Cogent and NSAN. They should be further helped by the improving image of the industry, due partly to the media association of the new build, energy gap and climate change issues. Nevertheless, arrangements for providing R&D skills are not yet adequately rebuilt for the future. The large number of organisations involved and the complexity of the relations between them means the provision of R&D skills and training in the UK is fragmented. Simplification of the responsibilities for ensuring the UK has the requisite skills should therefore be seriously considered.

4.50 NDA appears to be making good progress within the area of its own remit but nationally the wider scenario lacks strategic control. The inter-relationships between the responsible organisations are extremely complex and it is far from clear which take overall responsibility for providing leadership and co-ordination. This applies both to the identification of skills requirements and the provision of training. NSAN is an important initiative but has tended to focus on industry's more immediate needs. With Cogent, NSAN is now looking towards skills shortages to 2025 but these are still defined by current industry profiles. CoRWM encourages NSAN to develop some pro-active initiatives rather than relying entirely on employers' perceived needs and to do so over a timescale of decades.

4.51 In parallel with the depletion in R&D skills in the UK nuclear industry, the provision of research skills *via* higher degrees was seen as very "fragile" until recently. The establishment of the URAs by BNFL marked the beginning of a considerable improvement in the nuclear area which has continued with the funding by the Research Councils (mainly EPSRC) of nuclear-related research and training consortia and other university-based programmes. However, there appears to be an assumption in the industry that now the URAs are established the higher level skills problem is solved (CoRWM doc. 2630). These research centres require continued support to go on delivering skilled researchers in the relevant areas and without it may be forced to further reduce their nuclear-related activities. The commitment of the NDA to supporting research through its DRP,

SLCs and other avenues has also contributed to the improving situation, although questions have been raised about the effectiveness of this support.

4.52 It is to be hoped that the establishment of the NNL will provide further impetus to skills improvement but CoRWM has concerns about how training and provision of research skills will be reconciled with the need for commercial operation. While NNL will be a customer-funded organisation and it is appropriate that it operates as "just another supplier" in most circumstances, it is important to identify and agree those areas in which a strategic role needs to be played. In these areas it will be necessary to ensure that arrangements are in place to facilitate delivery of such strategic support. Skills provision is a strategic area and it is unclear to CoRWM how NNL funding for this will be assured.

4.53 There is still a shortage of Master-level courses with a significant nuclear component. In addition, EPSRC has now terminated its funding for the NTEC Masters' programme so, although NDA has provided interim funding for 2009, its future is unclear. The supply of relevant, non-nuclear, research skills in other disciplines is perceived as better but in some areas, like geoscience, not as healthy as it should be. Particular deficiencies remain in the numbers of MSc and PhD graduates in key sub-disciplines for implementing geological disposal, such as hydrogeology and numerical modelling. Since other countries' geological disposal programmes are likely to overlap with that of the UK, as will other challenging and attractive international projects, such as carbon capture and sequestration, CoRWM believes there is significant risk in over-reliance on attracting this expertise from overseas.

4.54 Despite some positive developments, research with its integral skills training in areas relevant to the R&D needed to underpin the implementation of geological disposal, remains fragmented overall. Responsibility for the provision of R&D skills is split between many organisations and there appears to be little effective national leadership and insufficient strategic direction.

4.55 Although not focused specifically on the nuclear industry, Cogent is well placed to provide guidance on the basic skills and training requirements of the industry through its employer-driven approach and alliance with NSAN. However, it is not directly involved in the provision of higher level research training of the sort required to underpin the MRWS programme nor is it in a position to make strategic judgements on the research programmes of which such training is part, especially those towards the fundamental end of the research spectrum. Consequently, CoRWM considers that additional expertise would be required within Cogent to enable it to provide effective national leadership and strategic direction for the provision of R&D skills pertinent to the management of higher activity wastes.

5. INFRASTRUCTURE REQUIRED FOR R&D

5.1 In this context, infrastructure means laboratories and other research facilities and the equipment within them.

5.2 R&D to support the MRWS programme may be viewed as falling into two groups: that which is specific to the nuclear industry (for example development of plutonium wasteforms), and other broadly applicable R&D which is relevant to the management of higher activity wastes as well as other industries (for example, remote subsurface investigation in support of structural geological characterisation and mapping). The former usually requires work with radioactive materials and has very specific and complex infrastructure requirements. By contrast, the latter relies mainly on the UK's broader national R&D capability. CoRWM hopes to examine the broader group in more detail in future. This report focuses on infrastructure to support nuclear specific R&D.

5.3 This section begins with consideration of "active facilities", that is research facilities where work with radioactive materials can be carried out, in the UK and other countries. There is then a discussion of underground facilities for geological disposal R&D.

UK Active Facilities

Universities

5.4 Within UK universities there is very little capacity to work with radioactive materials relevant to the nuclear fuel cycle. Several groups (*e.g.* Sussex, Edinburgh, Oxford, Imperial College) work on fundamental aspects of the chemistry and materials science of uranium and thorium but have no infrastructure to support experiments with transuranium elements. The majority of this research is based around one or two academic staff in each institution. Loughborough University has dedicated radiochemistry laboratories, but limited capacity to work with high hazard radioisotopes.

5.5 Starting in 1999, BNFL created a series of university partnerships (University Research Alliances, para 4.26 and Box 4). The MPC and ISL have the capacity to work with uranium-active materials (and irradiated graphite in the case of MPC), while the CRR has some capacity for work with neptunium and plutonium, including the UK's remaining supply of plutonium-242, whose long half-life allows work with milligram quantities in a limited range of conditions. All four URAs have access to a wide range of instruments although their use, even with uranium, can be quite restricted.

5.6 BNFL's start-up funding was provided to each URA for 5 years, with the expectation that they would become self-sufficient after that time. This is the case for all four URAs, which have diversified and now have major programmes in areas such as propulsion, new build, national security and non-nuclear topics.

National Nuclear Laboratory Facilities

5.7 NNL runs facilities at Springfields (relatively new uranium-active laboratories) and Sellafield, specifically the B13 and recently built BTC (BNFL Technology Centre)

facilities. The BTC has been renamed the Central Laboratory. NNL does not own these B13 and Central Laboratory facilities but leases them from NDA and operates them under the Sellafield SLC site licence (para 3.28). The contractual arrangements are not currently the same in all its facilities although this is set to change with the informal arrangements currently in place being progressively replaced by more formal contracts. The time frame for this is not yet established, although NNL considers that in the meantime the various interfaces could all be managed.

5.8 B13 contains shielded caves and a range of instruments and is undergoing refurbishment and improvements with the aim of ensuring it can continue to play a role through to 2025. The availability of equivalent facilities after this date is unclear though they will still be needed. The Central Laboratory is not yet fully commissioned. Phase 1 (gloveboxes, fumehoods and a graphite laboratory) has been commissioned. Phases 2 and 3, the MOX laboratories and hot cells respectively, have been in care and maintenance for 1-2 years. NNL is currently preparing a business case for the commissioning of Phases 2 and 3, based on HM Treasury Green Book guidance, and is hopeful the case will be accepted. Emphasis is being put on demonstrating there is a demand for the facilities proposed for Phases 2 and 3. NNL can provide, at least in outline, several programmes which would require these facilities and its customers, particularly Sellafield Ltd., are starting to develop longer term projects, which would justify commissioning. Even if fully commissioned, the Central Laboratory will require significant changes to, or further development of, its infrastructure (*e.g.* installation of specialised controlled atmosphere gloveboxes; instruments for characterisation of active samples) to carry out a research programme in geological disposal comparable to those undertaken overseas.

5.9 Further commissioning and expansion of capability in NNL facilities will be dependent on customer demand and successful preparation of business cases to support this demand (*e.g*. from NDA, SLCs and Research Councils).

5.10 While STFC and NNL have held discussions, CoRWM understands that there are currently no plans to include any major facilities at the NNL under the auspices of the STFC in order to ensure access for industry-independent R&D (CoRWM doc. 2443).

5.11 In general NNL has a limited equipment base for characterisation of radioactive materials, funded either by customers through specific projects or, in some cases, through self-investment. The Central Laboratory has only a limited range of equipment and has few routes to expanding this. As a result, this facility is significantly less well equipped than its overseas equivalents. This situation arises because NNL makes an annual profit of £5-6M which is insufficient to allow investment in high capital cost items, especially in a nuclear environment.

5.12 CoRWM understands that the management contractor for the NNL is required to increase access to facilities for universities and other organisations that carry out R&D. Although it is intended to provide access to allow fundamental research funded by the Research Councils to be carried out, and discussions are in progress, at present there is no mechanism by which the Research Councils can fund university research in NNL facilities, particularly when it involves the

purchase of equipment. In addition, the potential user community is confused about the process and terms of access to NNL active facilities (CoRWM doc. 2630).

Other Facilities

5.13 There are a number of supply chain organisations that have some capacity to work with radioactive materials. These include AMEC, which operates the NIRAS facility, Serco and Waste Management Technology. Most of these facilities can only handle low levels of activity. For example, most of the NIRAS facility is geared towards environmental radioactivity and it can only accommodate experiments with the less active ILW. The MoD also has some facilities, for example on the Aldermaston site.

International Examples of Active Facilities

5.14 Several countries, particularly the major nuclear nations, have R&D facilities to support civil and/or military programmes. However, direct comparisons of UK facilities with those overseas are not straightforward. There are substantial differences in national requirements, depending largely on whether or not fuel has been reprocessed on an industrial scale, while some laboratories incorporate nuclear research into a more general energy programme, and some support both civil and military programmes. Nevertheless, it is possible and instructive to identify a few illustrative examples for comparison.

France

5.15 France operates a nuclear fuel cycle that includes reprocessing of irradiated fuel and recycling of plutonium in mixed oxide fuel (MOX), and has done so for some decades. In France, much R&D is conducted by CEA, which has responsibilities in both civil and military nuclear energy. This includes decommissioning and some aspects of waste disposal, together with new reactors, nuclear fusion and novel waste management technologies such as partitioning and transmutation (para. 3.14).

5.16 The focus of R&D on radioactive waste in CEA is Marcoule, and particularly the recently (2003) completed Atalante facility.[20] In many ways, this is a close parallel to the Central Laboratory of the UK NNL (para 5.7). Marcoule is a long-established site, with both old and current facilities, and Atalante is a purpose-built R&D facility on that site. Atalante has 19,000 m^2 of laboratories, including 17 glovebox-equipped laboratories and seven sets of shielded hot cells and remote manipulators. Some other specialist facilities have also been developed by, or with the involvement of, the CEA, for example, the Soleil synchrotron built at Saclay, and the dedicated radioactive materials beamline (MARS) on Soleil. Recent and planned CEA active facilities include the Phénix fast neutron radiation source, which was taken off-line in March 2009, the prototype sodium fast reactor ASTRID (which can be used to produce plutonium, americium and other actinides) that is planned to be operational by 2020, and the Jules Horowitz reactor that will provide irradiated materials by 2015.

[20] *http://www-marcoule.cea.fr*

Germany

5.17 Although Germany has operated civil nuclear reactors for many years, fuel has never been reprocessed on a large scale in that country. A significant quantity of German fuel has been shipped to France and the UK for reprocessing and, under the terms of these contracts, vitrified HLW has been returned to Germany for disposal. Germany also proposes geological disposal of spent fuel and its early power reactors are now being decommissioned. In the former East Germany, large scale uranium mining has led to extensive contamination both on the surface and underground.

5.18 R&D into cleanup and waste disposal is concentrated in two federally-supported research centres, Institut fur Nukleare Entsorgung (INE) at Karlsruhe and Forschungszentrum Dresden (FZD). Both have links to universities, and academic institutions such as the Technical University, Munich, or the University of Mainz which have significant infrastructure, including a research reactor at Mainz.

5.19 INE is co-located with the ANKA synchrotron on the Forschungszentrum Karlsruhe site, and has a dedicated beamline on ANKA which can be used with radioactive materials. FZD operates the ROBL radioactive materials beamline at the European Synchrotron Radiation Facility, Grenoble. Both INE and FZD have extensive glovebox facilities optimised for geological disposal research.

5.20 Germany also hosts the European Institute for Transuranium Elements (ITU) on the Forschungszentrum Karlsruhe site. This is one of the EU Joint Research Centres and has extensive glovebox and hot cell facilities in which it conducts experiments on wasteform development and performance, and the behaviour of fuel in disposal conditions. Its EU-funded institutional budget is €37.9m per year.

USA

5.21 The USA has exploited nuclear fission on a large scale since the 1940s. Most reprocessing was focused on production of plutonium for weapons, while the West Valley reprocessing plant, built to support civil nuclear power, never entered full operation. Spent fuel from USA nuclear power stations is currently stored awaiting disposal but there is a policy review and there is increasing interest in reprocessing this material to reduce the volumes of waste for disposal. Decommissioning and cleanup of the weapons plants, in particular the Hanford and Savannah River sites, present many challenges comparable to those faced in the UK. Transuranic waste from the USA military programme (in many respects similar to UK plutonium contaminated material (PCM)) is disposed of underground in the Waste Isolation Pilot Plant (WIPP) in New Mexico.

5.22 The majority of relevant R&D in the USA is conducted in the “DOE complex”. Within this, seven National Laboratories have active facilities which are, or could be, used to support radioactive waste management and disposal R&D. The DOE programme also includes collaboration with numerous universities, including Washington State, Florida State, University of Nevada at Las Vegas, and University of California, Berkeley. Several of these universities have glovebox facilities.

5.23 The Pacific Northwest National Laboratory (PNNL) is close to the Hanford site, which was a major USA plutonium production facility for many decades and is now decommissioning. Two of PNNL's flagship facilities are the Radiochemical Processing Laboratory,[21] which is equipped with gloveboxes and hot cells, together with a wide range of instrumentation for use with radioactive samples, and the Environmental Molecular Science Laboratory, which has a major programme in subsurface science.

5.24 The USA has several synchrotron radiation sources which can be used with radioactive materials, including SSRL (Stanford Synchrotron Radiation Laboratory) at Stanford, APS (Advanced Photon Source) at Argonne and ALS (Advanced Light Source) at Berkeley.

5.25 USDOE recently commissioned from the National Academy of Sciences (NAS) an independent evaluation of its nuclear energy research programme (USDOE, 2008b). A common theme among the NAS recommendations was the need to invest in research facilities that enable the Office of Nuclear Energy (ONE) to meet its research priorities and to develop a process for prioritising, evaluating and obtaining those capabilities. Battelle Memorial Institute and Idaho National Laboratory were then asked to report on the type of facilities needed for the next twenty years as summarised by NAS (USDOE, 2008b). The facilities that ONE plans to invest in include hot cells, materials test reactors including fast reactors and demonstration reprocessing technologies.

Accessibility to the UK of Active Facilities in Other Countries

5.26 Access to USA National Laboratories is difficult because they are generally not open to collaborations, beyond USDOE-funded research, in which overseas institutions rarely participate. In addition, for the nuclear weapons laboratories, there are major issues with security clearance (a US Q-clearance, rarely allowed for non-US nationals, is generally required).

5.27 European facilities can be accessed to a limited degree through, for example, the FP6 Actinet-6 Network of Excellence and its proposed successor, Actinet I3. However, access through this route is very competitive, relatively limited in scale, short term (project duration less than a year) and lacking in continuity (the last call for Actinet-6 was in November 2007 and the first call under Actinet I3 is still awaited). Most significantly, users accessing the facilities through Actinet have no say in specifying the capability of the facilities or the instrumentation available. Given these constraints, the UK could not rely on these access routes to sustain major strategic R&D programmes.

5.28 The logistics of transporting radioactive materials make working overseas complex and expensive. For example, it is prohibited to move fissile material by air in the USA, so samples have to be transported by sea and road. UK groups have moved small transuranic samples to both European and USA facilities as Excepted Packages. The lead time is up to 4 weeks, which is an issue for unstable materials, while the cost for a single movement is normally £1K and can be up to £4K, depending on the material moved. Further, real time analyses of

[21] *http://rpl.pnl.gov/documents/pdf/rpl2008.pdf*

reactions and atmosphere sensitive materials cannot be performed at these facilities.

5.29 Larger samples of transuranic materials or samples with high external dose rates require large, often heavily-shielded containers, sometimes specially designed, for shipping and again, this is logistically complex and very expensive.

5.30 International nuclear materials safeguards agreements require detailed accountancy and record-keeping. This is complex within the EU (the Euratom system) and even more so if material is exported from the EU.

Underground Facilities

5.31 Many countries have radioactive waste management policies that involve geological disposal. Waste management organisations (WMOs) in these countries face broadly similar challenges in demonstrating, not only to regulators but also to the broader scientific/technical communities, politicians and the general public, that any proposed GDF is technically feasible, that it can be operated and maintained safely and that it will remain safe over very long periods of time after it has been closed and sealed. The scientific and engineering arguments that have to be developed to satisfy this level of scrutiny must be extremely robust.

5.32 WMOs in many countries have developed underground research facilities (URFs) to assist in this process by filling knowledge gaps and providing evidence to support the technical case for GDF development. This is the situation in Belgium, Canada, Finland, France, Germany, Japan, Sweden, Switzerland and the USA. In each case the WMO has made a decision that the level of knowledge in certain areas can only be brought to that required by performing R&D underground in an environment that approaches real conditions for a GDF.

5.33 Underground facilities fall into three categories:

1. facilities constructed as part of, or in conjunction with, other underground developments (*e.g.* mines or civil engineering projects)
2. generic URFs developed at sites that are not scheduled for geological disposal
3. site-specific facilities developed at sites at which geological disposal is planned.

5.34 Facilities in the first category were used in the early years of geological disposal R&D and have now largely been superseded by facilities in the other two categories (examples were the Stripa mine in Sweden and the Climax mine in the USA). Generic facilities have been developed in Japan, Canada, Belgium, Switzerland and Sweden. The current policy in France, Finland, USA and Germany has been to develop site-specific facilities. However, the technical cases for both the operational WIPP GDF in the USA and the licensed GDF at Konrad in Germany were developed without the aid of site-specific underground facilities.

5.35 The range of possible functions of underground facilities can be summarised as follows:

1. Comparison and calibration of geosphere data collected from surface-based investigations with that from underground investigations.
2. Comparison and calibration of data collection methods and equipment for geosphere characterisation purposes.
3. To develop and enhance understanding of the impacts of rock excavation on both the rock mass and existing underground openings.
4. To develop and enhance understanding, through simulating the effects of the placement of waste in actual conditions that replicate those in a GDF.
5. To develop and enhance conceptual and numerical models for the transport of radionuclides through a rock mass.
6. To develop an improved understanding of, and test how, a proposed engineered barrier system (EBS) will perform under conditions that replicate those in a GDF.
7. To design and undertake experiments that will give an understanding of the long-term performance of the disposal facility as a whole to ensure the robustness of the safety case for a GDF.
8. Build and maintain public confidence that all practical steps are being undertaken to establish the technical feasibility and safety performance of a GDF.

5.36 Some of the activities carried out in underground facilities come under the heading of site characterisation (*e.g.* items 1 and 2 above); others are R&D. Some of the R&D activities are required as input to GDF design or safety case development. Others will be needed during much of the period that a GDF is open in order to maintain the safety case and to allow improvements to be made to, for example, backfilling and sealing materials and methods. Examples of R&D topics are shown in Box 6.

5.37 The UK has never had a URF. However, UK scientists have participated in R&D programmes in facilities in several other countries.

5.38 By only mentioning site-specific underground investigations, the White Paper (Defra *et al*., 2008) implicitly rules out the construction of a generic URF in the UK. It states that the NDA shall undertake long-term underground investigations to confirm that the site selected to host a GDF is suitable and that a facility can be constructed that can meet all safety and environmental regulatory requirements. The process of site characterisation will commence with non-intrusive surface based investigations followed by intrusive borehole investigations from ground surface (Stage 5 in the MRWS site selection process). The White Paper makes it clear that characterisation work will continue into Stage 6, during which tunnels at depths of hundreds of metres will be constructed for the purpose of underground investigation. The investigations in this underground environment are planned to be long-term and are intended to draw on a range of scientific and technical disciplines such as geology, geophysics, hydrogeology, chemistry and others. In the context of Stage 6 of the MRWS process, underground investigations will in effect be the first stage of the construction of a GDF.

Box 6. Examples of Topics on which Underground R&D is needed for GDF Design and Safety Case Development

- The responses of the rock mass and existing underground openings to excavation, this could include:
  - excavation techniques and excavation support techniques for the long term
  - deep drilling techniques
  - research into the response of rock masses to excavation technique, and opening size and orientation;
  - the development of EDZs
  - the possible effect of excavation on existing underground openings in given *in situ* stress conditions and the influence of excavation on stress fields.
- Engineered barrier performance:
  - full scale barrier tests
  - container tests
  - buffer and overpack tests
  - tunnel and shaft seals and ultimately facility seals
  - borehole sealing
- Radionuclide movement through the geosphere:
  - solute advection and diffusion
  - colloidal transport
  - radionuclide sorption
  - gas threshold pressure relationships
- Waste handling under realistic conditions:
  - effects of heat and radiation on the host rock
  - heat effect on structures
  - thermal-hydraulic-chemical-mechanical testing
- The long-term performance of the GDF and the efficacy of the EBS under realistic conditions:
  - demonstration and testing of disposal concept
  - materials interfaces, for example surrounding the co-location concept
  - backfill behaviour and efficacy
  - corrosion of waste containers
  - degradation of waste forms
  - long-term performance of multiple underground openings.

5.39 The RWMD R&D Strategy explains how its R&D will evolve during the MRWS process (NDA, 2009b). It states that during Stage 5 (surface-based investigations) its R&D will focus on the site-specific processes that will determine the performance of engineered barriers or control the movement of fluids and radionuclides. For Stage 6 it states that:

> "*A key aspect of this phase will be underground investigations. There will be some site-specific information at a large spatial scale, which can only be obtained by investigation underground in the specific geology to be considered for hosting the facility. We will carry out these investigations as part of the construction of the facility and therefore our planning does not include a separate phase for R&D in an underground research laboratory.*"

5.40 Early in 2009 the emphasis in RWMD planning seemed to be on site characterisation and on confirming that R&D results obtained in the laboratory or in URFs in other countries would be applicable to the specific site at which it is proposed to construct a GDF in the UK (NDA, 2009b). This would be similar to the approach in Finland, where the ONKALO facility at the Olkiluoto GDF site is to be used for characterisation and confirmation but not for extensive R&D. However, scientists from Finland have for many years participated in R&D programmes in URFs in Sweden, which are in geological environments that are relevant to Olkiluoto. RWMD has recently indicated that its underground investigations will include R&D to address uncertainties and support safety case development (CoRWM doc. 2630; NDA, 2009k).

Conclusions on Infrastructure for R&D

Active Facilities

5.41 The UK has a limited number of facilities that are able to support research with radioactive materials. In particular, the country has very few research facilities in which it is possible to handle materials with levels of radioactivity above the very low concentrations found in the environment. The key facilities are those run by the NNL, which as a result of rationalisation operates the majority of the UK's active civil research infrastructure.

5.42 In CoRWM's view, the NNL's currently planned facilities, even when fully commissioned, will be inadequate to support the full range of research required to manage higher activity wastes. Significant improvements and additional facilities are needed to provide the UK with the capability to do research for its wide range of higher activity wastes.

5.43 It is unclear to CoRWM how the NNL facilities will be made available for the full spectrum of research that is needed to underpin the MRWS programme. The only R&D that can be performed in NNL facilities is that funded by NNL customers, namely NDA and other nuclear industry organisations, who are unlikely to support much fundamental research. There is currently no mechanism for the Research Councils to fund university research carried out in NNL active facilities, particularly that for which equipment must be bought.

5.44 CoRWM believes that further development of NNL facilities for research with highly radioactive materials, and greater access to them, are the only realistic route to the provision of the national research infrastructure needed for the management of higher activity wastes.

Underground Research Facilities

5.45 It is clear to CoRWM that both underground site characterisation and underground R&D are needed at any prospective GDF site in the UK. Surface-based investigations will not be sufficient for site characterisation. Even with the latest investigative techniques, significant underground site characterisation will be required in relation to rock mass characteristics, hydrogeology, geochemistry and stress conditions. Underground R&D will be needed to inform GDF design and support safety case development, including by finding out whether R&D results obtained elsewhere are applicable to a UK site. In practice, there is

unlikely to be a clear distinction between site characterisation and R&D; rather there will be a continuum of activities, all supporting GDF design and safety case development.

5.46 In CoRWM's view, the most effective way to carry out the necessary underground R&D would be in a URF at any site where it is proposed to construct a GDF. The URF could share access with the GDF but should be constructed so as to avoid interaction with it. The URF would be used prior to the start of waste emplacement and for as long as necessary while the GDF is open. It could, for example, hold dummy waste packages that could be retrieved for detailed inspection, or be used to develop and test post-closure monitoring techniques.

5.47 The R&D to be carried out in a URF before waste emplacement begins must be clearly specified, discussed with a wide range of stakeholders, including the host community and researchers independent of the NDA, and agreed with regulators. It is important to allow sufficient time to carry out the R&D, and to process and assimilate the results, before a decision is taken to construct the GDF. All those involved in the geological disposal programme need to be aware that the R&D may take decades.

5.48 Until a site-specific URF is available in the UK, there will need to be increased participation in generic R&D programmes in underground facilities in other countries. This would enable UK researchers to gain experience and to develop techniques for use in this country, as well as providing additional knowledge for the UK's geological disposal programme.

5.49 Other countries that are investigating the feasibility of geological disposal have carried out underground R&D, either at prospective disposal sites or in separate facilities in similar geologies to such sites. The international consensus is that underground R&D helps to increase public confidence. Carrying it out at a prospective disposal site will be more cost effective than establishing a separate URF in a similar geological environment.

5.50 RCUK (Section 3) has the ability to fund, or part-fund directly, large scale research facilities. Examples of generic large-scale facilities are aircraft, ships and large data sets. It is possible that RCUK could contribute to the funding of a URF, particularly supporting provision of infrastructure or equipment, or access to underground facilities, for fundamental research.

6. SOME R&D ISSUES

6.1 R&D carried out over the last few decades in the UK and other countries has produced a substantial body of knowledge about the conditioning, packaging, storage and geological disposal of higher activity wastes. This knowledge base is sufficient to support the choice of long-term management methods for these wastes. In particular, CoRWM is convinced that enough is currently known about geological disposal to engender confidence that it is the right way forward. However, there are still uncertainties that need to be addressed and knowledge gaps that need to be filled before it can be implemented at a specific site in the UK. Further information is also required as input to detailed decisions on the conditioning, packaging and storage of the UK's higher activity wastes. R&D over the next few decades must focus on these uncertainties and gaps in knowledge.

6.2 During the course of its work in 2008 and 2009, CoRWM became aware of a number of specific topics which it believes may require significant R&D. Details of these topics are given in Appendix A. In this section CoRWM highlights key points arising from its examination of these topics. The Committee's consideration of specific topics was by no means exhaustive but serves to illustrate the nature and extent of some of the key issues. It is not in CoRWM's remit, nor does it have the resources, to cover all issues in detail.

Key Points on Waste Conditioning, Packaging and Storage R&D

ILW Product Lifetimes

6.3 CoRWM is concerned about the level of R&D effort being devoted to determining the lifetimes of ILW wasteforms. Given the number and diversity of ILW packages that will be produced over the rest of the lifetime of the UK's nuclear sites, and the potential significance of wasteform performance for transportability and disposability, the effort being devoted to resolving uncertainties over product lifetimes does not seem to be sufficient. NDA's UK storage review (NDA, 2009d) identifies the existence and nature of this problem but gives no indication that there will be substantial further R&D.

Graphite

6.4 If immobilised and packaged in similar ways to other ILW, bulk graphite would occupy a great deal of space in a GDF. It is therefore important to explore treatment options that would reduce the volume of graphite for geological disposal. Current graphite R&D is being carried out under the 4-year EC Carbowaste programme. NDA is taking the lead on UK strategy development for graphite, with support from its Magnox SLCs and involvement of British Energy. CoRWM understands that the IAEA is also establishing a Co-ordinated Research Project on graphite. This is to be welcomed because it will enable a wider range of countries to share expertise and ideas. There may also be a need for bilateral co-operative approaches.

Management of Spent Fuels

6.5 There are several topics on which R&D is likely to be needed in order to develop reference and contingent strategies for the management of spent fuels. These include:

- drying Magnox fuel, prior to dry storage
- encapsulation of Magnox fuel for geological disposal
- drying AGR fuel, prior to dry storage
- conditioning and packaging of AGR fuel for geological disposal
- conditioning and packaging Sizewell B PWR fuel for geological disposal.

6.6 R&D on some of these topics is in hand but some have yet to be addressed. It is anticipated that work on management strategies for "exotic fuels" and for submarine fuel will lead to the identification of a number of R&D needs.

Key Points on Geological Disposal R&D

Radionuclide Migration with Groundwater from a Closed GDF

6.7 If predictions of radionuclide migration with groundwater are to be reliable they need to be based on a good understanding of the mechanisms involved. This requires, for the key radionuclides, advances in knowledge of:

- the physico-chemical forms of the radionuclides
- the spatial variability, temporal evolution and reactivity of mineral surfaces
- upscaling molecular level models to estimate bulk chemical properties and predict transport over hundreds of metres.

Gas Generation and Migration in a Closed GDF

6.8 Gas generation and migration are of particular importance to geological disposal in the UK because of the high volumes and diverse nature of higher activity wastes, and the volumes of groundwater that could be present in a closed GDF after resaturation. The bulk gases of concern are hydrogen and methane. BGS is the lead researcher in the EU FORGE project and is supported in this by the NDA. This is a good example of working with the international community on an issue of particular relevance to the UK.

Criticality in a Closed GDF

6.9 Previous UK work on criticality in a closed GDF has focused on ILW, for which the criticality hazard appears to be low. The hazard for spent fuel and/or plutonium is higher and requires rigorous assessment for the purposes of safety case development and optimisation of GDF design. The assessment of criticality hazard is demanding, requiring knowledge of wasteform performance, nuclear physics data, fissile material migration in the GDF environment, and neutron transport modelling. In the absence of specific information on the GDF, wasteforms and inventory, the primary need for research into criticality is to preserve and develop UK capability and make the most use of work carried out in countries that have been working on geological disposal of spent fuel for many years.

Co-Location of Various Types of Waste in a GDF

6.10 There are several issues on which research is likely to be required to inform a decision on whether it is preferable to have one GDF in which all higher activity waste is co-located or two (or more) GDFs for different types of higher activity wastes. These issues include: the potential for and extent of cement-bentonite

interactions, the impact of highly alkaline waters on HLW, the effects of thermally-driven circulation on performance of the ILW disposal system, and the impact of gas generation in the ILW/LLW part of a GDF on groundwater movement in the HLW/spent fuel part.

GDF Design

6.11 CoRWM recommended (CoRWM doc. 2550) that there should be an integrated process for GDF design, site assessment and safety case development. Such a process is likely to highlight areas of uncertainty in relation to design development, detailed design and assessment of design performance throughout the operational life of a GDF. For example, R&D may be required at the concept development stage to understand the impact that co-location will have on GDF design. At the detailed design stage the site specific response of the rock mass to construction activity will need to be understood and the long-term stability of all underground openings will need to be established.

Geosphere Characterisation

6.12 Surface-based characterisation will be undertaken during Stage 5 of the MRWS site selection process and underground characterisation during Stage 6. The NDA is carrying out a Geosphere Characterisation project that aims to develop and maintain an understanding of the approaches to the design and implementation of the investigations (both surface and sub-surface) that will be required and to prepare for such work.

6.13 The project has not yet concluded but areas have been identified that, CoRWM considers, would benefit from R&D. For example, R&D may be required to define the chemical descriptions and models for the near field, geosphere and biosphere and in the definition of models of site-scale hydrology, hydrogeology and paleohydrogeology. As the project progresses other topics for R&D will be identified. It is unclear, to CoRWM, whether R&D needs identified from this project are progressing or are being planned, or whether the skills and resources have been identified to undertake the work.

Microbiology

6.14 Microbial processes are poorly understood and may impact on the performance of a GDF. Whilst many aspects of a GDF's microbial ecology will be site specific, there is a need to build capability to conduct site specific R&D and it is desirable to carry out generic research in advance of site specific studies. It is necessary to develop UK capability in techniques for the sampling and characterisation of subsurface microbial communities, which are technically difficult. Generic research areas could include the ecology of high pH, anaerobes and thermophiles and the ecology of radioactive, hydrogen-rich systems.

Geosphere Evolution

6.15 Over the lifespan of a GDF there will potentially be significant changes in groundwater chemistry, regional groundwater gradients, rock hydraulic properties, geochemical properties (including mineralogical surfaces for adsorption), mechanical loading, microbial ecology and sea level. To reduce uncertainty in model predictions of physical, chemical and microbiological geosphere evolution there is a need for further research to develop fundamental

process-based models. Further, to validate such models, new field analogues should be sought that illuminate the role of individual processes in geosphere evolution and are applicable to the timescales appropriate for geological disposal of higher activity wastes.

7. CONCLUSIONS AND RECOMMENDATIONS

Strategic Co-ordination of UK Radioactive Waste Management R&D

7.1 CoRWM considers that there is a need for more strategic co-ordination of R&D for the management of higher activity wastes throughout the UK. This strategic co-ordination is required within NDA (including its SLCs), between NDA and other parts of the nuclear industry (including MoD), amongst the Research Councils, and between the nuclear industry, its regulators and the Research Councils.

7.2 Within NDA the need is for more strategic co-ordination of R&D carried out by its SLCs, RWMD and within its DRP. It is particularly important to co-ordinate RWMD's R&D for implementation of geological disposal with SLC and DRP R&D for waste conditioning, packaging and storage and on the management of spent fuels, plutonium and uranium that may be declared to be wastes. The lack of such co-ordination would lead to a poor use of the NDA's resources (effort, time and money).

7.3 Between NDA and the nuclear industry there is a need for strategic co-ordination of R&D and agreement on national priorities. As well as enabling better use to be made of resources, this would ensure that key issues are tackled in a timely way.

7.4 Of the five Research Councils that could potentially fund research relevant to the management of higher activity radioactive wastes, only two are doing so at present and only one at a substantial level. The Research Councils do not seem to have recognised the need to come together to identify the fundamental research required to underpin the MRWS programme. They should work together in an open and transparent way and involve prospective researchers in all the relevant fields, as well as the nuclear industry and its regulators. All these stakeholders should agree national priorities for the research to be funded by the Councils. This will maximise the benefits of the Research Councils' resources to the MRWS programme.

7.5 CoRWM does not wish to be prescriptive about the co-ordination mechanisms to be used in any of these cases. However, it has identified a number of attributes it thinks the mechanisms should have in all cases. These are that the mechanisms should:

- cover the R&D needs of all the relevant UK organisations
- be open and transparent
- involve researchers, the nuclear industry, its regulators and other stakeholders
- agree national priorities for R&D
- encourage innovation
- foster collaboration with other countries
- ensure R&D is carried out in a timely manner
- involve independent national and international review
- ensure R&D results are disseminated and acted upon.

7.6 In CoRWM's view no single existing body, as presently constituted, is capable of overseeing the necessary strategic co-ordination mechanisms. Either several bodies would need to work together or an existing body would need to be augmented in order to fulfil the oversight role.

7.7 It is essential that future UK R&D programmes for the management of higher activity wastes contain sufficient fundamental research, as well as applied research and development. In deciding which R&D to fund and when, account should be taken of the needs of the overall programme for the management of higher activity wastes, the needs for safety case development and the lead times and durations of R&D projects.

Recommendation 1

CoRWM recommends to Government that it ensures that there is strategic co-ordination of UK R&D for the management of higher activity wastes. Such co-ordination is required within the NDA, between the NDA and the rest of the nuclear industry, amongst the Research Councils and between the whole of the nuclear industry, its regulators and the Research Councils.

Regulatory Research

7.8 HSE has a responsibility to ensure that appropriate nuclear safety research programmes are carried out, including nuclear safety research related to the management of higher activity waste. It has a well-established mechanism for fulfilling this responsibility. HSE commissions its own research and sets out the research topics that nuclear site licensees should address.

7.9 EA and SEPA have relatively modest research programmes on topics of regulatory interest in the areas of radioactive waste management and related health and environmental protection issues. CoRWM believes that EA will need to commission more independent research as the MRWS programme proceeds in order to carry out its role as a regulator of geological disposal of higher activity wastes. CoRWM also expects that SEPA will need to commission research to assist it in the regulation of the management of higher activity wastes in Scotland.

Recommendation 2

CoRWM recommends to Government that it ensures that the Environment Agency and the Scottish Environment Protection Agency obtain the resources that they need to access and commission the additional independent research required to support them fully in their regulation of the management of higher activity wastes.

R&D Skills to Support the MRWS Programme

7.10 The importance of maintaining nuclear skills in the UK was recognised some years ago and steps have been taken to reverse the decline that was occurring. In recent years there has been a significant improvement but there is some way to go, particularly for R&D skills.

7.11 CoRWM has found that responsibility for the provision of R&D skills is split between many organisations. Although each organisation is playing its part, there seems to be a lack of national leadership and strategic direction. CoRWM thinks that this would be best rectified by assigning to a single organisation the responsibility for providing this leadership and direction. This organisation should be capable of taking a clear overview of the R&D skills needs of the whole of the nuclear industry, existing and new, civil and defence. CoRWM believes that the Cogent Sector Skills Council, with additional expertise, could fulfil this role.

Recommendation 3

CoRWM recommends to Government that it assigns to a single organisation the responsibility for providing national leadership and strategic direction for provision of R&D skills relevant to the long-term management of radioactive wastes.

Infrastructure Required for R&D – Facilities for Research with Highly Radioactive Materials

7.12 CoRWM considers that the UK's existing facilities for research with highly radioactive materials are inadequate and in need of improvement. In addition, new facilities need to be established in order to support the full spectrum of research relevant to the management of higher activity wastes, including geological disposal.

7.13 Almost all of the existing facilities for research with highly radioactive materials are operated by NNL. There are plans to widen access, but at present the only R&D that can be performed in these facilities is that funded by NNL customers, primarily the NDA and other nuclear industry organisations. It is essential that funders and providers of fundamental research can access the facilities they need in order to contribute to R&D for the management of higher activity wastes, both now and in the future.

Recommendation 4

CoRWM recommends to Government that it ensures that facilities for research with highly radioactive materials are improved and their capability enhanced so that they can be used for the full spectrum of research relevant to the long-term management of higher activity wastes. These facilities should be accessible to all researchers who need them.

Infrastructure Required for R&D – Underground Research Facility

7.14 Underground investigations will be needed at the site of any proposed GDF in the UK. These investigations need to include both underground site characterisation work and underground R&D if they are to provide sufficient input to GDF design and safety case development. CoRWM is of the view that this R&D should be carried out in a URF at any site where it is proposed to construct a GDF.

7.15 An R&D programme should be carried out in the URF prior to the decision as to whether to proceed with GDF construction. This programme should be discussed with a range of stakeholders, including the community local to the site and

independent scientists, and agreed with regulators. The geological disposal programme should allow time to carry out the required R&D and to disseminate and assimilate its results. It should be recognised that this underground R&D may take decades. The URF should continue to be used for as long as is necessary while the GDF is open.

7.16 Until a URF is available in the UK, generic R&D should be carried out in underground facilities in other countries. This would allow UK researchers to gain the necessary experience, as well as providing information and techniques to be used in the UK geological disposal programme.

Recommendation 5

CoRWM recommends to Government that an underground research facility be constructed at any site where it is proposed to construct a geological disposal facility.

Public and Stakeholder Engagement for R&D

7.17 At present, as in the past, stakeholders who are outside the organisations that fund and carry out R&D have little opportunity to influence UK R&D programmes on radioactive waste management. There is a general lack of transparency in establishing R&D requirements and commercial reasons are often cited as a reason for not publishing results.

7.18 CoRWM believes that this situation must change. As implied in Recommendation 1, a wider range of stakeholders should be involved in establishing R&D requirements. It is also necessary to make accessible information available to the public about R&D needs, progress and plans.

Recommendation 6

CoRWM recommends to Government that mechanisms are put in place to ensure that a wider range of stakeholders than to date will be involved in establishing R&D requirements for the long-term management of higher activity wastes and that accessible information will be made available to the public about R&D needs, plans and progress.

Specific R&D Issues

7.19 In addition to arrangements for providing R&D and the skills and infrastructure needed for it, CoRWM also considered some of the topics on which further R&D is likely to be required for the long-term management of the UK's higher activity wastes. In doing so it recognised that future R&D programmes will need to build on the substantial body of knowledge that already exists as a result of past R&D in the UK and other countries. This current knowledge base is sufficient to be confident that geological disposal is the right way forward. In future R&D it will be necessary to focus on knowledge gaps and uncertainties that are important for UK wastes and, in the case of geological disposal, for the types of rocks in which a GDF may be located. The results of CoRWM's consideration of specific topics are in Section 6 and Appendix A. CoRWM did not attempt to identify, consider or prioritise every topic on which R&D may be needed. The material in Section 6

and Appendix A is only intended to illustrate the range of R&D that could be required over the next few decades.

APPENDIX A EXAMPLES OF R&D ISSUES

A.1 As highlighted in paragraphs 6.1 and 6.2, a substantial body of knowledge exists about the conditioning, packaging, storage and geological disposal of higher activity wastes. This knowledge base is sufficient for CoRWM to be confident that geological disposal is the right way forward. During its work CoRWM became aware of a number of topics, given in this Appendix, which it believes may require significant R&D. This list of topics, while extensive, should not be taken as a reason for not proceeding with geological disposal. It simply highlights that there are still uncertainties and knowledge gaps, inevitable in such a large undertaking, which will need to be addressed by further R&D.

Waste Package Specifications, Post-Closure Safety and Retrievability

A.2 The waste package specifications used by the NDA were developed by Nirex and are closely linked to its concepts for geological disposal of ILW (Nirex, 2007). The post-closure safety cases for these concepts did not take any credit for the waste container or the physical durability of the waste form. However, they assumed cementitious waste forms and took into account a contribution of these to the alkaline environment which would exist within a disposal facility, largely as a result of the cementitious backfill. The package specifications now include a target container life (500 years) and target time for the waste form to retain its integrity (200 years) based on storage, emplacement in a GDF and the potential for the GDF to remain open for a few hundred years with waste packages readily retrievable (NDA, 2008a). Post-closure safety is dealt with in the LoC process by assessing whether the proposed waste form will be compatible with the assumed cementitious backfill, rather than by explicit specifications. This lack of a clear link between the safety case and the waste package specifications causes confusion and makes it difficult to specify R&D requirements on the behaviour of waste packages after disposal.

A.3 In the IoP Storage meeting (CoRWM doc. 2519) the issue of the impact of the need for retrievability on R&D programmes was emphasised. However, like the issue of store lifetime, the lack of clarity on retrievability makes defining R&D programmes difficult for those in the industry. In its 2006 recommendations CoRWM made it clear that it did not see retrievability as a necessary prerequisite of any geological disposal concept for the UK's higher activity wastes. However, Government decided (Defra *et al.,* 2008) that host communities should have a role in deciding on the time for which a GDF is designed to remain open, with waste packages retrievable.

A.4 NDA waste package specifications are currently based on an assumption that retrievability may be needed for up to 300 years. This leads to a target container life of 500 years. Demonstrating this target could be met would require considerable R&D. It is thus important to clarify the status of the target. This in turn requires an examination of the technical implications of retrievability. In addition, earlier waste packages have been prepared to different, less stringent specifications, and it is uncertain whether these will comply with the newer, more demanding specifications.

Current and Planned R&D for ILW

A.5 In CoRWM's meetings with NDA, NNL, SLCs, other waste producers, regulators and others it has been made aware of some topics that are, or it believes should be, the focus of R&D programmes for ILW. CoRWM has some concerns that the 2006 NDA Needs, Risks and Opportunities in R&D document (NDA, 2006a) does not address conditioning, packaging and storage of ILW to the extent that is now appropriate. It hopes the version currently in preparation will cover these issues in this section of Appendix A in more detail. Documents that proved useful in preparing this section include the NDA's Review of UK Storage Related R&D (draft seen by CoRWM) and Nexia Solutions (now NNL) Review of the Current Status of Underpinning R&D Relating to ILW Package Longevity (Nexia, 2007). The latter report is based on a meeting of interested groups including EA, SEPA, Nirex, UKAEA, BNGSL, Magnox SLC and Nexia Solutions which was chaired by the NDA and is an example of good practice in terms of bringing all relevant stakeholders together.

ILW Containing Reactive Metals

A.6 After about 15 years of storage localised surface bulges have been observed on Magnox Encapsulation Plant (MEP) drums containing reactive metals (EA, 2008). Since these anomalies were discovered the regulators have required Sellafield Ltd to investigate what caused them to appear, as input to determining whether remedial action is required. The original LoC for the MEP drums took full account of the likely corrosion of Magnox metal in the drums during storage and contained a caveat about the uranium content of the drums. The bulges are thought to be a result of the presence of large (kilogramme-sized) pieces of uranium in the drums and operational procedures have been changed to prevent this in future. Work is continuing to confirm the causes of the bulges and assess their significance (CoRWM doc. 2464; NDA, 2008a).

A.7 Questions of wasteform durability are described within SLC TBuRDs, for example 35185 Encapsulated ILW Drum Storage and 35125 Magnox Waste Encapsulation in the Sellafield TBuRD. It is stated explicitly in the Sellafield TBuRD "This strategy covers encapsulation and safe storage of ILW products produced by consignor plants on the Sellafield site up to the point at which a disposal route becomes available".

A.8 In the context of a 500-year target lifetime for the waste container (CoRWM doc. 2389), both measurement of "store corrosivity" and quantitative assessment of "waste package degradation" are very challenging, not least because there is no current consensus on those parameters which need to be measured, and there will be a need to measure non-linear processes which give rise to very small changes and operate at very slow rates. A required element of the safety cases for storage and disposal will be a well-founded predictive model for waste package behaviour. Due to the long timescales, CoRWM believes that any such model will need to be derived from a process-based, mechanistic understanding; extrapolation from empirical data is unlikely to be sufficient. Currently, this required level of mechanistic understanding does not exist for UK waste packages.

Graphite

A.9 The UK has a large volume (about 86,300 tonnes of ILW equivalent to a raw volume of about 73,000m^3) of graphite that is activated or contaminated. This has implications for the geological disposal programme due to the large space the graphite would potentially occupy in any GDF unless waste volume minimisation technology is applied. Options for graphite treatment, reuse and disposal have been discussed at several recent workshops (Norris *et al*., 2007; NDA, 2006b). Apart from its volume, a key concern with this waste is that it contains significant quantities of the potentially mobile and relatively long-lived radionuclides carbon-14 and chlorine-36. Since geological disposal of the current volume of graphite may not be the optimal route, R&D is being undertaken to identify the better solutions. The options being considered for bulk reactor graphite are:

- Treat all graphite waste as ILW and ensure the GDF caters for the large volumes of material. This is the baseline option.
- Condition graphite waste to remove the long-lived radioisotopes and dispose of the residual graphite at LLWR or an alternative near-surface disposal facility.
- Condition LLW and/or ILW graphite waste to remove most of the contamination and free release or reuse the graphite where possible.
- Separate disposal facility (or facilities) for graphitic wastes, including a near-surface disposal option.
- Interim store ILW graphitic wastes and condition for either LLW disposal or free release.

A.10 Current graphite R&D is being carried out under the 4-year EC Carbowaste programme. The NDA is taking the lead in UK strategy development for graphite, with support from its Magnox SLCs who are optioneering potential treatment and disposal options for irradiated graphite for NDA. Currently, the reference position in the UK for the disposal of graphite is geological disposal. The reference position in France is underground disposal at depths of between 15 and 200 metres, though preliminary investigations by CEA that indicated potential for migration of chlorine-36 have led to a recommendation for disposal at depths of greater than 100 metres in thick mudrock. Russia also has a major interest in the disposal of graphite and Spain and Italy have graphite reactors. CoRWM understands that the forthcoming IAEA Co-ordinated Research Project on graphite will bring all these countries together to share expertise and ideas. There may also be a need for bilateral co-operative approaches, for example between the UK and France.

Other Planned ILW R&D

A.11 The NDA's 2006 Needs, Risks and Opportunities document (NDA, 2006b) identified some key issues for R&D. For ILW these included increasing the ratio of waste to cement, improving grout percolation through waste and reducing the difficulties of reactive metals. Other needs highlighted included alternative (but cheap and room temperature) matrices for ILW wastes that currently are reacting with cement, an understanding of the long-term behaviour of stored wastes so minimising degradation, and remedial action on stored sea dump drums. In addition the Review of the Current Status of Underpinning R&D Relating to ILW Package Longevity (Nexia, 2007) identified issues including: failure criteria,

wasteform integrity at end of storage period, overpack strategy and reworking, reactive metals, alternative options to encapsulation and alternative containers (materials/design).

A.12 CoRWM believes that R&D into remedial action on failed or out of specification packages should be addressed as a priority. Options have been examined in a review by EA (EA, 2005). NDA has also carried out some work on overpacking (NDA, 2008a), as have Magnox sites (McHugh, 2008).

Steel Corrosion

A.13 A recent review of the long-term behaviour of the steels used for ILW storage containers (Lyon, 2008) supports the general assertion that the current container materials (typically 316L and some 304 austenitic stainless steels although some early drums were mild steel) will last suitable (500 year) timescales if manufactured appropriately and stored in controlled atmospheric conditions. However, there were concerns that limited overall confidence including container material specifications, manufacture and failure criteria; aspects of internal and external corrosion; and the nature of the desired storage atmosphere. A specific concern is the ability of current steels to resist atmosphere assisted stress corrosion cracking (ASCC) which is exacerbated by the saline atmospheres prevalent at many UK storage locations.

A.14 Current research is focused on using high performance duplex alloy (mixed austenite and ferrite) stainless steels which are more resistant to ASCC. Currently, there is no national programme of developing a single best (in terms of corrosion resistance, cost and ease of fabrication) container material and different nuclear site licensees use different steels. Other key drivers in container development (CoRWM doc. 2386) are to match the container to the wasteform it contains (so high risk wastes can be packaged in a more robust container), matching containers to the store and eventual GDF environment and standardising and simplifying container design. In addition failure criteria for the containers are not well established making it difficult to develop a safety case since, in principle, any microscopic pinhole constitutes failure.

High Temperature Conditioning Processes

A.15 To date, high temperature conditioning processes have not been used in the UK for ILW. They are used in Europe and have the advantage of producing durable waste forms with low volumes. Interest in such processes has increased recently. For example, British Energy is considering hot pressing for the Sizewell B ion exchange resins (CoRWM docs. 2419, 2489), and Sellafield is considering thermal treatment for SIXEP sand, clinoptilolite and sludge (NDA, 2008a). These investigations of alternatives to encapsulation in cement are timely.

Storage Systems

A.16 An issue in storage systems is the balance between the contribution of the store building and that of the container. Some stores (*e.g.* the EPS1 store at Sellafield) are massive and provide the radiation shielding for the packages they hold but are expensive. Alternatives are simpler weatherproof store buildings with self-shielded containers, such as mini store systems, inside. The mini store concept in which ILW waste is stored in robust, thick-walled, self-shielding cast iron

containers is one of several which may offer more flexibility in terms of storage and disposal options but it is at an early stage of development in the UK context. Other research and development issues for storage systems brought to our attention in meetings with NDA, SLCs, British Energy and at the IoP Storage R&D meeting (CoRWM doc. 2519) include:

- Especially for older existing stores, how do we make better predictions of their lifetimes, how can ventilation systems be improved, how can conditions in the store be better monitored and better arrangements be introduced for inspecting waste packages?
- For future stores, who is performing R&D on the newer mini-store concept now being considered?
- If Scotland plans extended near-site, near-surface storage as an option in its own right then R&D will be needed to develop appropriate concepts and detailed designs.

A.17 The first point is highlighted in paragraphs 3.36-3.38 of the CoRWM Interim Storage report (CoRWM doc. 2500) which covers the lack of suitable atmosphere control in some older stores. This has led to waste container corrosion that is faster than that envisaged when the LoC was issued, due in large part to salty coastal atmospheres. As a result it is more likely that remedial action (*e.g.* overpacking will eventually be needed prior to waste transport and disposal. There is a need to assess options for improving ventilation systems and for monitoring atmospheric conditions in stores where such conditions exist or could occur in future. It is also essential that new storage systems are designed with appropriate ventilation and atmosphere monitoring provisions. They should also have appropriate arrangements and regimes for monitoring and inspecting waste packages. The industry recognises it is not able to carry out more than very limited inspection on ILW packages in some stores and that R&D is required to develop remote monitoring and inspection techniques (CoRWM doc. 2630). Some of these points are recognised in the NDA UK storage review (NDA, 2009d).

A.18 Further R&D is needed to demonstrate that existing stores will achieve the design lives claimed for them and to assess whether these lives can be extended, and if so by how much. If controlled atmosphere stores are to be required for many decades, R&D into atmosphere-independent packages (such as ceramic overpacks) may be needed. The option of using of such packages could then be compared with the controlled atmosphere option.

Management of Spent Fuels

A.19 The existing and committed UK inventory of spent or used nuclear fuels can be divided into categories depending on type and source. The categories are: Magnox fuel, advanced gas cooled reactor (AGR), pressurised water reactor (PWR) fuel, “exotic” fuels and MoD fuels. The current management strategy for each is summarised below along with the related current and planned R&D and areas in which further R&D is likely to be needed are highlighted. An option related to the long-term management of spent fuels that is rapidly gaining favour is dry storage and R&D issues connected to this are also identified below.

Magnox Fuel

A.20 Magnox fuel consists of uranium metal in a magnesium-alloy cladding. The NDA's current strategy, as embodied in the Magnox Operating Plan, MOP8 (NDA, 2009e) is to reprocess all spent Magnox fuel. The UK Inventory indicates that around 5,800 tonnes (heavy metal, tHM) of Magnox fuel remains to be reprocessed (Defra/NDA, 2008b). Some of it is in operating reactors, some in temporary dry storage in shut-down reactors and in the Wylfa dry store, and the rest is stored under water, mainly at Sellafield. The reprocessing strategy is contingent upon the Sellafield Magnox Reprocessing Plant continuing to operate until all Magnox spent fuel that can be reprocessed has been. Given the elderly nature of the Magnox Reprocessing Plant, considerable effort and resource is being expended on keeping it operating but the possibility of chronic or acute failure before reprocessing is completed (currently projected as 2016) must be considered (CoRWM doc. 2520).

A.21 Accordingly, contingency plans for any un-reprocessed Magnox fuel are required (CoRWM doc. 2520). The NDA is investigating these (NDA, 2008d; CoRWM docs. 2418, 2500, 2624) along three principal lines, namely:

- *Reprocessing through the Thermal Oxide Reprocessing Plant (THORP)* with the recovered uranium and plutonium and the associated HLW being managed in the same way as other THORP products. This would be difficult and costly, entailing modification to the THORP head end, and would require significant R&D for the necessary adaptations of the THORP process. It would also disrupt and prolong the THORP programme. For these reasons this option is currently 'shelved' by the NDA.
- *Dry storage followed by geological disposal.* This necessitates drying the spent fuel before placing it in one of the preferred forms of dry storage (para A.34). An issue is how dry to make the fuel. There is at present no capability in the UK for drying spent fuel of any kind on a large scale but there is considerable experience in other countries. The work at Hanford in the USA, where metal fuels have been successfully dried as a prelude to dry storage and eventual disposal, is of relevance to Magnox fuel. Although the Hanford process has been shown to be viable, even for seriously corroded fuel elements, it is unlikely it could be transferred to the UK for Magnox fuel without substantial R&D (CoRWM doc. 2520). The Hanford experience is with smooth zircaloy clad metal fuel. In contrast, Magnox fuel cladding has large fins which result in a much higher surface area. Magnox fuel cladding is considerably more reactive than zircaloy and hence is much more susceptible to corrosion in water. In addition, carbonaceous deposits, which may be particularly difficult to dry out, are often found on Magnox fuel. Due to the potential for continued reactivity of uranium metal further R&D would be needed on packaging the dried product for storage and geological disposal in a UK facility (CoRWM doc. 2500). Our understanding is (CoRWM docs. 2418, 2523, 2624) that the NDA is funding some R&D into the drying of Magnox fuel and into packaging it for disposal, and will evaluate this option shortly with a view to pursuing it further.
- *Encapsulation in preparation for interim storage and geological disposal.* Experience with encapsulation of relatively small amounts of reactive metals such as uranium has shown that existing cement formulations would not be

suitable for uranium metal fuels. It would thus be necessary to carry out a substantial (and successful) programme of R&D into new encapsulants, such as polymers, glasses and alternative cements, before this option could be pursued. This would need to include R&D to demonstrate that the selected encapsulation system was suitable for geological disposal.

A.22 Even in the event that the reprocessing strategy proceeds to 'completion', it is inevitable that there will be some spent Magnox fuel that cannot be reprocessed (Defra & NDA, 2008a). In particular, the corroded and degraded fuel from the legacy ponds and silos at Sellafield (CoRWM docs. 2418, 2520) will have to be treated as waste. R&D is in progress on suitable conditioning and packaging options for legacy ponds and silos waste, in parallel with the development of methods to retrieve it (CoRWM doc. 2520; NDA, 2008a). Reducing the hazards associated with the Sellafield legacy ponds and silos has been identified as a matter of urgency by the regulators and NDA has prioritised funding to undertake the necessary work as quickly as possible (NDA, 2009a, d).

AGR Fuel

A.23 AGR fuel consists of low-enriched uranium oxide pellets in stainless steel cladding with graphite sleeves. For management purposes it is divided into two tranches, referred to as "historic" and "new" (CoRWM doc. 2419). The former includes all AGR fuel loaded into reactors on and before 14 January 2005 and the latter all fuel loaded after that date. The historic AGR fuel is the property of British Energy and about three quarters of it is contracted for reprocessing through THORP with the rest contracted to the NDA to store or reprocess at their discretion. The new AGR fuel, including any arising from extensions of AGR lifetimes, is contracted to the NDA to manage as they see fit.

A.24 For economic reasons, it is unlikely that THORP will continue operation beyond its baseload reprocessing (due by 2015) and it is predicted that between 5,500 (Defra/NDA, 2008b) and 7,000 (CoRWM doc. 2520) tHM of AGR spent fuel will remain in storage at Sellafield. The current plan for AGR spent fuel is essentially for it to remain in pond storage. Apart from capacity issues, this is not a satisfactory long-term strategy and it is incumbent upon the NDA to develop an alternative.

A.25 AGR spent fuel is stored in ponds at Sellafield. Some of it is in the THORP Receipt and Storage pond alongside (overseas owned) light water reactor (LWR) spent fuel and a large number of empty multi-element bottles. The pond water chemistry cannot be kept sufficiently alkaline to prevent corrosion of the steel cladding on the AGR fuel and there is a risk of leakage into the pond water. Sellafield Ltd has introduced short-term measures to manage the situation, including the prioritisation of reprocessing for corroded AGR fuel (CoRWM docs. 2386, 2520) and work is in progress to find a longer-term solution.

A.26 In response to the regulators, the NDA is developing an “oxide fuels strategy” (NDA, 2009d; CoRWM docs. 2418, 2520, 2624) in which it will set targets for how much of the remaining AGR fuel will be reprocessed and how and where the rest will be stored. The baseline plan is wet storage pending conditioning for disposal, with dry storage being looked at as an option. However, this would require drying of the fuel which has been stored under water. As with Magnox spent fuel, no

capability exists in the UK for doing this and a substantial programme of R&D will be needed in order to pursue the dry storage option.

A.27 There has been much R&D in other countries on the conditioning and packaging of LWR spent fuel for geological disposal but there are significant differences between these fuels and AGR fuel (CoRWM docs. 2480, 2520, 2533). It is of some concern that relatively little R&D has been undertaken into the conditioning and packaging of AGR spent fuel for geological disposal (*e.g.* CoRWM doc. 2520). NDA has investigated whether the Swedish KBS-3 concept could be adapted for this purpose and has identified R&D requirements for such adaptation (CoRWM doc. 2630). Another possibility worth investigating could be the encapsulation of AGR fuel pins in lead, as has been proposed (Gibb *et al.,* 2008) as a prelude to the geological disposal of LWR spent fuel pins. Other issues likely to be important include the type of canister to be used and the leaching behaviour of the fuel once it comes into contact with groundwater.

A.28 Without demonstrating that geological disposal of AGR spent fuel is feasible, AGR fuel strategies are incomplete. Given the amount of spent AGR fuel likely to require disposal and the fact that it is almost unique to the UK, it would be sensible to give AGR fuel priority in any NDA/RWMD R&D programme into the geological disposal of spent fuels, including transport to a GDF.

PWR Fuel

A.29 PWR fuel consists of low-enriched uranium oxide pellets in a zircaloy cladding. At present it is used in the UK only at Sizewell B, where the spent fuel is stored in the fuel pond. Over the scheduled 40-year lifetime of the reactor it is expected to generate around 1,200 tHM of spent fuel (Defra & NDA, 2008b), which remains the responsibility of British Energy. British Energy has no plans to reprocess Sizewell B spent fuel (CoRWM doc. 2489). It is currently seeking to increase the approved capacity of the Sizewell storage pond by re-racking but the potential for further increase is limited.

A.30 British Energy is currently investigating dry storage (CoRWM docs. 2419, 2489) with a view to having “dry cask” storage (para A.35) on site at Sizewell by 2015. Drying of PWR fuel is much simpler than drying Magnox or AGR fuel because of its robust zircaloy cladding. PWR spent fuel is dry stored in several other countries, particularly the USA, and British Energy sees an opportunity to buy into 'off the shelf' technology. A further issue relates to the fate of the stored spent fuel. There will need to be R&D on conditioning and packaging Sizewell B spent fuel for geological disposal, and this should take into account the extensive research carried out in other countries on geological disposal of PWR fuels.

Exotic Fuels

A.31 Metal, oxide and carbide fuels from a number of experimental and other reactors, such as the Windscale Piles and the Dounreay Fast Reactor (DFR) and Prototype Fast Reactor (PFR), are grouped together as ‘exotic’ fuels. Baseline plans for the management of these exist but are poorly underpinned by R&D (CoRWM doc. 2520) and the NDA is now developing an exotic fuels strategy (CoRWM doc. 2624). Dealing with such a wide range of materials is a complex problem and it is a matter of some urgency to identify the preferred options for

some of them, such as the DFR fuel, because they could involve utilising the Magnox Reprocessing Plant or THORP, both of which have limited life expectancy. DFR breeder fuel has been used as an example of the approach to be followed and the preferred strategy for it has been identified to be reprocessing in the Magnox plant at Sellafield (CoRWM doc. 2523). At present it is unclear which of the other exotic fuels can be recycled and which will have to be declared as waste (some, such as the Windscale Piles fuel, already have (Defra & NDA, 2008a)).

A.32 CoRWM agrees with the NDA that it is important to have plans for dealing with exotic fuels, so that plant, infrastructure and R&D requirements are clear (CoRWM doc. 2500).

MoD Used Fuel

A.33 Naval PWR fuel consists of zirconium-clad highly enriched uranium. The used fuel is stored under water at Sellafield on behalf of MoD, which regards it as an asset, but has no current plans for reprocessing or anything beyond the status quo. Reprocessing of such highly enriched fuel could prove difficult and could not be undertaken without a programme of R&D. The stored fuel is showing no evidence of corrosion so there is less urgency for decisions to be made compared to other forms of nuclear fuel; but it cannot remain in storage indefinitely. It is encouraging that the MoD is joining the NDA groups (such as the Strategy Development and Delivery Group and the Spent Fuel and Nuclear Materials Topic Overview Group) that deal with spent fuel management (CoRWM docs. 2523, 2500).

Dry Storage of Spent Fuels

A.34 Magnox and AGR fuels are designed for use in dry environments. They can only be stored underwater for limited periods because of the risk of corrosion and degradation. Control of the water chemistry can reduce these effects but is complex, especially where different types of fuel and other materials are present in the same pond. Dry storage is an alternative that is in use for spent fuels in a number of countries, especially for LWR fuels. It has also been used in the UK but only on a very limited scale and mostly for fuels that have not been previously stored in ponds (CoRWM doc. 2480). It is potentially cheaper than pond storage, minimises degradation and would be an appropriate precursor to geological disposal.

A.35 The spent fuel is dried, usually with hot air, and sealed into steel containers under an inert atmosphere (*e.g.*, helium, nitrogen). The containers are then stored either in modular concrete vaults (called 'silos' in the USA) or in free-standing casks of concrete, steel or other materials. Vault systems are substantial buildings, often partly below ground, in which the containers are stored in vertical tubes cooled by passive buoyant advecting air that does not come into contact with the spent fuel. These can be constructed in 2-3 years. An example of such a system is the Paks MVDS project in Hungary. Casks are large cylinders, usually of concrete and steel, and can be designed for vertical (more usual) or horizontal storage. They are cooled by convection and heat radiation from their outer surface and may be stood on outdoor dispersal pads (similar to a fenced car park) exposed to the elements in remote areas or inside a simple,

purpose-built building. The former is common in the USA but the latter would be more appropriate for the UK.

A.36 Although much of the dry storage technology could be bought 'off the shelf', especially from the USA, there are a number of significant R&D issues that would need to be addressed before it could be used in the UK for Magnox and AGR spent fuels. For AGR fuel, foremost among these are studies related to how dry the fuel needs to be in order to avoid corrosion of its steel cladding during storage and so be safely stored (and subsequently disposed of), and to potential drying processes (CoRWM docs. 2480, 2500, 2520, 2533). The former include studies of the fuel clad corrosion processes in the presence of residual moisture and under different 'inert' gases. USA experience of drying metal fuels and worldwide experience of drying LWR fuels is valuable but R&D specific to the UK's fuels is required.

Management of Plutonium

A.37 R&D into management of the UK's civil plutonium[22] stockpile has been an NDA priority since its inception and has, CoRWM believes, been an example of good practice which could be used as a model for future R&D programmes. It has involved collaboration between the NDA, NNL, universities and learned societies in a co-ordinated manner. The strong input from the Royal Society (Royal Society, 2007; CoRWM doc. 2374) has lent credibility to the programme as has participation in the EU-funded Euratom programme entitled Red Impact (Red Impact, 2007).

A.38 In 2008 the NDA issued a consultation paper on options for the management of plutonium and held two stakeholder workshops (NDA, 2008e). It used the results of the consultation and the workshops in preparing a paper on "credible options" for plutonium management that was submitted to Government, with supporting technical documents (NDA, 2009f, g, h, i). The 2009 NDA documents identify four high level strategy options for managing the UK's separated plutonium:

i) continued storage until 2120, then immobilise the plutonium in a suitable waste form and dispose of the waste in a geological facility
ii) immobilise the plutonium as soon as practicable, store the resulting waste, then dispose of it in a GDF when one is available
iii) sell or lease the plutonium for recycling, then dispose of the resulting spent fuel
iv) some combination of the above.

A.39 The NDA proposed that option (i) be adopted as the reference strategy for planning purposes, while further work is carried out to develop and assess the other options (NDA, 2009f).

A.40 To date the NDA has considered several immobilisation options for plutonium. These are use of a composite cement, use of a glass composite material, use of multiphase ceramics made *via* hot isostatic pressing or cold pressing and

[22] MoD also has holdings of plutonium. Any plutonium that is declared surplus to MoD requirements becomes part of the civil stockpile and is managed under civil arrangements, although it is still owned by MoD.

sintering, and making the plutonium into low specification MOX (either in a new plant that would make MOX assemblies or by modifying the Sellafield MOX plant to produce MOX in cans). The cement option is the most expensive but also the one with the largest variations in cost, depending on how much plutonium there is in each waste package. The NDA proposed to carry out a programme of work to assess the possible waste forms in more detail, particularly from the point of view of their suitability for geological disposal (NDA, 2009g, h).

A.41 So far, the NDA has not considered the option of recycling plutonium in UK reactors (either existing or new build). This is because a further "justification" exercise would be required to allow MOX fuel to be used in this country. The NDA has assumed in its analyses that recycling would occur in another country, either in an LWR or in a CANDU reactor (use of fast reactors was not considered "credible" at present, because of the long lead time.) The NDA proposed to undertake market engagement to gauge the level of interest in recycling plutonium. If the option seemed viable, the NDA would then need to discuss with Government the type of commercial arrangement that would be acceptable (NDA, 2009g, h). There would also need to be R&D on interim storage and geological disposal of MOX fuel. This R&D would be carried out by the countries using the MOX fuel.

A.42 Government intends to hold a public consultation on long-term management of plutonium starting in autumn 2009. As a precursor it is publishing two discussion papers.[23] NDA technical work on immobilisation options for plutonium is continuing. It is possible that the Government will make a decision on the preferred method for the long-term management of plutonium in early 2010 (UK Government, 2009).

Management of Uranium

A.43 The total UK civil holdings of uranium were 96,400 tonnes at the end of 2007. Almost all of this is depleted, natural and low enriched uranium. Less than 1.5 tonnes is highly enriched uranium (*i.e.* with 20% or more uranium-235). Future arisings are estimated to be about 90,000 tonnes of depleted, natural and low enriched uranium (Defra/NDA, 2008b). Uranium is stored in various locations and in many forms including as oxides, hexafluoride, nitrates, carbides and metal. The NDA is developing a strategy for managing its uranic materials and is considering both re-use and disposal options (CoRWM doc. 2418; NDA, 2009j). It has R&D in progress for immobilisation options for separated uranium.

A.44 "Hex tails" are uranium hexafluoride (UF_6) residue from the production of enriched uranium. The tails are depleted in uranium-235 to levels well below the 0.72% by weight (wt%) of natural uranium minerals, usually about 0.2 wt%. Uranium hexafluoride is a stable solid at room temperature and pressure but sublimes to a vapour at 56.5^{o}C. It also gives off hydrogen fluoride, which is hazardous, in contact with water or water vapour. Most of the UK's holdings of Hex tails are at Urenco UK Ltd Capenhurst site. Urenco plans to "deconvert" the Hex tails back to uranium oxide (U_3O_8), which is a stable solid, and store it

23 http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/issues/plutonium/plutonium.aspx

pending a decision on its long-term management. The technology for deconversion has been established in other countries. Urenco aims to build a Tails Management Facility (TMF) at the Urenco UK Ltd site at Capenhurst, consisting of a deconversion plant for Hex tails and a uranium oxide store. The planning application has been submitted and it is hoped that the TMF will start operations in 2014.

A.45 The uranium oxide could be reconverted to UF_6 if it became attractive to re-enrich it and sell it. Another option is to condition and package the oxide and dispose of it in a geological facility in the UK. CoRWM has been told that Urenco has applied for an LoC as part of the demonstration that such an option would be practicable. This will entail providing evidence that its proposed waste form would be suitable for both storage and disposal. Urenco is also supporting international work that is investigating the possibility of sending the uranium oxide back to the original producers of the ore, for disposal in exhausted uranium mines. This would require an international agreement on the transport of uranium oxide waste from the countries where it is held to the countries where ore is produced.

A.46 The Encapsulation of Metallic Uranium Steering (EMUS) Group predates NWRF (para 3.10) and was established by Sellafield Ltd. although many other SLCs participate. Its purpose is to ensure that current and future operations, which require metallic uranium conditioning for treatment, storage and disposal, have a sound technical foundation and to facilitate timely delivery of the plans of the SLCs for site clean-up. It shares information through NWRF, but it is not an official sub group.

A.47 There is a need for a UK uranics R&D strategy to include uranium held by organisations other than the NDA, such as the MoD and Urenco (CoRWM doc. 2520).

Management of Thorium

A.48 There are small amounts of thorium at various NDA sites (*e.g.* Dounreay, Winfrith). There is no market for thorium and the current strategy is to treat it as waste for geological disposal. This strategy is straightforward if the thorium is in oxide form (because the oxide is stable and insoluble). However some forms of thorium can be pyrophoric and may require conversion to a more stable form, such as the oxide for their long-term management. It is for the NDA sites to carry out R&D on the management of their thorium holdings (CoRWM doc. 2418). Winfrith plans to complete immobilisation of its thorium metal in 2009/10. Dounreay has liquid thorium nitrate, which will need to be converted to a solid for long-term storage or disposal. The site holds an LoC for the material and plans further R&D prior to its solidification.

Some Specific R&D Issues for Geological Disposal

A.49 CoRWM has neither the remit nor resources to identify all R&D required to underpin design and construction of a GDF and to develop the safety cases, which will be made to the relevant regulators. The safety cases will indicate how the GDF is anticipated to perform during the operational and post-closure periods and will demonstrate that regulatory requirements are met.

A.50 Information on what is needed in an environmental safety case (ESC) is given in the Guidance on Requirements for Authorisation (GRA) (EA & NIEA, 2009). The GRA states that an ESC should, *inter alia*:

- demonstrate a clear understanding of the GDF in its geological setting and how it will evolve over time
- include a clear outline of the key environmental safety arguments and say how the major lines of reasoning and underpinning evidence support these arguments
- make use of multiple lines of reasoning, based on a variety of quantitative and qualitative evidence, leading to complementary safety arguments
- explain how uncertainties have been considered
- include quantitative environmental safety assessments for the operational and post-closure periods
- be updated at each stage in the development of the GDF, at suitable intervals during its operation, and at closure.

A.51 CoRWM believes that both fundamental and applied research will be needed in order to develop a robust ESC.

A.52 While some international research, particularly that of a more fundamental nature, will be helpful to the UK's geological disposal programme, much of the required R&D will be site-specific and hence cannot be conducted until candidate sites are identified. However, there are a number of underpinning non-site specific areas, both applied and fundamental, where strategic investment in R&D is required. Many of these areas are well known and have been the subject of research programmes worldwide for many years (see *e.g.* MRS, 2008). Some of them are highlighted below but CoRWM also emphasises the differing and complex needs associated with the UK's diverse wastes and the fact that the geology in which a UK GDF will be located is not yet known.

A.53 While a range of detailed R&D issues are discussed below, CoRWM considers that enough is currently known about geological disposal from previous UK and international R&D programmes to engender confidence that it is the right way forward. The current state of the UK R&D scene in the areas discussed in this section was highlighted at a meeting supported by CoRWM at the University of Sheffield in April 2009 (CoRWM doc. 2619). Other issues which came up at the meeting include: prospects for deep borehole disposal as an alternative to mined repositories for HLW; the potential for crossover of knowledge from the oil, gas and mineral industries, including seismology and geophysics techniques for site characterisation; testing of modelling predictions; and assessing the characterisation of geological environments.

Migration (Sorption, Colloids and Water Flow)

A.54 After a GDF has been closed and sealed it will resaturate with groundwater. The waste containers will slowly corrode and the radioactive species will be released from the wasteforms. These radionuclides will then interact with their environment, which will include: in the near field, backfilling materials such as cement or clay and other minerals and rocks; the engineering and chemically disturbed zones around the GDF; the host rock; and the groundwater flowing

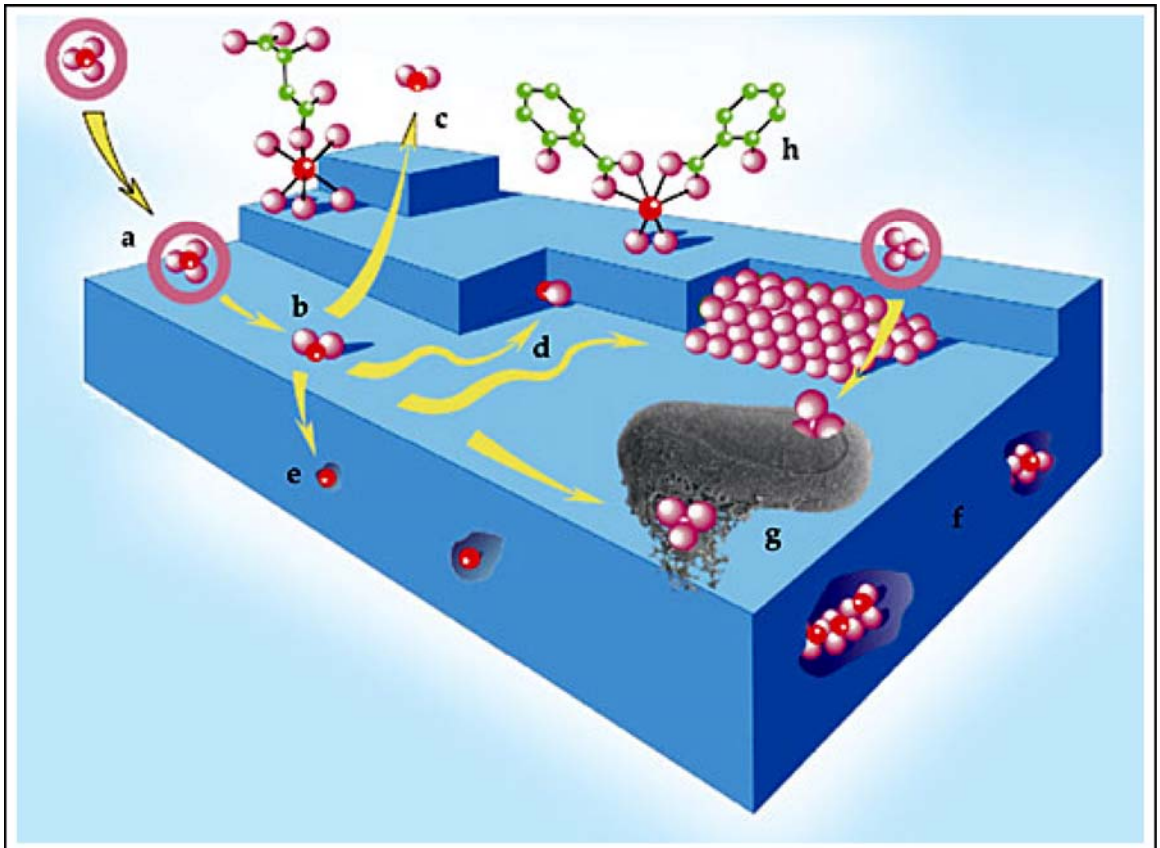
through all these. The nature of the escaping radionuclides will be complex since they may be dissolved in fluids, associated with small particles (colloids), or present in other forms. Their behaviour and their rate of migration to the far field depends on their ability to react with and become trapped on the various materials through which they pass (*e.g.* by sorption on available surfaces) and the water flow behaviour through the GDF. A review of the fundamental research required to advance geosphere understanding sufficiently to enable reliable radioactive waste disposal is provided by DePaolo and Orr (2008) who conclude that

> "*A deep understanding of the fundamental physical and chemical processes that control migration of chemical constituents underground is essential for safe and effective sequestration … of radioactive waste. Building that understanding will require a new generation of experiments and computational models… new laboratory and field techniques and perhaps most importantly, a continuing supply of broadly trained geoscientists"*

A.55 To understand and model the likely migration of radionuclides within the geosphere it is necessary to understand the fundamental properties of minerals, rocks and fluids (both liquids and gases) and their interactions. The migration of radionuclides is affected by several factors including the chemical form of the element when dissolved, its solubility, and its interactions with both mineral surfaces and with colloidal particles carried in the fluid. A wide range of adsorption processes exist (see Figure 6) and for prediction over long-time scales it is vital for models to be based on a process-based mechanistic understanding of transport phenomena. The principles governing adsorption are complex and depend critically on the nature of the mineral surface, which may vary significantly over any migration route from a GDF to the surface.

A.56 There have been a number of studies of migration, although until the geological setting of a UK GDF is known, their relevance to the UK situation is unclear. Research in this area has been a long-standing theme in the EU Euratom programme. For example, the now completed 51-partner FP6 FUNMIG project[24] involved Nirex, Loughborough University and the University of Manchester, focused on providing tools for scientifically sound performance assessment for radionuclide migration from near-field to hydrosphere/biosphere and encompassing the range of different radioactive waste disposal approaches and host-rocks types under investigation in Europe. In addition, the recently-ended NF-Pro (FP6)[25] programme had 40 partners, including RWMD, Serco, Galson Sciences Ltd., BGS, Quintessa and the Universities of Cardiff and Sheffield from the UK. The project investigated key processes operating in the near field.

[24] *http://www.funmig.com/*
[25] *http://www.nf-pro.org/*



A variety of chemical transport processes (yellow arrows) and structures exist at a mineral surface in contact with a fluid. A trace-metal ion (red) is carried in the fluid as a complex with a hydration shell (pink circle). The processes depicted include **(a)** physical adsorption, **(b)** dehydration followed by chemical adsorption, **(c)** detachment, **(d)** surface diffusion and attachment at a step, **(e)** ionic substitution with an atom in the bulk, **(f)** trapping at crystal imperfections, **(g)** the binding of atoms to an organic coating (gray), and **(h)** adsorption of an organo-mineral complex.

Figure 6. Adsorption Processes
Source: DePaolo and Orr, 2008.

A.57 Further work is needed to understand and model radionuclide migration to a level that captures the uncertainty over future behaviour so that migration can be represented appropriately in a safety case. In particular, more understanding is required of:

- radionuclide physico-chemical form (speciation)
- the spatial variability, temporal evolution and reactivity of mineral surfaces
- upscaling molecular level models to estimate bulk chemical properties, both thermodynamic and kinetic, and transport over spatial scales from nanometres to hundreds of metres.

A.58 These issues are discussed in detail in Boxes 7-9.

Box 7. Radionuclide Speciation

Many of the elements which are important in geological disposal (*e.g.* iodine, technetium, uranium, neptunium, plutonium) can access different oxidation states with very different chemical properties, and hence may be present as different complexes with bound water and other ligands (Runde, 2000). The chemical form will control solubility and subsequent sorption. In the extreme (carbon-14), speciation changes may even affect whether a radionuclide is present in the solid, liquid or gas phases. Chemical speciation is also influenced by biological processes, either directly through entrainment of a radionuclide in active metabolic processes, or indirectly, through reaction of a radionuclide with a biogenic chemical species.

A chemical reaction will only proceed when the system as a whole moves from a higher to a lower energy. A reaction which proceeds rapidly to the lower energy state is said to be under "thermodynamic control". However, the existence of an energetic driving force does not necessarily mean that the reaction will occur to any significant extent because the reaction may proceed slowly. In such a case, the reaction is said to be under "kinetic control".

It is relatively easy to predict the thermodynamic end state of a reaction, but many reactions which are important in geological disposal, for example reaction of rocks with alkaline fluids, or the crystallisation of minerals, are kinetically controlled and, because the progress of such a reaction will depend on the time elapsed, it is much harder to predict the behaviour of such systems. Several key processes relevant to geological disposal are in practice under kinetic control and some, such as colloid-mediated transport, represent major uncertainties in establishing the GDF safety case (King *et al.* 2001). Biological effects can affect the path of a reaction; for example, CO_2 is thermodynamically unstable in strongly reducing conditions but the kinetics of chemical reduction to CH_4 are so slow that the reaction essentially does not occur. However, biotransformation by some micro-organisms of CO_2 to CH_4 is efficient, so a system with appropriate biological activity will contain CH_4, whereas one which cannot support bioreduction will contain CO_2.

Box 8. Mineral Surface Reactivity

At the molecular level, the surfaces of minerals are very reactive through a range of different mechanisms. Some, such as the feldspar surface, undergo a series of pH-dependent leaching, dissolution and precipitation reactions, leading to the formation of altered and secondary layers on the surface (Chardon *et al.,* 2006) while others interact through dissolution and reprecipitation, which leads to overturn of the surface (Morse & Arvidson, 2002). These surfaces interact with solutes by a range of processes, including inner- and outer-sphere surface complex formation, surface precipitation and other poorly defined interactions. Although they differ in the detail of their mechanisms, and this has important implications for mobility, these are often collectively referred to as "sorption" reactions (*e.g.* Brown *et al.,* 2007).

Box 9. Modelling

At a spatial scale of metres to hundreds of metres, which is appropriate to geological disposal, given the complexity of both the engineered and natural components of the GDF, host rock and biosphere, and given the timescale over which the safety of the GDF must be assessed, it is necessary to use predictive computer models. These are often referred to as reactive transport models, and many of these are now very sophisticated, incorporating multiphase flow and detailed description of the system (Steefel *et al.,* 2005). However, these models inevitably incorporate considerable simplifications and approximations.

There is also a range of modelling approaches which can be used to understand interaction of radionuclides with surfaces at the molecular level, complementing experimental studies of sorption reactions. Density functional theory is well established and is now sufficiently developed to describe complex elements such as actinide ions in solid matrices or adsorbed on surfaces (see *e.g.* Skomurski *et al.,* 2006). Although such modelling is far from routine, draws heavily on very demanding experiments, and remains very challenging, it offers the prospect of understanding and predicting reactions in complex, environmentally relevant systems at a fundamental, molecular level.

The integration of this molecular scale modelling, which is soundly rooted in physical and chemical principles, and prediction over much larger spatial and time scales, which is needed to assess GDF performance, remains very difficult. Nevertheless, if the gap between these different scales and approaches can be bridged, the product will be a powerful predictive tool. The USDOE has identified three Grand Challenges in the geosciences, two of which centre around this particular question (USDOE, 2008).

Gas

A.59 The generation and movement of gases in a GDF are of concern for two reasons. One is that sufficient gas might be generated to affect groundwater movement or even disrupt the GDF. The other is that radioactive gases could move through the rocks to the surface and lead to radiation exposure of humans and other organisms. Consequently, a balance must be sought between providing sufficient gas permeability within the GDF to prevent an excessive rise in gas pressure, and inhibiting both fluid flow and the migration of trace radioactive gases into the geosphere. The principal mechanisms for generation of bulk gases are anaerobic corrosion of metals, especially steels, and decomposition of organic wastes. Radioactive gases can be formed by interactions of bulk gases with the wastes, and by decay of some radionuclides (for example, radon is a decay product of uranium).

Hydrogen

A.60 The GDF, particularly after closure and resaturation, will contain large volumes of water, either free groundwater or bound in waste encapsulants like cement, or in backfill. Radiolysis (breakdown by reaction with radiation arising from radionuclides) of water generates hydrogen gas, which is vented from most ILW waste containers. The external radiation field around ILW and HLW containers will promote water radiolysis in groundwater and backfill. There will be several hundred thousand tonnes of metals in any GDF, most of which will be steels, which are a constituent of some wastes and of most ILW containers (Royal Society, 1994). HLW containers are also made of steel and may be placed in steel overpacks for disposal. Anaerobic corrosion of metals will generate considerable quantities of hydrogen. Tritium will be released from wastes and

could mix with the bulk hydrogen gas or form tritiated water, although its short half-life (12.6 years) means that is very unlikely to reach the surface in significant quantities.

A.61 Subsurface microbial communities are often well adapted to exploit hydrogen as an energy resource (*e.g.* Nealsen *et al*., 2005; Pedersen, 2002) so the fate of hydrogen is intimately linked to the evolving microbial ecology of the GDF. For example, the hydrogen supply in a GDF will be much greater than that in a pristine environment, with the potential to trigger a microbial bloom whose consequences may be difficult to predict.

A.62 BGS is the lead researcher in the ~£2M EU FORGE programme on gas migration and is supported in this by the NDA. The FORGE project is designed to characterise and quantify the conditions during geological disposal under which the formation of hydrogen and other gases will occur with sufficient pressure increase to result in radionuclide migration from the repository into the surrounding host rock. It is predicted that corrosion of ferrous materials under anaerobic conditions in a repository will lead to the formation of hydrogen. Radioactive decay of the waste and the radiolysis of water will produce additional gas. Movement of these repository gases through host rocks will occur by the combined processes of molecular diffusion and bulk advection. If the gas production rate exceeds the rate of diffusion of gas molecules in the pores of the EBS or host rock, it is possible that a discrete gas phase could form and accumulate until its pressure becomes sufficiently large for it to enter the EBS or host rock. The FORGE project is designed to characterise and quantify the conditions under which this may occur, enabling modelling to underpin GDF design that lies within a safe gas generation envelope. BGS is involved in experimental, monitoring and modelling research contributing to three of the five work packages comprising FORGE. These include its Large Scale Gas Injection Test (Lasgit), fundamental issues of gas migration in bentonite, carbonation reactions of buffer/backfill cements and their impact upon gas and radionuclide migration, the effect of stress field and mechanical deformation on permeability and fracture self-sealing, validation of critical stress theory applied to repository concepts, and baseline hydraulic and gas transport properties of Callovo-Oxfordian argillite.

Carbon-containing gases

A.63 Methane and carbon dioxide will be produced in bulk by the various mechanisms involved in the decomposition of organic materials in the wastes. The volumes of methane and carbon dioxide generated will be much smaller than the volume of hydrogen because there will smaller quantities of organic materials in a GDF than there are of metals (perhaps a few tens of thousands of tonnes of organic materials (Royal Society, 1994)). How much of the methane and carbon dioxide is radioactive will depend on how much carbon-14 there is in the wastes in the GDF and in what chemical form. This will in turn depend largely on how much irradiated graphite is present and the method of treatment prior to disposal.

A.64 Carbon gases can be exploited by anaerobic micro-organisms either as an energy resource (methane) or as a terminal electron acceptor (CO_2), so there is potential for a microbial community to cycle between these forms of carbon. The chemical behaviour will also be very different, depending on whether the carbon

is present as methane or carbon dioxide. For a given pressure and pH, methane is significantly less soluble than carbon dioxide. Further, carbon dioxide solubility is particularly dependent on pH: in a high pH GDF, ^{14}C-carbon dioxide is expected largely to exist in solution as carbonate and bicarbonate ions and to form relatively insoluble calcium carbonate solid. By contrast, a neutral pH GDF, for example one with bentonite backfill, will be much less efficient at trapping carbon dioxide.

Other gases

A.65 Some ILW streams, for example Dounreay raffinates, contain relatively-high concentrations of nitrate which, in an anaerobic system, can be transformed by biological processes into gaseous nitrogen species, particularly nitrogen gas. The implications of this occurrence on GDF performance are not clear although it may be useful to estimate the inventory of nitrate proposed for the GDF and, if it is significant, to consider the likelihood of nitrogen gas generation. Similarly, sulphate will be present in cementitious materials (encapsulant and backfill), with the potential for microbial production of hydrogen sulphide. Radiolysis of polyvinylchloride (PVC), used extensively in waste packaging, generates gaseous hydrogen chloride (LaVerne *et al*., 2008). Both hydrogen sulphide and hydrogen chloride are chemically reactive and are very likely to react close to the point of generation, with the potential to promote localised corrosion, perhaps accompanied by a decrease in pH.

Criticality

A.66 A key issue in design and construction of a GDF is the amount of radioactive material present which, if it collects together over time, could have the potential to aggregate into a critical or super-critical mass and cause a nuclear fission reaction. In this discussion, the term fissile is used specifically to describe an isotope which has a significant ability to undergo fission when irradiated with thermal neutrons. Only a relatively small proportion of the GDF inventory is fissile.

A.67 The likelihood of criticality within a GDF will depend primarily on the inventory of fissile isotopes disposed, the form in which they are disposed and the long-term behaviour of the relevant wasteforms. Criticality was considered in relation to the original Nirex ILW repository concept (*e.g.* Hicks & Green, 1999). It is much more of an issue for any GDF containing spent fuel (and separated plutonium) because the fissile inventory of such a GDF would be greater by many orders of magnitude than that of an ILW repository. There has been substantial work on criticality in those countries that plan to dispose of spent fuel, for example the USA and Sweden. This is an area in which the UK can make extensive use of the R&D carried out in other countries.

A.68 Criticality can arise from either the removal of neutron-absorbing waste components, or the leaching out and accumulation of fissile material. The risk of criticality will change over time due to radioactive decay which can both remove and create fissile isotopes. As the isotopic mix changes, so the cross sections, critical mass and spontaneous fission-derived neutron flux will all change. Thus plutonium-239 (fissile; half life 24,100 years) decays to uranium-235 (fissile; half life 750 million years) but the critical mass for plutonium-239 is substantially lower

than that for uranium-235. Likewise, plutonium-241 (fissile; half life 14.3 years) decays to americium-241 (non-fissile; half life 432 years).

A.69 Several transuranic elements decay by spontaneous fission to some degree, and while this is often a minor pathway (*e.g.* 5.75 x 10^{-6}% for plutonium-240), it can be very significant in some cases (*e.g.* 8.39% for curium-248). The presence of such isotopes is important in criticality because spontaneous fission maintains an elevated neutron flux and the higher the neutron flux, the easier it will be to initiate a self-sustaining criticality. The inventory of spontaneously fissioning isotopes will therefore be important. These are relatively low in AGR spent fuel but greater in higher burn-up fuels. There are uncertainties in the likely inventories of heavy actinides because the physical data for their formation are not well known.

A.70 The criticality hazard of a GDF depends on factors such as the facility design, the nature and distribution of wastes within the GDF, and the composition and geometry of the wasteforms. It may be possible to reduce the hazard, for example by including neutron poisons in waste forms or backfill, and hazard assessments are an important input to GDF design.

A.71 The assessment of criticality hazard is demanding, requiring knowledge of wasteform performance, nuclear physics data, fissile material migration in the GDF environment, and neutron transport modelling. In the absence of specific information on the GDF, wasteforms and inventory, the primary need for R&D into criticality is to preserve and develop capability for use as more details of the GDF are resolved. While we do not yet know the scope of the work undertaken, it is nevertheless encouraging that NDA has apparently recognised this need and has supported Serco Assurance and Imperial College to carry out some research.

Multiphase Fluid-Solid Interactions in Perturbed Geochemical Environments

> "*Over a wide range of scenarios, the thermodynamic properties of complex geological fluids and solids, and the reaction rates among phases and species, must be known to define the critical environmental parameters that control migration or immobilization of wastes*." (USDOE, 2008a)

A.72 It is accepted (USDOE, 2008a) that the emplacement of radioactive waste into a geochemical environment that has previously reached a steady or equilibrium state over a relatively long time will lead to reactions among minerals, pore waters, and the wastes or their engineered container/buffer system. The reactions and interactions triggered by perturbations to the original *in situ* conditions may be both sudden and gradual, because the changes in temperature and gas pressure, chemical gradients, oxidation-reduction conditions, or radiation fields are non-linear and subject to feedback effects.

A.73 Most fluid in fine-grained and/or low permeability rocks (*e.g.*, shales, bentonite, many igneous rocks), is present as nanometre-scale fluid films and in submicron-scale pores (USDOE, 2008a). This leads to mesoscopic reaction and transport rates that are governed by microscopic fluid-mineral surface environments. Transport of contaminants into these microenvironments is therefore an important first step leading to immobilisation on mineral surfaces or incorporation

into minerals by precipitation, coupled dissolution-precipitation, or solid state diffusion (*e.g.* Hoskin & Burns, 2003). Prediction of whether immobilisation of radionuclides may occur under the conditions that evolve as a disposal facility and its wastes change over time is important for assessment of GDF performance.

A.74 Almost any reaction between a GDF and emplaced wastes and EBS will result in chemical changes that are both kinetically and thermodynamically regulated (*e.g.* Grambow, 2006; Geisler *et al*., 2007; Putnis & Geisler, 2007). Hence, predictive theories are required that link relevant equilibria to reaction rates and mechanisms. These need to be founded on an integration of experimental, analytical and computational approaches. A key problem in applying reactive transport modelling to a GDF lies in quantifying the relative roles of surface reactions and diffusion processes on overall reaction rates (*e.g.* Grambow, 2006). There is at present no general model that can account for how coupled processes influence transport mechanisms and chemical reactions at grain surfaces and boundaries, in fluid films, and in pore throats and pores. This means that extensive experimentation is required. Even then in the absence of an integrated and robust theoretical model the mineral reaction rates obtained will apply only close to the chemical systems for which they were measured, and the extent of process coupling in these is usually unknown.

A.75 To add to the level of complexity, multiphase fluid systems are likely to prevail in engineered systems designed for geological disposal of nuclear waste (USDOE, 2008a). However, current understanding of such multiphase systems at 40-110°C and 2-10 MPa is very limited, and generally confined to macroscopic thermodynamic models for H_2O-CO_2 and H_2O-CO_2-NaCl-KCl at low salinities. The macroscopic models do not take into account the documented effects of surface tension on thermodynamic properties of aqueous species and the partial pressures of gases or supercritical fluids. Furthermore, mass transfer between fluid phases can alter the composition of those fluids. For example, the generation of fluid (gas) from radioactive decay in a repository may displace water from pore and compacted buffer space, leaving saline brine films on mineral surfaces, and these brine films may stimulate surface chemical reactions that preferentially degrade radwaste canisters.

A.76 These considerations apply to assessment of the impact of alkaline fluids on materials deposited in a GDF, including bentonite buffer and, potentially, vitrified HLW if and when canisters corrode and fail (USDOE, 2008b; Grambow, 2006; Geisler *et al.,* 2007). As such alkaline fluids may be generated through the interaction and equilibration of groundwaters with cementitious materials, GDF designs that limit the use of cement in the environments into which HLW is to be deposited have clear advantages (NUMO, 2004).

Co-location of ILW, HLW and Other HAW in One GDF

A.77 Co-location is a term used by Government and the NDA to mean disposal of HLW, ILW and other types of HAW in a combined GDF in which there are separate parts of the facility for the various types of waste (as shown schematically in Figure 3 of the MRWS White Paper, Defra *et al.*, 2008). NDA concepts for a co-located GDF involve the assumption that the geometry of the facility is such that there will be no significant adverse interactions between the

near-field of the part containing the ILW and LLW and the near-field of the part containing the HLW and spent fuel. An important question for site selection and GDF design is how this can be achieved in various geological environments. A key question is whether it is possible to demonstrate that there will be sufficiently limited interaction between the two near-fields over sufficiently long time periods for a post-closure safety case to be developed. There are a number of topics on which R&D is required in order to address these questions and hence inform a decision on whether one co-located GDF or two (or more) separate GDFs will be the most appropriate option.

A.78 ILW disposal concepts considered to date in the UK involve the use of large volumes of cement-based materials in the waste packages, the backfill and in construction of a GDF. Several concepts for the disposal of HLW and spent fuel involve the use of bentonite backfill. The cement-based materials will cause groundwaters that come into contact with them to become highly alkaline. The potential interactions between these high pH groundwaters and bentonite require further research, as do the interactions between high pH groundwaters and vitrified HLW.

A.79 At a major workshop on bentonite-cement interaction (NUMO, 2004) it was emphasised that significantly more and new experiments, and new coupled chemical diffusion–advection models, are required to understand and predict bentonite behaviour, including swelling and evolution of high gas pressures, dissolution, cementing and porosity reduction by precipitation of silica, cation and anion affinities under high pH, and overall barrier system performance. Most workers considered that low pH alternatives to Ordinary Portland Cement (OPC) and composite cement systems need development, and that systems with lower cement/bentonite ratios were less likely to be problematic than those in which the cement/bentonite ratio is high or the groundwater chemistry in a GDF environment dominated by cement interaction (NUMO, 2004).

A.80 The NUMO 2004 executive summary and conclusions, which constitutes their considered set of suggestions and recommendations for future action, is extracted below to illustrate the recognised issues:

- Additional experiments to verify present understanding should be undertaken.
- Additional information on the long-term evolution of cement-barrier systems would be desirable.
- Consideration should be given to long-term experiments.
- Analogues could yield useful information.
- There are underground laboratory facilities, such as the Mol URL in Belgium, which have been operating for 20 to 30 years and could be used to give useful information on these time-scales.
- It is desirable for new materials to be considered in place of cement and to question ‘conventional wisdom’ which states that cement is the best material to use for construction and barrier functions in many circumstances.
- It is desirable to develop low pH cements (pH ≤ 11, but not so low as to promote excessively rapid corrosion of steel materials) with particular

properties for certain applications, such as grouting where water-rock interactions at higher pH would have detrimental effects

- It is important to identify which of the possible problems that have been highlighted by experimental and theoretical investigations would actually be encountered in real repository environments.

A.81 Most investigations of the leaching behaviour of vitrified HLW have considered natural groundwaters, rather than the highly alkaline groundwaters that could be present in a co-disposal situation. As a result, there are significant uncertainties about the reactivity of borosilicate glasses in these circumstances. Whether radionuclides are immobilised through mineral precipitation or rendered mobile and then transported in alkaline but also saline fluids are issues that also need intensive study (Hoskin & Burns, 2003; Grambow, 2006; Geisler *et al*., 2007; Putnis & Geisler, 2007). UK glasses are more reactive than the French equivalents due to their high Mg content (Abraitis *et al*., 2000), illustrating the need for caution in using experimental data from overseas. There is a clear need for further experiments on borosilicate glass stability in the presence of complex alkaline and saline fluids under both static and dynamic (*i.e.* with fluid flow) conditions.

A.82 Corrosion of metals will generate gas in both the ILW/LLW and HLW/spent fuel parts of a co-located GDF. However, the amounts of gas that will be produced in the ILW/LLW part are greater because there will be more metallic waste containers, much ILW consists of metals, and some ILW is organic and will degrade to form gases (paras A.59-A.65). There is therefore an issue of whether gas generated in the ILW/LLW part of a facility could affect groundwater movement in the HLW/spent fuel part of a facility.

GDF Design

A.83 The process of GDF design is discussed in the CoRWM report to Government on geological disposal (CoRWM doc. 2550). In that report CoRWM emphasised the need to consider a wide range of disposal concepts, constructed using various techniques, at depths ranging from about 200m to more than 1km. R&D may be required to enable the options (including co-location) to be evaluated and compared at the conceptual level.

A.84 Options for GDF designs cannot be developed in any detail until potential sites have been identified and assessment of these sites has begun. An integrated process of GDF design, site assessment and safety case development work is then required to provide input to design and siting decisions (CoRWM doc. 2550). R&D requirements will be identified in the course of this process. In the meantime, useful studies could be undertaken to define the influence that the form of the underground openings and excavation and support methods have on design. In relation to tunnel and shaft design the quality of the rock mass and the *in situ* stress conditions will greatly influence the size, shape, support requirements and the proximity of openings to one another. It is considered that research is required in the following areas:

- Response of the rock mass to excavation and extent of any disturbance of the rock adjacent to underground openings.

- Long-term stability and performance of underground openings.
- Long-term operation and maintenance of GDF tunnels and shafts.

Geosphere Characterisation

A.85 MRWS Stage 5 involves undertaking surface based investigations at the site of any proposed GDF (Defra *et al*., 2008). This is part of the process of geosphere characterisation which involves obtaining geological, hydrological and environmental data related to the development of a GDF. The purpose of collecting the data is to support the development of a safety case and will underpin the engineering design of the facility.

A.86 NDA is currently progressing a Geosphere Characterisation Project which was started in 2004 by Nirex with the purpose of demonstrating that it was practicable to characterise a site for development of a GDF. Under the NDA the current aims of this project are to maintain and develop an understanding of the approaches to the design and implementation of the investigations (both surface and sub-surface) that would be required and prepare for such a project.

A.87 The characterisation of a potential site or sites for a GDF is a major multi-disciplinary project requiring a wide range of skills many of which are specialist. The NDA status report on the Geosphere Characterisation Project (NDA, 2007) indicates to CoRWM that the complexity and magnitude of the task is recognised and that techniques and procedures are being developed to deliver the project.

A.88 The status report indicates that site investigations will be focused on obtaining data that are pertinent to the dual tasks of engineering design and the development of a safety case while avoiding data that has no relevance to these objectives. In doing so it will be necessary to identify what the data needs are for the project and then establish what the state-of-the-art practices are with respect to data collection, investigation equipment, analysis, interpretation and application.

A.89 The Geosphere Characterisation Project will then review these practices and their applicability to the UK's range of geology, the proposed disposal concepts and the availability of skills and supporting infrastructure (laboratories *etc*). RWMD has started this process by identifying the principal subject areas in which data will be required and it has commenced the assessment of state-of-the-art practices in some of these. The areas in which data are required have been identified by review of current and previous investigations both in the UK and overseas. The establishment of current best practice in each subject is being undertaken by the NDA technical supply chain.

A.90 It is CoRWM's view that the processes established within the Geosphere Characterisation Project are well planned and the objectives are clear. In the context of this report, CoRWM's interest lies in whether the review of state-of-the-art practices in subject areas is effectively highlighting gaps that require R&D, and whether such work is being, or will be, actively pursued.

A.91 CoRWM is aware that the NDA has appointed technical consultants with a series of framework contracts to support the development of the Geosphere

Characterisation Project. Work has commenced in developing and understanding of the information needs of the project and current best practices. The status report presents overviews of the assessment of geochemistry, deep drilling, wireline testing and groundwater monitoring instrumentation. These subject areas were selected for early study by the NDA because it was recognised through dialogue with overseas WMOs that these are the most significant challenges to the implementation of a geosphere characterisation programme.

A.92 The status report (NDA, 2007) sets out areas for possible R&D in these subject areas, a summary of which is as follows:

Geochemistry (Intellisci, 2008)

- Research is required into the methods and equipment for sampling groundwater and down hole monitoring of *in situ* redox and pH.
- Research is required to define the chemical descriptions and models proposed to describe the EBS (near field), the geosphere and the biosphere. Similarly work is required to define the models of site-scale hydrology, hydrogeology and paleohydrogeology and how these can be tested and calibrated.
- Research and development is suggested in relation to the sampling of groundwater concurrent with drilling operations to ensure that "first strike" samples can be obtained from discrete target sampling zones.

Deep Site Investigation Borehole Drilling (EPS International, 2007)

- The optimal drilling method proposed was the use of hybrid drilling rigs suitable for both test/sample drilling and coring. These rigs are not readily available and while no research is required there needs to be developmental work with regard to rig design and borehole casing strategies.

Geophysical Wireline Logging, Logging-While-Drilling & Wireline Testing

- The status report highlights the fact that there is variable accuracy among various techniques for down hole data acquisition. It is likely therefore that some research is required to establish absolute accuracy.

A.93 CoRWM considers that the process of identifying the information needs summarised above is sound and that research identified in future through this process should be undertaken. Currently it is unclear to CoRWM whether R&D arising from this process is progressing or is planned or whether the skills have been identified to undertake the work. In defining the research needs it is important to recognise that any GDF may not be sited in hard crystalline rock but, for example, in low permeability mudrocks.

A.94 The status report (NDA, 2007) states that studies for 2007-08 comprised geomechanical testing, groundwater sampling, radionuclide migration properties and geophysical surveys. CoRWM considers that through the adopted process information gaps will be identified that require R&D. Among these will be the following issues:

- The performance of any rock mass is dictated to a large extent by the characteristics of naturally-occurring fractures. These vary in scale from a

few millimetres to tens of metres. They are generally formed as a result of stresses applied to the rocks over geological time and their presence has a significant effect on the geomechanical behaviour of the rock mass. To understand the influence of these features fully it is considered that their genesis should be understood. This is an area where site specific research in the related fields of structural geology and rock mechanics would aid site characterisation.

- The current distribution of stress within a rock mass is influenced by the distribution, frequency and nature of the fractures present. Research into the relationship between fracture distribution and stress fields would aid in site characterisation.
- Understanding the controls on identification and description of the distribution of permeability in low-permeability rock units will be essential to the characterisation of a potential GDF site.
- Research will be required in relation to understanding, in a fractured hard rock, the connectivity and transmissivity of the network of fractures. In addition research will be required into any lithological and structural controls on permeability distribution.
- Water passing through fractures in the rock mass is influenced by the surface characteristics of the fracture surfaces. This will change depending upon the *in situ* stress conditions. Research to understand the influence of fracture wall roughness and *in situ* stress would be useful in the characterisation process.
- Geophysical techniques will be employed during site characterisation to understand the spatial variability both horizontally and vertically of the various rock types and geological structures at any proposed site. This will assist in understanding groundwater movement and an initial assessment of rock mass and material parameters. 3D seismic investigation and other geophysical techniques have been developed for mine planning over recent years as highlighted at the RWIN Meeting in April 2009 (CoRWM doc. 2619). It is considered that research into the use of these techniques in relation to possible GDF sites could inform geosphere characterisation and assist in GDF layout and the design.

Microbiology

A.95 Biological, and particularly microbiological processes, have considerable potential to influence performance of a GDF, for example through accelerated degradation of *e.g.* cemented wastes (Avaim *et al.,* 2004; Rogers *et al.,* 2003), corrosion of steel containers (Landoulsi *et al*., 2008; Xu *et al*., 2008), perturbation of biogeochemical conditions, generation of colloids and complexants (Gaona *et al*., 2008; Glaus and Van Loon, 2008) and modification of flow paths (Suchomel *et al*., 1998; Ross *et al*., 2007).

A.96 The microbial ecology of the GDF will be complex for several reasons. First, it is very likely that there will be an indigenous microbial community in the host rock formations. This will be perturbed during construction and exposed to a very diverse array of immigrants, many of which could potentially colonise. On closure and resaturation, when anaerobic conditions are reinstated, the new community will evolve further. Evolution in community composition and genomes will be driven by factors such as pH (potentially very high), temperature, the radiation

field, water availability (possibly low in a highly compacted bentonite buffer or an evaporite geology) and generation of hydrogen as an electron donor. In any event, the microbial community will certainly not return to its pristine state. Thus, microbial processes represent major uncertainties in the performance of a GDF.

A.97 While many aspects of a GDF's microbial ecology will be site specific, there remains a requirement to conduct generic research and build essential capability, for example in techniques for the sampling and characterisation of subsurface microbial communities, which are technically very difficult (Pedersen, 2002); the ecology of high pH, anaerobes and thermophiles; or the ecology of radioactive, hydrogen-rich systems.

Temporal Evolution of Geosphere

A.98 Temporal evolution of the geosphere is poorly understood over timescales of one hundred to one million years. Direct experimental observations and human induced perturbations (*e.g.* effects of oil and gas extraction or mining) are all based on short time periods of less than 100 years (often substantially less), whereas observations of geosphere evolution based on geological analogues are on long timescales (10 thousand to 100 million years).

A.99 Temporal evolution of the geosphere will potentially produce significant changes in groundwater chemistry, regional groundwater gradients, rock hydraulic properties, geochemical properties (including mineralogical surfaces for adsorption), mechanical loading, microbial ecology and sea level. Evolution of the geosphere may involve gradual change such as mineralisation of fracture surfaces causing a gradual decrease in local permeability and increase in mechanical strength, or may be much more rapid as result, for example, either of climate change causing rapid global temperature change or of earthquake activity. Isotope geochemistry can provide data on evolution of past geochemical environments (over 100 to one million year timescales). However, it is not possible to determine from these data the *rate* of individual mineralisation episodes (*e.g.* short episodic pulses of rapid fluid movement versus constant time averaged flow rates); there is also no clear basis for using such data to predict the future.

A.100 To better characterise geosphere evolution and reduce uncertainty in model predictions, CoRWM believes that a fundamental mechanistic understanding is required of the processes governing physical, chemical and microbiological evolution of the geosphere. Further, to validate such models, new field analogues should be sought that illuminate the role of individual processes in geosphere evolution and are applicable to the timescales appropriate for geological disposal.

Radionuclide Movement in the Biosphere

A.101 In the geological disposal context "biosphere" means soils, surface waters, sediments, the atmosphere and the animals and plants that live in these parts of the environment, including humans. It is clear that, over the timescales of interest in geological disposal, it is not possible to predict how the surface environment at any particular site will change, nor how plants and animals will evolve. The approach used for the purposes of developing GDF safety cases is to carry out calculations based on a range of possibilities for temporal changes in the surface

environment, all with the characteristics and behaviour of humans, other animals and plants taken to be as they are in similar environments today. This is known as the “reference biosphere” approach (Health Protection Agency, 2009). Typical safety case calculations employ several reference biospheres, each for a different climate state that could occur at the future at a GDF site. The states differ in aspects such as temperature and rainfall, and, for coastal sites, sea level.

A.102 The models and data required for the reference biosphere approach largely exist. The models have been developed over many years using experimental and observational data (for example, on the movement of radionuclides routinely discharged to air and sea from nuclear facilities). Since the whole ‘calculational’ approach is stylised, it is unnecessary to perform uncertainty analyses.

A.103 The adoption of the reference biosphere approach means that there is a limited requirement for biosphere R&D for geological disposal safety case purposes. This is not to say that such R&D is not needed for other purposes, or that the knowledge gained in other contexts should not be used for GDF safety cases. There may also be a need for R&D to improve predictions of radionuclide movement through the geosphere-biosphere interface (for example, movement from rocks to soils and sediments).

APPENDIX B REFERENCES

CoRWM Documents

Note: All CoRWM documents are available on the CoRWM website, *www.corwm.org.uk*.

Number	*Title*
700	Recommendations to Government, 2006
2266	CoRWM Work Programme 2008-2011, June 2008
2323	Working Group C Work Plan, April 2008
2373	Note of meeting with NDA on R&D issues, 29 April 2008
2374	Note of plutonium follow-up meeting, Royal Society, 22 April 2008
2386	Note of meeting with Sellafield Sites Ltd, 19 June 2008
2389	Position Paper on R&D for Conditioning, Packaging and Interim Storage of Higher Activity Wastes and Management of Spent Fuels, Plutonium and Uranium, June 2009
2408	CoRWM comments on draft NDA-RWMD R&D Strategy, January 2009
2414	Note of meeting with Office for Civil Nuclear Security, 23 July 2008
2418	Note of meeting with NDA on spent fuels, plutonium and uranium, 8 August 2008
2419	Note of meeting with British Energy, 11 August 2008
2443	Note of meeting with NNL, 1 September 2008
2444	Meeting with Adrian Bull, Chair NSAN NW & NE Employer Steering Group, 3 August 2008
2455	Note of R&D meeting at Geological Society, 11 September 2008
2456	Note of meeting with BGS, 26 September 2008
2459	Note of meeting with NDA on LoC Process and Waste Package Specifications, 6 October 2008
2464	Note of meeting with EA and SEPA on waste conditioning, packaging and storage, 17 October 2008
2480	Note of Radioactive Waste Immobilisation Network (RWIN) technical meeting on radwaste storage R&D, 16 October 2008
2484	Note of meeting on scientific issues in site selection and characterisation, Geological Society, 13 November 2008
2488	Report of 30 October 2008 PSE event
2489	Note of visit to Sizewell B, 23 October 2008

Number	*Title*
2500	Interim Storage of Higher Activity Wastes and the Management of Spent Fuels, Plutonium and Uranium. CoRWM Report to Government. March 2009
2515.2	CoRWM's 2009-12 Work Programme, March 2009
2519	Note of Institute of Physics / CoRWM Interim Storage Meeting, 26 November 2008
2520	Note of meeting with HSE and EA on spent fuels, plutonium and uranium, 9 December 2008
2523	Note of meeting with NDA on spent fuels, plutonium and uranium, 11 December 2008
2524	Note of meeting with RCUK, Swindon, 3 December 2008
2540	Log of responses to consultation on outline Interim Storage report
2550	Geological Disposal of Higher Activity Radioactive Wastes. CoRWM report to Government, July 2009
2562	Log of responses to consultation on full draft of Interim Storage report
2563	Report of CoRWM 19 February 2009 stakeholder workshop on the draft Interim Storage report
2581	Storage R&D consultation response log, June 2009
2619	Note of Radioactive Waste Immobilisation Network (RWIN) technical meeting on geological disposal R&D, 23 April 2009
2624	Meeting with NDA on CoRWM Interim Storage Tasks for 2009-10, 11 June 2009
2630	Log of responses to consultation on CoRWM's report on national research and development for interim storage and geological disposal of higher activity radioactive wastes, and management on nuclear materials, October 2009
2677	Report of CoRWM 9 September 2009 stakeholder workshop on draft R&D report
2688	Note of visit to Harwell re LoC Process, February 2008

Other Documents

Note: All documents are available on the website of any organisation listed, unless otherwise stated.

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APPENDIX C GLOSSARY AND ACRONYMS

Glossary of Terms

Notes
1. The Glossary defines terms in the way that CoRWM uses them. Differences from definitions given in publications by the Government, the regulators, the NDA and others are intentional.
2. Definitions are in normal text; additional comments and examples are in square parentheses [ ] and italics.

Active facility	A facility where radioactive materials can be used. [*Such facilities are subject to safety, security and environmental regulation.*]
Advanced Gas-Cooled Reactor (AGR)	A UK designed, gas-cooled reactor with a graphite moderator. [*It uses enriched uranium oxide fuel with steel cladding and graphite sleeves. The primary coolant is carbon dioxide.*]
Applied research	Investigation directed primarily towards a specific practical aim or objective, which can involve using existing knowledge and understanding or acquiring new knowledge.
Basic research	See "Fundamental research".
Becquerel (Bq)	The standard international unit of measurement of radioactivity, equivalent to one disintegration per second. [*Related units are the:* *kilobecquerel (kBq) – one thousand Becquerels* *Megabecquerel (MBq) – one million Becquerels* *Gigabecquerel (GBq) – one thousand million Becquerels* *Terabecquerel (TBq) – one million million Becquerels.*]
Biosphere	That part of the environment where most organisms live. [*Includes soils, surface waters and their sediments, and the atmosphere.*]
Chemically disturbed zone	A region surrounding the engineered zone of a "geological disposal facility" that is affected by release of leachate. [*Particularly significant where cementitious backfill is used, since the high pH effluent from the GDF will cause extensive reaction with the host rocks.*]
Co-disposal	Generally, disposal of wastes with differing physical and chemical characteristics in the same facility. Now specifically used in the UK by Government, CoRWM and others to mean disposal of new build waste in the same facility as existing and "committed" waste. [*Often used in radioactive waste management literature to mean "co-location".]*

Co-location	Disposal of “high level waste”, “intermediate level waste” and other types of “higher activity waste” in a combined “geological disposal facility” in which there are separate parts of the facility for the various types of waste. *[For example, there could be one part of the facility for intermediate level waste and another part for the high level waste and spent fuel.]*
Committed waste	Radioactive waste that will arise in future from the operation or decommissioning of existing nuclear facilities. [*As distinct from existing waste, which already exists, and new build waste, which will only arise if new facilities are built.]*
Conditioning	Any process used to prepare waste for long-term storage and/or disposal. [*Usually by converting it into a suitable solid form e.g. incorporation in glass (vitrification), encapsulation in cement*.]
Contingent strategy	A strategy that can be used if it becomes clear that the “Reference strategy” is no longer appropriate. [*Colloquially, “Plan B”. In most radioactive waste management situations several contingent strategies are required, in order to address various possible future scenarios (“Plans C, D etc.”*).]
Deep borehole disposal (DBD)	Disposal of waste in boreholes more than 1000m deep. [*Also known as very deep geological disposal and very deep disposal.*]
Desk-based studies	Review, summary, collation or evaluation of existing knowledge, information, facts and research outcomes. *[In the context of the UK geological disposal site selection process, assessing the suitability of sites using existing knowledge about the geology, surface environment, communities etc.]*
Development	Progressive, systematic use of knowledge and understanding gained from “research” directed towards the production or improvement of materials, devices, systems or methods. [*Includes the design and development of processes*.]
Disposal	Emplacement of waste in an appropriate facility without the intention of retrieving it. [*Retrieval may be possible but if intended the appropriate term is “storage”.*]
Disposable	A waste package is disposable if it can be safely removed from a store, transported to a disposal facility and emplaced in that facility, and if it will play its planned role in ensuring the post-closure safety of that facility.

Encapsulation	A conditioning process in which radioactive waste is physically enclosed in a non-radioactive material that prevents radionuclides from moving. [*The most commonly used encapsulants are types of cement. Others include polymers.*]
Engineering disturbed zone	A region surrounding the engineered part of a "geological disposal facility" that has been affected by construction of the facility. [*For example through stress or fracturing*.]
Enriched uranium	Uranium in which the mass content of the isotope uranium-235 is above the level in natural uranium ores (0.72% by mass).
Exotic fuel	Term used by the UK for any type of nuclear fuel that is not from a commercial nuclear power reactor. [*Mainly fuels from research reactors and nuclear powered submarines*.]
Far-field	The "geosphere" beyond the "near-field". [*i.e. the rocks and subsoil undisturbed by the presence of the geological disposal facility.*]
Fundamental research	Original, exploratory investigation involving experimental or theoretical work undertaken primarily to acquire new knowledge and understanding of phenomena and observable facts without necessarily having any immediate application or use in view.
Geological disposal	Generally, emplacement in the Earth's crust with no intent to retrieve. Used specifically in the MRWS programme to mean "disposal" of radioactive waste in an underground facility, where the geology (rock structure) provides a barrier against escape of radioactivity and where the depth, taken in the particular geological context, substantially protects the waste from disturbances arising at the surface.
Geological disposal concept	Any variant of geological disposal, including the use of a "mined repository", "deep boreholes" and more than one "geological disposal facility".
Geological disposal facility (GDF)	Any facility used for geological disposal. [*Includes mined repositories, natural caverns, disused man-made caverns or mines, and deep boreholes*.]
Geological disposal facility design	The detailed drawings and specifications that will allow construction of a "geological disposal facility". *[Includes nuclear, civil, mechanical, electrical. Materials, chemical, geotechnical and geological engineering aspects.]*
Geological repository	See "Mined repository".

Geosphere	Solid portion of the earth consisting of the crust and part of the upper mantle. *[Often used in the geological disposal context to mean rocks, subsoil and the water and organisms in them].*
Hex tails	Uranium hexafluoride residue from the production of enriched uranium. [*Hex tails are depleted in uranium-235 to levels well below the 0.72 wt% of natural uranium, usually about 0.2 wt%. Uranium hexafluoride is a stable solid at room temperature and pressure but sublimes to a vapour at 56.5 ^{o}C. It reacts vigorously with water or water vapour.*]
Higher activity waste (HAW)	Radioactive waste with activity above the thresholds for low level waste (LLW), *i.e.* above 4 GBq/tonne alpha activity or above 12 GBq/tonne beta gamma activity. [*It is usually also taken to include LLW unsuitable for near-surface disposal.*]
High level waste (HLW)	Radioactive waste in which the temperature may rise significantly as a result of its radioactive content, so that this factor has to be taken into account in the design of waste storage or disposal facilities. [*In practice the term is only used in the UK for the nitric acid solutions arising from reprocessing spent fuels and for the vitrified form of the solutes in these solutions.*]
Historic waste, historical waste	See “legacy waste”.
Host community	A community in which a geological disposal facility may be built. [*It is a community in a small geographically well-defined area, such as town or village, and includes the population of that area and the owners of the land.*]
Hot cell	A heavily shielded containment in which manipulations of highly radioactive materials can be carried out using remote handling techniques.
Immobilisation	A conditioning process in which radioactive waste is chemically incorporated into a non-radioactive material so that radionuclides cannot move. [“*Vitrification” and incorporation in ceramics are types of immobilisation processes.*]
Interim storage	Storage of radioactive waste prior to implementing a final management step, such as “geological disposal”.
Intermediate level waste (ILW)	Radioactive waste exceeding the upper activity boundaries for “low level waste” (*i.e.* over 4 GBq/tonne alpha activity or 12 GBq/tonne beta gamma activity) but for which its heat output need not be taken into account in the design of storage or disposal facilities.

Legacy facility	A nuclear facility constructed several decades ago where waste has been generated or stored.
Legacy waste	Radioactive waste that arose several decades ago. [*A subset of existing waste; sometimes called "historic waste" or "historical waste". The term is usually reserved for wastes kept in, or that have arisen in, legacy facilities.*]
Low level waste (LLW)	"Radioactive waste" with activity levels that do not exceed 4 GBq/tonne alpha activity or 12 GBq/tonne beta gamma activity. [*Subsets of LLW include "very low level waste" (VLLW) and exempt waste (i.e. "radioactive waste" with activity levels below those in the various Exemption Orders made under the Radioactive Substances Act).*]
Low Level Waste Repository (LLWR)	The UK national disposal facility for low level waste. [*Located near the village of Drigg in Cumbria.*]
Magnox reactor	A UK designed gas-cooled reactor with a graphite moderator. [*It uses uranium metal fuel of natural isotopic composition with a magnesium alloy cladding.*]
Mined repository	A facility specifically excavated and constructed for the "geological disposal" of radioactive waste. ["*Mined and engineered repository" is a more correct description. Most designs consist of shafts or adits leading to tunnels and vaults*.]
Near-field	The part of a disposal facility near or in contact with the "waste packages", including filling or sealing materials and those parts of the host rock whose characteristics have been or could be altered as a result of the presence of the disposal facility.
Near-surface disposal	Disposal at or close to the surface of the Earth. [*Includes underground disposal in the Earth's crust at depths less than a few tens of metres, and emplacement in engineered structures at or just below ground level. Formerly called "shallow land burial" or emplacement in a "near surface repository".*]
Neutron transport modelling	Simulation of the pathways, energetics and lifetimes of neutrons. *[Used particularly in the control of criticality which is mediated by neutrons.]*
Overpack	An additional container for a waste package. [*Usually to make it more suitable for storage, handling, transport or disposal*.]
Package	See "Waste package".

Packaging	Placing waste into a container for long-term storage and/or disposal. [*In most cases this includes conditioning but sometimes waste is simply placed in containers, with or without compaction to reduce its volume*.]
Primary research	The obtaining of knowledge, facts and data that did not previously exist. [*All fundamental and much applied research is primary.*]
Pond	A water-filled structure in which nuclear fuel is stored. [*Usually made of concrete, the water provides cooling and shielding*.]
Pressurised water reactor (PWR)	A nuclear reactor in which water is used as the coolant and moderator. [*The fuel is enriched uranium oxide with "zircaloy" cladding. PWRs operate above atmospheric pressure to prevent the water boiling.*]
Public	People who have no particular interest in, and are not affected by, radioactive waste management. [*CoRWM distinguishes between "stakeholders" and the public.*]
Radioactive waste	Radioactive waste is defined in the Radioactive Substances Act 1993. In essence it is any substance for which there is no further use and in which artificial radionuclides are present at any level and/or natural radionuclides are present above the levels given in Schedule 1 of the Act. [*Note that spent fuels, plutonium and uranium are not radioactive wastes unless it has been decided that there is no further use for them and they are declared to be wastes*. *The Radioactive Substances Act definition of radioactive waste is under review and it is expected that a revised definition will be put in place in 2010.*]
Radioactive waste management	All the activities involved in managing radioactive wastes. [*Includes minimising arisings, all types of treatment (e.g. decontamination, sorting, segregation), "conditioning", "packaging" and "disposal"*.]
Raw waste	Waste that has not been conditioned.
Recoverability	The ability to remove wastes from a closed disposal facility by mining, drilling boreholes *etc*. [*Unlike "retrievability", recoverability does not entail the inclusion of any specific design features in a disposal facility.*]
Reference strategy	A strategy that is based on realistic assumptions about the future and that represents the course of action that is to be followed unless circumstances change. [*Colloquially, "Plan A". See also "Contingent strategy".*]

Repository	A facility where waste is emplaced for disposal. [*Often used as shorthand for "mined repository", but also used in other contexts, e.g. the UK's Low Level Waste Repository (LLWR)*.]
Research	An investigation directed to the discovery of some fact or principle by a course of study or scientific enquiry.
Retrievability	An ability to withdraw wastes from a disposal facility that is achieved by means designed into the facility other than simply reversing waste emplacement. [*See also "reversibility" and "recoverability".*]
Reversibility	The ability to withdraw wastes from an open disposal facility by reversing the emplacement process.
Rock Characterisation Facility (RCF)	An underground facility for use in characterising the physical, chemical, mechanical and hydrological suitability of the geological environment for "geological disposal". [*A term used mainly by Nirex for the facility it proposed to construct in Cumbria.*]
Safety assessment	An assessment of whether a nuclear facility or operation is or, if particular actions are taken, will be safe.
Safety case	The complete set of arguments that demonstrates that a nuclear facility or operation is or, if particular actions are taken, will be safe.
Secondary research	Review, summary, collation or evaluation of existing knowledge, facts and outcomes of basic and applied research.
Scientific research	The application of the scientific method to obtaining new information to explain the nature, properties or behaviour of something in the universe around us.
Silo	A structure used for storage or disposal of radioactive waste. [*The term is applied in the UK mainly to concrete structures (buildings) used for temporary storage of wastes, but it can also apply to vertical shafts in rock used for underground storage or disposal*.]
Spent fuel	Fuel that has been used in a nuclear reactor and for which there is no further use as fuel.
Stakeholder	A person or organisation who has an interest in or is affected by radioactive waste management. [*In the context of CoRWM's work, stakeholders include waste producers, regulators, non-governmental organisations, local authorities and communities near existing nuclear sites and potential disposal sites*.]
Stakeholder fatigue	A situation in which stakeholders are overwhelmed by communications and consultations on a particular topic, and do not respond to requests for their views.

Stillage	A metal frame used to hold drums of radioactive waste.
Storage	Placing wastes or other materials in a facility with the intention of retrieving them at a later date.
Surface-based investigations	Investigations of a potential geological disposal site that are carried out from the surface, rather than underground. [*For example, seismic investigations and boreholes.*]
Tonne	One thousand kilograms.
Underground Research Laboratory (URL)	An underground facility for "research" into "geological disposal". [*Some URLs are at prospective disposal sites, others are in geological settings similar to those proposed for geological disposal but remote from potential disposal sites.*]
Underground Research Facility (URF)	A site- or host rock specific underground facility for characterisation <u>and</u> R&D related to geological disposal.
Very low level waste (VLLW)	Very low level radioactive waste (VLLW) is LLW that has radioactivity levels well below the maximum for the category. It can be disposed of with non-radioactive waste, rather than being placed in the Low Level Waste Repository or other specialised facility. [*There are two types of VLLW: low volume and high volume. Low volume VLLW is radioactive waste that can be disposed of safely to an unspecified destination with municipal, commercial or industrial waste (so-called "dustbin disposal"). It has an activity not exceeding 400 kBq in any 0.1m^3 and no individual item in the waste should have an activity above 40 kBq. These levels are increased by a factor of ten for tritium or carbon-14 (i.e. 4 MBq in 0.1m^3 and 400 kBq per item, where the limits apply to tritium and carbon-14 taken together). High volume VLLW is radioactive waste that can only be disposed of to a specified landfill site. Its activity level must not exceed 4 MBq/tonne or 40 MBq/tonne for tritium.*]
Vitrification	The process of converting wastes into a glass or glass-like form.
Voluntarism	An approach to siting geological disposal facilities that involves communities voluntarily expressing an interest in holding discussions with Government, then deciding whether to participate any further.
Waste hierarchy	The hierarchy of principles used in waste management. These consist of: (1) non-creation of wastes where practicable; (2) minimisation of arisings; (3) recycling and reuse; (4) disposal.
Waste package	A container and all its contents . [*Includes the waste, any encapsulating material, any capping grout, etc.*]

Zircaloy	An alloy of zirconium used for cladding nuclear fuel.

List of Acronyms

AECL	Atomic Energy of Canada Ltd
AGR	advanced gas cooled reactor (A type of reactor with a graphite core, and uranium oxide fuel in steel cladding with a graphite sleeve.)
ALARA	as low as reasonably achievable
ALARP	as low as reasonably practicable
ALS	Advanced Light Source (at University of California Berkeley, USA)
ANDRA	Agence Nationale des Déchets Radioactifs (French state-owned agency for radioactive waste management)
ANRE	Agency for Natural Resources and Energy (Japan)
APM	adaptive phased management (of spent nuclear fuel, Canada)
APS	Advanced Photon Source (at Argonne National Laboratory, USA)
ASCC	atmosphere assisted stress corrosion cracking
ASN	Autorité de Sûreté Nucléaire (French regulator)
AWE	Atomic Weapons Establishment (at Aldermaston). (AWE plc is the company that runs Aldermaston and Burghfield under contract to the Ministry of Defence.)
BAT	best available techniques
BE	British Energy
BERR	Department for Business, Enterprise and Regulatory Reform (now part of the Department for Business, Innovation and Skills)
BGS	British Geological Survey
BIS	Department for Business, Innovation and Skills
BNES	British Nuclear Energy Society
BNFL	British Nuclear Fuels Ltd
BNG	British Nuclear Group

BNGSL	British Nuclear Group Sellafield Ltd
BPEO	best practicable environmental option
BRGM	Bureau de Recherches Géologiques et Minières (French equivalent of BGS)
BTC	BNFL Technology Centre (now the Central Laboratory) at Sellafield
BWR	boiling water reactor
CANDU	Canadian deuterium uranium reactor (a reactor with natural uranium fuel and heavy water (deuterium oxide) as the moderator and coolant)
CASE	Co-operative Award in Science and Engineering (scheme to support PhD research in UK)
CEA	Commissariat à l'Energie Atomique (French government-funded technological research organisation)
CEGB	Central Electricity Generating Board
CNE	French national R&D evaluation commission
CNRS	Centre National de la Recherche Scientifique (French government-funded national centre for scientific research)
CoRWM	Committee on Radioactive Waste Management
CPD	continuing professional development
CRIEPI	Central Research Institute of the Electric Power Industry (Japan)
CRP	Co-ordinated Research Project (run by IAEA)
CRR	Centre for Radiochemistry Research (BNFL URA at Manchester University)
DBD	deep borehole disposal
DECC	Department of Energy and Climate Change
DECOVALEX	Development of Coupled THCM Models and their Validation against Experiments (an international project)
Defra	Department for Environment, Food and Rural Affairs
DFR	Dounreay Fast Reactor or Directorate of Fisheries Research (part of MAFF)

DfT	Department for Transport
DIAMOND	Decommissioning, Immobilisation and Management of Nuclear Wastes for Disposal (a consortium of universities carrying out research, funded by RCUK)
DIUS	Department for Innovation, Universities and Skills (now part of the Department for Business, Innovation and Skills)
DOE	Department of Energy (USA)
DoE	Department of the Environment (UK, subsequently the Department for Environment, Transport and the Regions, DETR))
DRP	Direct Research Portfolio (the directly funded NDA research programme)
DSSC	disposal system safety case (being developed by NDA)
EA	Environment Agency (for England and Wales)
EARP	Enhanced Actinide Removal Plant (at Sellafield)
EBS	engineered barrier system
EC	European Commission
EDF	Electricité de France
EDZ	engineering disturbed zone
EIA	environmental impact assessment
EMUS	Encapsulation of Metallic Uranium Steering Group (established by Sellafield Ltd)
EPS	Encapsulated Product Store (at Sellafield, there are three stores: EPS1, EPS2 and EPS3)
EPSRC	Engineering and Physical Sciences Research Council
EU	European Union
FEPs	features, events and processes (to be considered in post-closure safety cases for GDFs)
FHP	fuel handling plant
FORGE	Fate of Repository Gases (an EU project)

FP	Framework Programme (of the European Union)
FSD	Food Sciences Division (part of MAFF)
FUD	Forskning, Utveckling och Demonstration (Research, Development and Demonstration programme, Sweden)
FZD	Forschungszentrum Dresden (federally-supported research centre, Germany)
GBq	gigabecquerel (a unit of radioactivity)
GDF	geological disposal facility
GLEEP	Graphite Low Energy Experimental Pile (a research reactor at Harwell)
GOCO	Government owned, contractor operated
GRA	Guidance on Requirements for Authorisation (for disposal of solid radioactive wastes, produced by the environment agencies)
HAW	higher activity waste
HAWS	higher activity waste strategy
HLW	high level waste
HMIP	Her Majesty's Inspectorate of Pollution
HPA	Health Protection Agency
HSE	Health and Safety Executive
IAEA	International Atomic Energy Agency (a United Nations agency)
IGSC	Integrated Group on the Safety Case (of NEA's RWMC)
ILW	intermediate level waste
INE	Institut für Nukleare Entsorgung (Institute for Nuclear Waste Disposal, federally-supported research centre at Karlsruhe, Germany)
INSU	Institut National des Sciences de l'Univers (French national institute for earth sciences and astronomy, maintained by CNRS)
IOMMM	Institute of Materials, Minerals and Mining
IoP	Institute of Physics

IPSE	Institute for Particle Science and Engineering (BNFL URA at Leeds University)
IRSN	Institut de Radioprotection et de Sureté Nucléaire (French agency that advises ASN on radiological and nuclear safety
ISL	Immobilisation Science Laboratory (BNFL URA at Sheffield University)
ITRG	Independent Technical Review Group (Canada)
ITU	Institut für Transurane (European institute for transuranic elements, Karlsruhe, Germany)
IVO	Imatran Voima Oy, (Finnish nuclear power company, now Fortum)
JAEA	Japanese Atomic Energy Authority
JRC	(European Union) Joint Research Centre
KNOO	Keeping the Nuclear Option Open (a consortium of universities carrying out research, funded by RCUK)
KTA	Knowledge Transfer Account (an EPSRC funding scheme to encourage knowledge transfer from universities to industry)
LLW	low level waste
LLWR	Low Level Waste Repository (near Drigg, in Cumbria)
LMI	labour market intelligence (research)
LoC	Letter of Compliance (previously Letter of Comfort)
LTP	lifetime plan (produced for each NDA site)
LWR	light water reactor (a generic term, includes BWRs and PWRs)
MAFF	Ministry of Agriculture, Fisheries and Food
MEP	Magnox Encapsulation Plant (at Sellafield)
METI	Ministry of Economy, Trade and Industry (Japan)
MKG	Miljöorganisationernas Kärnavfallsgranskning – (Swedish NGO office for nuclear waste review)
MoD	Ministry of Defence
MOP	Magnox Operating Plan (the current plan is the eighth, MOP8)

MOX	mixed oxide fuel (contains uranium and plutonium oxides)
MPC	Materials Performance Centre (BNFL URA at Manchester University)
MRC	Medical Research Council
MRP	Magnox reprocessing plant (at Sellafield)
MRWS	Managing Radioactive Waste Safely (the UK programme for the management of higher activity wastes)
NAS	(USA) National Academy of Sciences
NDA	Nuclear Decommissioning Authority
NDARB	Nuclear Decommissioning Authority Research Board on nuclear decommissioning and waste clean-up
NEA	Nuclear Energy Agency (part of the Organisation for Economic Co-operation and Development)
NERC	Natural Environment Research Council
NGO	non-governmental organisation
NIEA	Northern Ireland Environment Agency
NII	Nuclear Installations Inspectorate (part of HSE)
NNL	National Nuclear Laboratory
NRI	Nuclear Research Index (compiled by HSE)
NSAN	National Skills Academy for Nuclear
NSG	Nuclear Skills Group
NTEC	Nuclear Training Education Consortium (UK)
NuSAC	Nuclear Safety Advisory Committee (now disbanded, advised HSE)
NUMO	Nuclear Waste Management Organisation (Japan)
NVQ	National Vocational Qualification
NWAT	Nuclear Waste Assessment Team (within the Environment Agency)
NWMO	Nuclear Waste Management Organisation (Canada)
NWRF	Nuclear Waste Research Forum (a group convened by the NDA)

OCNS	Office of Civil Nuclear Security (part of HSE)
OECD	Organisation for Economic Co-operation and Development
ONE	(USA) Office of Nuclear Energy
OPC	ordinary Portland cement
OPECST	Office Parlementaire d'Evaluation des Choix Scientifiques et Technologiques (French Parliamentary Office for evaluation of scientific and technical options)
P&T	partitioning and transmutation
PACE	Programme sur l'Aval du Cycle Electronucléaire (French programme of nuclear research)
PCM	plutonium contaminated material
PDRA	post-doctoral research associate
PFR	Prototype Fast Reactor (at Dounreay)
PIA	Preliminary Investigation Area (Japan, for a GDF)
PNNL	Pacific Northwest National Laboratory (USA)
PVC	polyvinylchloride
PSE	public and stakeholder engagement
PWR	pressurised water reactor
RADREM	Radioactivity Research and Environment Monitoring (Committee of UK DoE)
RAEng	Royal Academy of Engineering
RCEP	Research Councils Energy Programme or Royal Commission on Environmental Pollution
RCF	rock characterisation facility
RCUK	Research Councils UK (co-ordinating body for the various Research Councils)
R&D	research and development
RRG	Research Review Group (advises HSE on nuclear safety research)

RS	Royal Society
RSC	Royal Society of Chemistry
RWMAC	Radioactive Waste Management Advisory Committee
RWMC	radioactive waste management case (a safety case for a proposed waste conditioning and packaging process) or Radioactive Waste Management funding and research Centre (Japan) or Radioactive Waste Management Committee (of NEA)
RWMD	Radioactive Waste Management Directorate (of NDA)
SAC	Scientific Advisory Committee (of RCUK)
SEPA	Scottish Environment Protection Agency
SGHWR	Steam Generating Heavy Water Reactor (an experimental reactor at Winfrith)
SISB	Science and Innovation Strategy Board (NERC advisory committee)
SIXEP	Site Ion Exchange Plant (at Sellafield)
SKB	Svensk Kärnbränslehantering AB (Swedish nuclear fuel and waste management company)
SKI	Swedish Nuclear Power Inspectorate (now part of SSM)
SLC	site licence company (a company that runs an NDA site, under contract to the NDA, and holds the nuclear site licence)
SMS	strategy management system (of the NDA)
SNIFFER	Scotland and Northern Ireland Forum for Environmental Research
SNWF	Swedish Nuclear Waste Fund
SSEC	sub-surface exclusion criteria
SSI	Swedish Radiation Protection Institute (now part of SSM)
SSM	Strålsäkerhetsmyndigheten (Swedish Radiation Safety Authority)
SSRL	Stanford Synchrotron Radiation Laboratory (USA)
STFC	Science and Technology Facilities Council
STUK	Säteilyturvakeskus (Finnish radiation and nuclear safety authority)

TBuRD	Technical Baseline and underpinning R&D Document (produced by each SLC for its sites)
THCM	thermal-hydraulic-chemical-mechanical (coupled processes)
tHM	Metric tonnes of Heavy Metal (uranium and plutonium)
THORP	Thermal Oxide Reprocessing Plant (at Sellafield)
TMF	Tails Management Facility (to be built at Urenco's Capenhurst site)
TSB	Technology Strategy Board (of BIS)
TVO	Teollisuuden Voima Oy (Finnish nuclear power company)
UKAEA	United Kingdom Atomic Energy Authority (now used only as an acronym, mainly as part of the names of the organisations into which the Authority was split)
URA	University Research Alliance (*e.g.* with NNL)
URF	underground research facility
URL	underground research laboratory (or underground rock laboratory)
USDOE	United States Department of Energy
USGS	United States Geological Survey
USNRC	United States Nuclear Regulatory Commission
VPS	Vitrified Product Store (at Sellafield)
WAGR	Windscale AGR (an experimental reactor at Sellafield)
WIPP	Waste Isolation Pilot Plant (a geological disposal facility in New Mexico, USA)
WMO	waste management organisation
ZEBRA	Zero Energy Breeder Reactor Assembly (an experimental facility at Winfrith, now dismantled)

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Minutes of 54th plenary meeting, London, 9 June 2009

Item 1 Welcome and introduction by the Chair; apologies for absence

1. Present: Robert Pickard (Chair), David Broughton, Margaret Burns, Brian Clark, Mark Dutton, Fergus Gibb, Marion Hill, Bill Lee, Francis Livens, Rebecca Lunn, Les Netherton, John Rennilson, Andy Sloan, Lynda Warren. Secretariat: Sam Bains, Simon Mussett, Lisa Matta & Adam Scott. Apologies: Simon Harley.

2. The Chair welcomed the public to the meeting. While this was a meeting of the Committee, rather than a public meeting, comments and questions would be welcomed after the end of the agenda. (These are summarised in Annex A.) The Committee aimed to take all substantive decisions in public. Any closed meetings, such as those held to plan workload or to verify the accuracy of information, were reported publicly.

Item 2 Declarations of interest

3. Members were asked to declare any interest in the event of any conflict arising. There were no changes to their published declarations.

Item 3 Minutes of 21 April plenary & matters arising *(Document 2598)*

4. Members had commented on an initial draft; there were no corrections to this revised draft.

5. **Actions**:

    1. **Publish 21 April minutes**. Secretariat, June.
    2. **Publish e-bulletin from 9 June plenary**. Secretariat, June.
    3. **Draft 9 June plenary minutes**. Secretariat, June.

Item 4 Work Programme Development (*Documents 2602, 2603)*

6. Members noted paper 2602 (progress report). Les Netherton introduced paper 2603 which proposed organisational changes to reflect the Committee's plans for the 2009/10 work programme.

7. Annex A – Structure and Member allocation: Initial task group allocations had been made. Lynda Warren would be added to group 1 (interim storage) under 'other member interests'. Rebecca Lunn would be added to group 3 (voluntarism & partnerships). Mark Dutton and Marion Hill would support Fergus Gibb in group 4 (site assessment & geological disposal R&D) for task 6. Marion Hill would lead group 5 (new build wastes) with Mark Dutton in support.

8. Annex B – Watching briefs: Les said that this was an initial outline. Further work would need to be done to fill the gaps and it would be revisited at the July plenary.

9. Public and stakeholder engagement: task groups would determine their own PSE needs and this would need co-ordination.

10. Lynda Warren said that a group was needed to oversee PSE strategy, ensuring PSE needs came out from task groups with Member buy-in. This steering group could meet 'virtually' and start to plot in a rough timetable of PSE expectations. Task group lead members should report back to the PSE overseeing body lead member on a regular basis. There was also a need to discuss how CoRWM scrutinises other organisations' PSE processes. Brian Clark agreed to the proposal for virtual meetings, though the group needed an initial meeting in person.

11. Plenary meetings: Members were happy with the current two day arrangements with a mix of working-group and plenary discussion. Plenary papers would be marked for Information, for discussion or for decision. Information papers would be taken as read. Wherever possible, papers would be sent out by the secretariat two weeks before a plenary meeting.

12. Annex C: Presentations at Plenary meetings. Les said that this should be treated as an initial list that would be revisited and prioritised as groups developed their work plans. As a basic rule presentations should last no more than twenty minutes with twenty minutes for questions. The meeting decided that presentations should start once the Committee's reports on Geological Disposal and R&D had been submitted to Government by the end of October.

13. Annexes D & E: Les said that the draft 2009/10 Work Programme was awaiting Government approval. There was now a need to monitor it and record progress. Members agreed that the tables in Annex D and E were a sensible approach to monitoring and recording progress.

14. **Actions**:

    4. **Propose dates for organising a first meeting on PSE**. Lynda Warren.
    5. **Circulate papers 2 weeks before plenary meetings wherever possible**, marked for information, discussion or decision. To include papers for any eve-of-plenary preparatory meetings. Secretariat.

6. **When circulating papers to Members, indicate who needs to take action**, forward the paper &c. Secretariat.
7. **Report progress to secretariat, before each plenary meeting, on tasks in work programme** using pro-forma in doc. 2603. Members leading tasks.

Item 5 Storage R&D Position Paper (*Document 2389, 2581)*

15. Bill Lee said that the Storage R&D paper (doc. 2389) was originally conceived as a stand- alone report but was now a position paper. It would feed into CoRWM's full report on R&D that had been discussed in private on 8 June.

16. Document 2581 was a log of comments received on the storage R&D paper in February 2009. The paper had been revised in light of comments. It included no recommendations just emerging conclusions that would contribute to the full R&D report. Bill then asked for final Member comments before revising and publishing the position paper.

17. Comments included these:
    - The report referred to 'bottom-up' and 'top-down'' approaches to establishing R&D requirements and then identified a need for strategic co-ordination. There was a need to make clear that 'bottom-up' approaches were required as well.
    - There was a need to mention social sciences R&D.
    - There was a need to check whether the terms 'research' and 'R&D' were used in the right way throughout. (There seemed to be some instances where R&D was used but what was meant was research.)
    - Page 26, top 2 lines: what stakeholders actually said was that R&D was very important, not that there 'is a concern that it should be done'.
    - Members also had drafting suggestions including standardised use of abbreviations (e.g. for *million*).

Item 6 Deep Geological Disposal (*Documents 2593, 2604, 2550, 2592,2605)*

18. The discussion comprised two main sections.

    - First, Mark Dutton introduced reports from events in West Cumbria, where people had commented on the draft report or issues relevant to it.

    - Secondly, John Rennilson took the meeting through the Committee's draft report to Government, section by section, to discuss issues arising from the events and from stakeholders' written comments on the draft, and to identify where changes might be needed.

Event reports from West Cumbria. (*Documents 2604, 2605 and 2593).*

19. Mark Dutton introduced the second meeting report of the Copeland MRWS Partnership, held on 14th May 2009 (doc. 2604). He and Brian Clark had attended as observers and he highlighted the issues raised throughout the meeting, which included:

- Who should be the decision making body in areas where there is more than one tier of local government?
- When do potential host communities become involved in the site selection process, given that it will be some time before potential sites will be identified?
- Further Expression of Interests should not be accepted after the first Decision to Participate.

20. The Partnership meeting then went on to discuss the criteria for a Decision to Participate, which included:

    - Commitment from Government to a benefits package and clarity on how the community would benefit.
    - Confirmation that monitorability and retrievability would be an option.
    - Clarity and flexibility on the inventory. The community might not accept the disposal of spent fuel and plutonium.

21. Members discussed the report:

    - in regard to clarity on the inventory, a reason should be given why spent fuel and plutonium might not be accepted. (It is because Cumbria County Council favours reprocessing of spent fuel and recycling of plutonium, in Cumbria.)

    - the point that 'a clear understanding of the planning process is required before a Decision to Participate (DtP) can be made...' needed expansion as the lead planning authority would be the National Park Authority.

    - If underground workings were located under the sea, the Marine Act would apply and the local Planning Authority would likely act as the planning authority for the facility.

22. Mark Dutton said that the Expression of Interest in Cumbria could be affected by the local elections that took place on 4th June 2009, which had led to a change of control of the County Council and a new cabinet.

23. Mark then reported on the Cumbrian Stakeholder Workshop held in Workington on 15th May 2009 (doc. 2593). The event had been very useful and he thanked all those involved. A good lesson learnt from the event was having two Members on each table, which worked well and the feedback provided from them was very useful. Members had drawn up a list of the most important issues (doc. 2605) they perceived coming out of the meeting. These had been added to the public and stakeholder comments log (doc. 2592) for the purposes of the plenary discussion.

24. The following comments were made:

    - Participants' feedback forms on the event would need to be discussed with the PSE Working Group on how the event was run.

    - The location was a good one: future public and stakeholder events should be held where possible in local community centres.

- Participants on the industry table wanted the geological disposal process to move on and not stagnate.

- Participants from a local parish council felt that the concept of an Infrastructure Planning Commission went against voluntarism. They wished to be involved in discussions from the start in relation to benefits and financial packages. Members discussed how people from individual parishes could be involved in the siting process and how they could be represented e.g. by local councils or associations.

25. The Chair said that there were a number of issues relating to the decision making process. At the local authority level there was a desire for Government to get involved with working out local representation on the Decision Making Body or to recommend organisations that could help. Government believed that local authorities should work out representation locally, and would rather not interfere. He concluded that Workington was a worthwhile event with many useful comments received.

26. **Action**:

    8. **Collate the feedback forms from the Workington event and distribute to all members of the PSE Group.** Secretariat

Discussion of the Committee's draft report to Government. (*Documents 2550, 2592.)*

27. John Rennilson introduced the draft Report (doc. 2550) and the comments log (2592). This was the main item of business. The log contained the comments of stakeholders in response to the draft published on 27 April 2009, with the initial view of the Member or Members responsible for the relevant section: for example, that the comment should be noted; disagreed; agreed, either to the point of revising the Report (where appropriate, suggesting specific text) or taking some other follow-up action. As part of this, the Members had identified comments that raised issues which they felt needed plenary discussion.

28. The Committee discussed the draft report, taking account of stakeholders' comments in the log and in the event reports, also noting that some stakeholders had expressed views on more than one opportunity. Unless otherwise recorded here, the meeting agreed with the initial comments made by Members on the log. The discussion was part of a process that would include
    - on 9 June 2009: plenary debate of as many of the identified issues as possible, with opportunities for Members to send in further suggestions after the meeting;
    - on 19 June 2009: a meeting of members of the geological disposal drafting team, to develop the draft in the light of Members' comments, to discuss any remaining issues and suggest any drafting changes;
    - in late June 2009, a further opportunity for Members to comment;
    - a meeting with sponsors in early July 2009; and
    - publication of a final draft by 8 July 2009 for discussion at the plenary meeting on 15 or 16 July 2009.

29. *Table 1 of the log - title*. John Rennilson proposed that the term "deep" be dropped from "deep geological disposal" because of a comment raised by the

Nuclear Decommissioning Authority (NDA). This would be discussed later in relation to section 12 of the report.

30. *Table 3 - Report section 1: Introduction.* Members discussed comments from

    - Sellafield Ltd, about use of 'Higher Activity Wastes', generic term as there will be differences in how ILW and HLW would be addressed.
      Members' view was that the term already appeared in all MRWS-related publications, was well understood and needed no revision.

    - Dr Rachel Western, about failure to address generic issues from the 1990s Nirex inquiry.
      Members noted this: they did not propose changes to this Report, but the UK needed to learn the lessons, and the West Cumbria partnership was studying these.

31. *Table 4 – Report section 2: Voluntarism and Partnership.* Members discussed comments from

    - NuLeAF, about identifying a cut-off point for Expressions of Interest. Similar comments were made by
      - Allerdale Borough Council and
      - Copeland BC.

      Members took the view, as expressed clearly in the report, that other communities should not be discouraged or prevented from expressing an interest. There was a range of views on the extent to which the Committee should offer detailed advice and suggestions to Government. Members concluded that the Report should be worded so as to mention this concern but go no further Also relevant was the comment from:
      - Wylfa Site Stakeholder Group, on the need to keep open the possibility of further Expressions of Interest.

    - Wylfa SSG, about negative perceptions about the Expressions of Interest process. A similar point had been made by
      - Dr Brian Thompson, about lack of awareness about the process.

      Members saw this as a good point for following up, though the Report did not need redrafting.

32. *Table 5 – Report section 3: Decision Making.* Members discussed comments from

    - NFLA, about whether documents from the Geological Disposal Implementation Board and Waste Management Steering Group documents should be placed on a dedicated website. Members felt that this comment should be noted. CoRWM takes, wherever possible, the chance to recommend openness and transparency.

    - NFLA, about the need for more definition of a "willing" community. Members discussed the proposed text in the comments log, but felt that it was over-prescriptive.

    - Bradwell for Renewable Energy, about the need for substantive public involvement.

Again, while recognising the need for this, Members considered the proposed text too specific, and too focused on developments in Cumbria rather than the UK generally.

- Allerdale BC, on problems in defining decision-making roles and leads in an area where there were 3 tiers of local government including the county, district and parish. A similar issue was raised by
    - the Cumbria Association of Local Councils.

  Again, there was a range of views about the degree to which the Committee should offer detailed advice to Government. Generally, Members recognised the importance of the issue, and the need to refer to it in the Report, including the possibility that Government might have to take a more active approach. Meanwhile Members did not wish to be prescriptive about how the issue should be addressed by Government.

33. *Table 6 – Report section 4: Funding.* Members discussed comments from

- NuLeAF, about the need to ensure that the implementation of geological disposal was not jeopardised by lack of funding. Similar issues were raised at
    - the Workington event.

  Members discussed the extent to which the Committee could make useful comments or recommendations. There were local concerns at parish level about access to Engagement Packages, which should be referred to. On Benefits Packages, Government had declared itself open to discussion but it could not make commitments at this stage. There would need to be site specific negotiations with communities in due course.

34. Given the range of the report and the number of issues raised by commentators, Members decided to look next at comments on section 12 (concepts) and the Executive Summary (including the draft recommendations).

35. *Table 14 – Report section 12: Developing Concepts and Designs for Geological Disposal.* Members discussed Marion Hill's ***Concepts and designs note*** (doc. 2616) circulated to other Members on 3 June 2009) which looked at comments and recommended changes to the draft.

36. *Concepts and designs.* Members' comments included:

- Section 12, including recommendations 3 and 4, needed to be revised to clarify CoRWM's intentions. The Committee in 2006 had assessed long-term management options and, of these, had recommended geological disposal in a mined repository and had given an indicative range of depths. NDA was now assessing various disposal concepts but the focus was too narrow.

- Since CoRWM's 2006 recommendations, thinking had evolved so that, for example, deep borehole disposal was now seen by some as a form of geological disposal, which might be suitable for some, but not all, of the waste inventory. In its assessment of options CoRWM had considered deep boreholes as an alternative to a mined repository and one which it did not advocate but had said that developments should be actively pursued. There had been significant technical development since 2006 of

deep borehole disposal. If the Committee was now saying that deep borehole disposal should be subjected to detailed assessment by NDA, it would need to link its present position to the 2006 Recommendations and the Government response to them. (The response had merely said that deep boreholes should be kept under review.)

- The 2006 CoRWM definition of 'geological disposal' was too narrow needed to be revisited. There were many geological disposal concepts that needed to be considered including mined and non-mined facilities, at a wide range of depths, and combinations of those.

- Near-surface disposal of reactor decommissioning waste was also noted in 2006 as a possibility.

37. *Terminology.* This included the case for including the word "deep" alongside "geological disposal". Comments included:

    - The new definition of "deep geological disposal" will introduce unnecessary confusion and contradict CoRWM's previous position.

    - There was agreement from the Committee that there should be consistency with definitions and "deep" should be dropped. The definition should be redrafted along the lines of that provided in the Environment Agency's 'Guidance on Requirements for Authorisation', but noting that, internationally, 'geological disposal' included concepts involving the use of natural caverns.

38. *Co-disposal.* Members' comments included:

    - the need to clarify the difference between co-disposal and co-location, and to be consistent with the meanings given to those terms by Government;

    - the importance of the hydrogeological or hydrogeochemical regime in which the different wastes were emplaced (co-disposal implied emplacement in the same regime, co-location did not); and

    - the need for consistency between this report and the Committee's draft report on R&D.

39. *Other issues.* Members' comments included:

    - disagreement with the Environment Agency reference to "significant disadvantages" of deep borehole disposal.

40. *Table 2 – Executive Summary.* Members discussed the draft recommendations, focusing on recommendations 1 (funding) and 2 (planning), having already discussed concepts and designs which gave rise to recommendations 3 and 4.

41. *Funding*. Points made included:

- Government was not happy with the proposed recommendation and might regard it as unrealistic to expect assurances especially at this stage in local negotiations.

- However, there were precedents for assured funding, including the case of the Shetlands Islands.

- The Committee was not asking for assurance, rather it was saying that local communities would need it.

42. *Planning*. Points made included:

    - the need for 'hold points' in site investigations and disposal facility construction, with opportunities for local input; these might be the main issue, rather than the number of planning applications

    - uncertainty about how the new Planning Act / Infrastructure Planning Commission regime would operate in the case of geological disposal, and the need for more clarity on the extent to which it might affect local communities' role in decision making;

    - other risks to the process, including local authorities' ability to work together - though the Committee had just consulted on its draft recommendations and this was not a good time to be introducing new ones.

43. The Chair said that the Report would be redrafted in the light of plenary comments.

44. **Actions**:

    9. **Send any further comments to John Rennilson**. Members, by 16 June 2009.
    10. **Redraft the report taking account of plenary comments, review remaining issues raised by public and stakeholder comments, and propose any further changes to the draft.** John Rennilson and members of his drafting group, from 19 June 2009.
    11. **Consider any further comments from Members, and publish further draft for 15 July 2009 plenary.** John Rennilson, secretariat, by 8 July 2009.

Item 7 Fifth Annual Report, 2008-9 *(Document 2574)*

45. Members suggested a number of changes to the draft including the addition of dates and updating of biographical details.

46. **Action**:

    12. **Redraft reflecting Member comments and any further suggestions from Members**. Secretariat, late June.

Item 8 Any other business

47. There was no other business and the Chair thanked those present for attending.

List of papers for the meeting

Paper	Date sent	Doc. no.	Agenda Item
Minutes of 21st April plenary, Edinburgh		2598	3
Programme progress report		2602	4
Work programme development		2603	4
Storage R&D Position Paper		2389	5
Storage R&D Position Paper – comments log		2581	5
CoRWM's Cumbrian Stakeholder Workshop Note		2593	6
West Cumbria MRWS Partnership Meeting		2604	6
Deep Geological Disposal of Higher Activity Wastes		2550	6
Log of responses to consultation on full draft of CoRWM's deep geological Disposal report		2592	6
CoRWM's Cumbrian Stakeholder Workshop - Key Points		2605	6
Note on Parts of Deep Geological Disposal Report dealing with Development of Concepts and Designs for Geological Disposal		2616	6
Fifth Annual Report, 2008-9		2574	7

Annex A

There was an opportunity for the public to comment or ask questions after the end of the meeting. The following issues were raised. Members responded informally, i.e. their comments did not necessarily reflect a formal view by the Committee.

1. Phillip Rendal: raised an issue with the definition of 'design' of a GDF (section 12.34), "By 'design' CoRWM meant the detailed drawings and specifications...". Design development and preparation of specifications should be identified as two separate elements. Members replied that the two may or maynot be split, it depended on the procurement route chosen. Also, there was a difference between performance specifications and engineering specifications.

2. Phil Davies: Inter-generational equity (p.62 of draft geological disposal report) was not just about balancing the needs of different generations, but treating all the generations fairly. Also, consistency was needed between inter- and intra-generational equity. Both implied respecting rights, freedoms and dignity.

3. Phil Davies: Spent fuel from new reactors might need longer periods of storage for cooling - possibly 100 years after removal from the reactor. How would this comply with IAEA principle 7 (protection of present and future generations) and

with inter-generational equity? More generally, how would CoRWM fulfil its mandate to scrutinise Government policy?

While acknowledging the issues, Members noted that this would not be a new situation. At Sellafield, Dounreay and other UK sites there was waste in facilities that dated back half a century. The position would be much better for new build, where storage for decades was being planned for from the start.

4. Neil Smart, NDA: when speaking of the need for R&D to underpin geological disposal, it should be borne in mind that the key driver was the need for a robust safety case. It was harder to focus an R&D programme when one did not yet have potential geologies and disposal facility designs to work around.

   Members commented that some fundamental research would also be needed, as this would occasionally identify previously undiscovered gaps or uncertainties - in other words, the "what you don't know you don't know" as well as the "what you know you don't know".

5. Phil Davies: The Swedish KBS concept seemed to be favoured by NDA for spent fuel; had the copper containers been tested with irradiated fuel?

   NDA undertook to ask SKB.

Committee on Radioactive Waste Management

COMMITTEE ON RADIOACTIVE WASTE MANAGEMENT

PROPOSED PROGRAMME OF WORK 2010-2013

31 March 2010

CONTENTS

Annexes

INTRODUCTION BY THE CHAIR

I am pleased to present CoRWM's proposed work programme for 2010-13 to sponsor Ministers, the Secretary of State for Energy and Climate Change and Environment Ministers in Scotland, Wales and Northern Ireland.

CoRWM's proposed programme is outlined in the Executive Summary of this document. Further details of our proposed programme for 2010-11 are given in Sections 4 and 5 of the document, after a statement of our remit and a description of how we developed our proposed programme. Deliverables from the programme are pieces of advice to Government in various forms, including a number of CoRWM position papers and the Committee's Annual Report. Possible topics for subsequent years are in Section 6.

Robert Pickard

EXECUTIVE SUMMARY

1. CoRWM's proposed priorities for scrutiny and advice in 2010-11 are:
    - UK Government work to implement its policy on the long-term management of higher activity wastes (HAW)
    - Scottish Government development of its policy on the management of HAW and of proposals for its implementation
    - NDA Strategy II
    - NDA work on the implementation of geological disposal.

2. In each of these areas CoRWM will advise Government as required. Major proposed deliverables for 2010-11 are:
    - an Annual Report, in June 2011, that summarises CoRWM's work on each priority area during 2010-11 and contains a statement of CoRWM's view on UK progress in managing its HAW
    - position papers on:
        - the development of Scottish Government HAW policy (November 2010)
        - the British Geological Survey's screening out of areas in Cumbria unsuitable for geological disposal (September 2010)
        - NDA preparations for Stage 4 of the geological disposal facility siting process (March 2011)
        - public and stakeholder engagement (PSE) by all organisations involved in the management of HAW (December 2010)
    - a formal response to the NDA consultation on its Strategy II (November 2010).

3. In each of the areas, except scrutiny of the development of Scottish Government policy, CoRWM will consider existing, committed and new build wastes.

4. CoRWM will carry out its own PSE to support its work. This will make use of its website and other electronic means of communication. It will include meetings with various groups of stakeholders. CoRWM will also consider how it can bring itself to the attention of members of the public who do not have computers, so that they can engage with the Committee when they wish to do so.

5. In formulating its programme for 2010-11 CoRWM has assumed that its budget will be similar to that in 2009-10. The Committee has also assumed that the secretariat resources available to it will be similar to those it has had for the past two years.

6. This document also outlines topics that CoRWM may address in 2011-13.

7. The report of the House of Lords Science and Technology Committee (HL Paper 95, March 2010) was published while this document was being finalised. The report contains a number of recommendations that are relevant to the formulation of CoRWM's work programmes and to its methods of working. CoRWM anticipates that it will discuss these recommendations with its sponsors during the process of approval of its 2010-13 Work Programme.

1. INTRODUCTION

1. This is the third CoRWM work programme since the Committee was reconstituted in 2007. It covers the proposed programme for 2010-11 in detail and identifies topics that could be addressed in the next two years.

2. Document begins with a summary of CoRWM's remit (Section 2). It goes on to describe the development of the proposed 2010-13 work programme (Section 3). Section 4 outlines CoRWM's priorities for 2010-11 and describes the Committee's approach to its work. Section 5 contains the specific tasks for 2010-11 and the deliverables. Section 6 sets out possible topics for 2011-13.

2. CoRWM's REMIT

3. The Committee was set up in 2003 to oversee a review of options for the long-term management of the UK's solid higher activity radioactive waste and to recommend an option (or combination of options) to Government. CoRWM reported in July 2006 (CoRWM doc. 700) and Government responded in October 2006 (Defra *et al.*, 2006) accepting most of CoRWM's recommendations. The Government then began work on the implementation of a policy of geological disposal, using a voluntarism and partnership approach, preceded by robust interim storage and accompanied by the necessary research.

4. There was a public consultation in 2007 on a framework for implementing geological disposal (Defra *et al.*, 2007). The consultation was followed in June 2008 by a White Paper (Cm 7386) and an invitation to local communities to express an interest in hosting a geological disposal facility (Defra *et al.*, 2008). In 2007 the Scottish Government decided not to endorse geological disposal but to support near-surface, near-site storage (Lochhead, 2007).

5. On 25 October 2007 Government re-appointed CoRWM with revised Terms of Reference. These state that (Annex A):

"... The role of the reconstituted Committee on Radioactive Waste Management (CoRWM) will be to provide independent scrutiny and advice to UK Government and devolved administration Ministers on the long-term management, including storage and disposal, of radioactive waste. CoRWM's primary task is to provide independent scrutiny on the Government's and Nuclear Decommissioning Authority's proposals, plans and programmes to deliver geological disposal, together with robust interim storage, as the long-term management option for the UK's higher activity wastes."

6. The current membership of CoRWM is given in Annex B.

3. DEVELOPMENT OF THE 2010-13 WORK PROGRAMME

7. The proposed work programme was developed over the period from October 2009 to March 2010. There was an initial discussion at the October 2009 plenary meeting (CoRWM docs. 2693, 2712). After another discussion at the November 2009 plenary

meeting (CoRWM docs. 2721, 2729) proposals were issued for comment *via* the website and e-bulletin (CoRWM doc. 2730).

8. The proposed programme was discussed again at the January 2010 plenary meeting (CoRWM docs. 2754, 2763, 2770) and a paper issued for comment *via* the website and e-bulletin (CoRWM doc. 2771). Following a meeting with sponsors and the Nuclear Decommissioning Authority (NDA), there was a further plenary discussion in February (CoRWM docs. 2780, 2788).

9. A draft of this document was discussed at the March 2010 plenary meeting and then finalised.

10. The report of the House of Lords Science and Technology Committee (HoL STC, 2010) was published two days after the March 2010 plenary meeting and while this document was being finalised. The report contains a number of recommendations that are relevant to the formulation of CoRWM's work programmes and to its methods of working. CoRWM anticipates that it will discuss these recommendations with its sponsors during the process of approval of its 2010-13 Work Programme.

4. PRIORITIES AND APPROACH FOR 2010-11

Priorities

11. CoRWM's proposed priorities for scrutiny and advice in 2010-11 are:

- UK Government work to implement its policy on the long-term management of higher activity wastes (HAW)
- Scottish Government development of its policy on the management of HAW and of proposals for its implementation
- NDA Strategy II
- NDA work on the implementation of geological disposal.

12. These priorities are based on discussions with sponsors and on CoRWM's own views. The first, second and fourth priorities are continuations from 2009-10. The work on NDA Strategy II is largely a continuation of CoRWM's work on waste conditioning, packaging, storage and transport, and on the management of spent fuels, plutonium and uranium.

13. Research and development (R&D) will be considered in each priority area and the overall strategic co-ordination of HAW R&D will be dealt with in a separate task involving interactions with Government on CoRWM's 2009 R&D report (CoRWM doc. 2543).

14. There will be specific tasks on scrutiny of other organisations' public and stakeholder engagement (PSE). These will cover changes to be made to the Department of Energy and Climate Change (DECC) and NDA websites, as well as scrutiny of those PSE programmes of these and other organisations that are relevant to the management of HAW.

15. The programme will not contain a separate task on new build wastes. Instead, these wastes will be considered under all the other tasks except those related to Scottish Government policy. This is because the UK Government has not identified a requirement for specific advice on new build wastes in 2010-11. If such a requirement does arise, a suitable task will be added.

CoRWM's PSE

16. CoRWM will undertake PSE to support its programme. This will include consultation on draft documents, *via* the website and the e-bulletin, and meetings with various groups of stakeholders. It may also include one or more workshops to which selected stakeholders and members of the public are invited.

17. CoRWM will also be exploring other electronic means of PSE such as carrying out surveys on particular topics using services that are already available. It will be giving consideration to the use of social networking websites, particularly as a means of engaging with young people.

18. The Committee will also be considering whether there are any practicable and affordable methods of raising awareness of CoRWM amongst members of the public who do not have internet access. The aim would be to enable these people to engage with CoRWM when they wished to.

Reporting and Deliverables

19. During 2008 and 2009 CoRWM produced reports to Government on specific topics (CoRWM docs. 2500, 2543, 2550) and an Annual Report that described its activities during the year and gave details of its expenditure (CoRWM doc. 2574). CoRWM does not propose to produce any reports to Government on specific topics in 2010-11. It has agreed with sponsors that it will change the format of its Annual Report to include a summary of the Committee's work during the previous financial year and any statements that the Committee wishes to make on UK progress with managing its HAW, as well as the information on activities and expenditure. The proposed format for the report is shown in Annex C. The report on 2010-11 will be prepared in the period April to June 2011 and published by the end of June 2011.

20. Other major deliverables for 2010-11 will be:
    - position papers on:
        - the development of Scottish Government HAW policy (November 2010)
        - the British Geological Survey's screening out of areas in Cumbria unsuitable for geological disposal (September 2010)
        - NDA preparations for Stage 4 of the geological disposal facility siting process (March 2011)
        - PSE by all organisations involved in the management of HAW (December 2010)
    - a formal response to the NDA consultation on its Strategy II (November 2010).

21. Annex D shows the procedures that CoRWM will use to gather and test evidence for its various forms of advice and the PSE processes that it will apply in each case.

Resources

22. In developing the work programme for 2010-11 CoRWM has assumed that its budget will be similar to that in 2009-10. It is further assumed that secretariat resources will be similar to those available to it since its reconstitution in 2007.

5. PROPOSED TASKS FOR 2010-11

23. Table 1 shows the proposed tasks for 2010-11 and the corresponding deliverables.

24. In addition to these there is some work that was scheduled to be carried out in 2009-10 but which has had to be postponed because of Government delays in issuing documents. This work is to consider whether, and if so how, to respond to the Government consultations on:

    - a methodology for determining a fixed unit price for waste disposal and updated cost estimates for decommissioning, waste management and waste disposal for new nuclear power stations (DECC, 2010a)
    - regulations on financing arrangements for decommissioning and waste management for new nuclear power stations (DECC, 2010b)
    - the long-term management of plutonium (consultation document not yet published).

6. POSSIBLE TOPICS FOR 2011-12 AND 2012-13

25. Key tasks within the 2010-11 work programme will extend into future years. Additional topics will be considered according to the availability of resources.

26. The following are the main work areas for scrutiny and advice in 2011-13. Note that, as in 2010-11, each work area covers existing, committed and new build wastes.

    i) Treatment and packaging of HAW for storage, transport and disposal (deep geological or near surface), storage, transport, associated R&D; corresponding waste-related aspects of the management of spent fuels and nuclear materials.
    ii) Implementation of Scottish Government policy on HAW management, including NDA development of a strategy to implement the policy.
    iii) UK Government work on the implementation of its HAW policy, including the voluntarism and partnership approach to geological disposal facility siting.
    iv) NDA RWMD work on geological disposal implementation, including planning, desk-based studies, SEA, safety case work, R&D.
    v) Near-surface disposal of HAW in England and Wales.
    vi) PSE activities of Government, the NDA, other waste producers and the regulators related to HAW management.

REFERENCES

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Table 1 Proposed Tasks for 2010-11, with Deliverables

Potential tasks	*Task Group (TG) and Timing*	*Resource*	*Deliverables*
NDA Strategy II			
Task A Scrutiny of waste-related aspects of NDA draft Strategy II, respond to public consultation, advise Government as required during finalisation of Strategy II. Will include review of work in four themes: waste management, spent fuels, nuclear materials, critical enablers.	Full Committee, led by TG1. Completion early 2011	High	1. Formal response to public consultation (November 2010). 2. Advice to Government during finalisation of Strategy II (early 2011).
Task B *S*crutinise and advise on treatment and packaging of higher activity wastes (HAW) for storage, transport and disposal, on storage and on transport, in each case including associated research and development (R&D). Carry out similar work for waste-related aspects of the management of spent fuels and nuclear materials (plutonium and uranics). Sub-tasks are: **B1** scrutinise the NDA's development of its "topic strategy" for HAW, including strategic co-ordination of its work with that of other organisations that own or produce HAW **B2** as B1 for spent fuels **B3** as B1 for nuclear materials.	TG1 Mostly April to September 2010	B1 high B2 medium B3 low	1. Input to Strategy II consultation response and advice (see Task A). 2. Chapter in Annual Report (April-June 2011).

Potential tasks	*Task Group (TG) and Timing*	*Resource*	*Deliverables*
Scottish Government Policy			
Task C Complete scrutiny of the development of the Scottish Government policy for the management of higher activity wastes, including the associated Strategic Environmental Assessment (SEA) and advise accordingly.	TG2 Completion by end November 2010	Medium	1. Advice to Scottish Government, as required . 2. Position paper on scrutiny of policy development (November 2010).
UK Government Work on Policy Implementation			
Task D Scrutinise and advise on the voluntarism and partnership approach to geological disposal facility siting. Sub-tasks are: **D1** scrutinise Government work to increase awareness of the invitation to communities and monitor responses **D2** scrutinise Government engagement with and support for communities that have expressed an interest.	TG3 All year All year	 Low High	1. Chapter in Annual Report (April-June 2011). 2. Advice to UK Government, as required.
Task E Scrutinise the British Geological Survey's (BGS) screening out of unsuitable areas in Cumbria	TG4 Expected to be mainly April to August 2010	High	1. Position paper on screening process (September 2010).

Potential tasks	*Task Group (TG) and Timing*	*Resource*	*Deliverables*
NDA Work on Implementation of Geological Disposal			
Task F Scrutinise NDA preparations for stage 4 of the siting process (desk based studies), including SEA work.	TG4 Mainly October 2010 to March 2011	High	1. Position paper on NDA preparations for Stage 4 (March 2011).
Task G Scrutinise and advise on NDA implementation and safety case work. Sub-tasks are: **G1** scrutinise NDA's implementation planning, particularly for the next 5 years, includes familiarisation with RWMD "Steps to Implementation" document and DVD and with Business Plan for 2010-11 (all to be published April 2010) **G2** scrutinise NDA's development of its generic Disposal System Safety Case (DSSC) (to be published September 2010, draft to be made available to CoRWM in April 2010 for information).	TG4 All year Mainly after September 2010.	Medium Medium	1. Chapter in Annual Report on implementation planning (April-June 2011). 2. Chapter in Annual Report on DSSC development (April-June 2011).
Task H Scrutiny of R&D for geological disposal **H1** scrutinise NDA RWMD R&D on geological disposal **H2** maintain awareness of other UK organisation's plans for R&D related to geological disposal (e.g. NERC, EPSRC).	TG4 All year	Low	1. Chapter in Annual Report (April-June 2011).

Potential tasks	*Task Group (TG) and Timing*	*Resource*	*Deliverables*
Other Work			
Task I Scrutinise the PSE activities of Government, the NDA, other waste producers and the regulators related to HAW management. Sub-tasks are: **I1** scrutinise the dissemination of information on HAW management (including changes to the DECC main, MRWS and NDA websites) **I2** identify gaps in and assess effectiveness of organisations' PSE on HAW management	TG6 All year	Medium	1. Position paper on PSE (December 2010). 2. Chapter in Annual Report (April-June 2011).
Task J Interactions with Government on actions in response to recommendations in CoRWM's 2009 R&D Report	TG1 & TG4 All year	Low	1. Advice to Government, as required. 2. Chapter or section in Annual Report (April-June 2011).

Notes

1. Each task except Task C covers existing, committed and new build wastes.
2. All tasks will be covered in the Annual Report for 2010-11. The Annual Report is only mentioned in the table where it contains the main deliverable for a task.

ANNEX A CoRWM TERMS OF REFERENCE

Introduction

A1. Following the announcements by UK Government and the devolved administrations (Government), on 25 October 2006, a new Committee on Radioactive Waste Management (CoRWM) will be appointed under these revised terms of reference designed to meet the future needs of the Government's Managing Radioactive Waste Safely (MRWS) programme. The Committee will be jointly appointed by UK Government and relevant devolved administration Ministers. Details of its roles, responsibilities and membership are outlined below.

CoRWM's Role and Responsibilities

A2. The role of the reconstituted Committee on Radioactive Waste Management (CoRWM) will be to provide independent scrutiny and advice to UK Government and devolved administration Ministers on the long-term management, including storage and disposal, of radioactive waste. CoRWM's primary task is to provide independent scrutiny on the Government's and NDA's proposals, plans and programmes to deliver geological disposal, together with robust interim storage, as the long-term management option for the UK's higher activity wastes.

A3. Sponsoring Ministers (from Defra, DTI and the devolved administrations) will agree a three-year rolling programme and budget for CoRWM's work on an annual basis. Any in-year changes will be the subject of agreement by sponsoring Ministers.

A4. CoRWM will provide appropriate and timely evidence-based advice on Government and Nuclear Decommissioning Authority (NDA) plans for the delivery of a geological disposal facility for higher activity wastes under the Managing Radioactive Waste Safety programme. The work programme may include review of activities including waste packaging options, geological disposal facility delivery programmes and plans, site selection processes and criteria, and the approach to public and stakeholder engagement. Testing the evidence base of the plans for the delivery of a geological disposal facility will be a key component of the work. As well as ongoing dialogue with Government, the implementing body, local authorities and stakeholders, CoRWM will provide an annual report of its work to Government.

A5. CoRWM shall undertake its work in an open and consultative manner. It will engage with stakeholders and it will publish advice (and the underpinning evidence) in a way that is meaningful to the non-expert. It will comply, as will sponsoring departments, with Guidelines on Scientific Analysis in Policy Making (http://www.dti.gov.uk/files/file9767.pdf) as well as other relevant Government advice and guidelines. Government will respond to all substantive advice. Published advice and reports will be made available in respective Parliaments/Assemblies, as will any Government response. CoRWM's Chair will attend Parliamentary / Assembly evidence sessions as and when required.

A6. With the agreement of CoRWM's sponsoring Ministers, other parts of Government, the NDA and the regulatory bodies may request independent advice from CoRWM. Relevant Parliamentary / Assembly Committees may also propose work to sponsoring Ministers, for

consideration in the work programme. CoRWM's priority role is set out in paragraph 2 although sponsoring Ministers may also ask the Committee to provide advice on other radioactive waste management issues as necessary.

A7. In delivering its annual work programme, and where there is a common interest, the Committee will liaise with appropriate advisory bodies including Health and Safety Commission advisory bodies, and any advisory bodies established by the environment agencies.

A8. CoRWM shall consist of a Chair and up to fourteen members, one of whom will be appointed by Ministers as Deputy Chair on the recommendation of the Chair. Seats will not be representative of organisation or sectoral interests and the skills and expertise which will need to be available to the Committee will vary depending on the programme of work. For example, the relevant skills may include: radioactive waste management, nuclear science, radiation protection, environmental law, environment issues, social science (including public and stakeholder engagement), geology / geochemistry / hydrogeology, finance / economics, civil engineering / underground construction technology, geological disposal facility performance / safety issues, materials science, environmental impact assessment, local Government, planning, regulatory processes and ethics. Sponsoring Ministers may review the membership of the Committee, and the skills and expertise required.

A9. Appointments will be made following the Office of the Commissioner for Public Appointments (OCPA) code of practice. Initial appointments will be for three years and sponsoring Ministers retain the right to terminate appointments at any time in light of individual members' performance, changes in CoRWM's work requirements, or completion of the work required of CoRWM.

A10. The Committee, as agreed in the annual plans, may co-opt additional expertise to form or support temporary sub-groups set up to examine specific and defined problems.

Programme of work

A11. To support its work, CoRWM will need to familiarise itself with Government policy in this area, including ongoing meetings with relevant Government departments and the NDA. The outline framework within which CoRWM is then expected to work is:

(i) *recognising the policy framework within which it will operate including* the roles and responsibilities of Government and the NDA in relation to CoRWM's own advisory role;

(ii) *scrutinising Government and NDA proposals, plans and programmes* to implement geological disposal and other radioactive waste management issues on which Government might seek advice as agreed in CoRWM's work plan;

(iii) *formulation of advice and reporting to Government* based on the best available evidence and informed by the views of stakeholders and the public.

A12. CoRWM will prepare its draft work programme, within this outline framework, in conjunction with Government, the NDA and regulators, taking account of work by other advisory bodies (see paragraph 7 above). The programme will include details of specific areas of work, reports which it intends to produce, the proposed use of sub-groups and any other activities or events, including proposals for public and stakeholder engagement. CoRWM will submit its first draft three-year work programme proposal to its sponsoring Ministers for discussion and agreement at an appropriate early stage following appointment of the full Committee. Subsequent three-year work programmes will be agreed annually on a rolling basis.

A13. In familiarising themselves with the relevant background and issues, Members will make themselves aware, and take account, of previous engagement and reports in the Managing Radioactive Waste Safely programme, the UK Radioactive Waste Inventory and the nature of current and expected future UK holdings of plutonium, uranium and spent nuclear fuel. CoRWM will take account of existing technical assessments and research into radioactive waste management in the UK and elsewhere. In particular, it is recognised that CoRWM will need to engage with the NDA given that the Committee's advice will directly impinge on the long-term responsibilities of the NDA. CoRWM will also take account of other relevant policy developments.

A14. The Chair will submit a report to Ministers by 30 June each year on the delivery of the agreed work programme. This will be made available in the UK and Scottish Parliament, the National Assembly for Wales and the Northern Ireland Assembly.

Access to other sources of expertise

A15. Members of CoRWM itself will not have all the skills and expertise necessary to advise Government. The Committee will need to decide how best to secure access to other appropriate sources of expert input during the course of its work. Within this, it will have the option of setting up expert sub-groups containing both Members of CoRWM itself and other appropriate co-opted persons. A member of CoRWM will chair any sub-group of this nature and ensure its effective operation, as well as provide a clear line of responsibility and accountability to the main Committee, and hence to Ministers. This approach will enable the Committee to draw on a broad range of expertise in the UK and elsewhere.

A16. The number of such sub-groups will be kept to the minimum necessary. Their role will be that of providing advice for the main Committee to consider and assess as it sees fit, and managing any activity which CoRWM delegates to them. It will be for the main Committee to assess and decide upon the advice it receives from such sub-groups. CoRWM may also utilise other appropriate means of securing expert input, such as sponsored meetings and seminars. The Chair will ensure that sub-group work and all other activities are closely integrated.

Public and stakeholder engagement

A17. CoRWM must continue to inspire public confidence in the way in which it works. In order to secure such confidence in its advice it will work in an open and transparent manner. Hence, its work should be characterised by:

• a published reporting and transparency policy;
• relevant public and stakeholder engagement as required;
• clear communications including the use of plain English, publishing its advice (and the underpinning evidence) in a way that is meaningful to the non-expert;
• making information accessible;
• encouraging people to ask questions or make their views known and listening to their concerns;
• providing opportunities for people to challenge information, for example by making clear the sources of information and points of view on which the Committee's advice is based;
• holding a number of its meetings in public.

Responsibilities of the committee and its members

A18. CoRWM will have a corporate responsibility to deliver its advice to sponsoring Ministers in accordance with agreed work plans. It will be for Ministers, with appropriate reference to their respective Parliaments and Assembly, to take decisions on the advice it receives and to give directions to the NDA as necessary on any subsequent changes required in the delivery of geological disposal of the UK's solid radioactive waste.

A19. All members will need to be effective team workers, with good analytical skills and good judgement besides a strong interest in the process of decision-making on difficult issues. A number of them will need experience of project management, advising on scientific and technical issues directly relating to radioactive waste management, public and stakeholder engagement, excellent drafting and communication skills, or business experience and knowledge of economics.

A20. The Chair, in addition, will be capable of successfully and objectively leading committee-based projects, grasping complex technical issues, and managing a diverse group effectively and delivering substantial results, presenting progress and outcomes in public. He or she will be a person with appropriate stature and credibility.

Role of the Chair

A21. The Chair will be responsible for supervising the CoRWM work programme and ensuring that the Committee's objectives are achieved. The Chair will be responsible for advising Ministers promptly if he or she anticipates that the Committee will not complete its agreed work programme indicating what remedial action might be taken. He or she will be the main point of contact with the public and the media, in presenting progress and answering questions. The Chair will meet Ministers on appointment, and then at least annually along with other members as appropriate. Notes of these meetings will be published. The Chair will ensure CoRWM submits its annual written report to Ministers, by 30 June of each year. The Chair may be required to present the position of CoRWM to Parliament or Assembly committees and representatives as appropriate. The report will set out, among other things, CoRWM's progress with the agreed work programme, advice deriving from it and costs incurred. Ministers will also appoint a Deputy Chair who can assist the Chair as the latter sees fit.

Role of Members

A22. Members will work, under the Chair's supervision, to the programme agreed with sponsoring Ministers, so as to ensure its satisfactory delivery. Members will have a collective responsibility to ensure achievement of CoRWM's objectives and delivery of its work programme. Individual Members may be appointed by the Chair to undertake specific, active roles, for example chairing sub-groups or in representing CoRWM in meetings with the public, organisations who are contributing to the work, or the media. All members will abide by CoRWM's Code of Practice and will be subject to individual performance appraisal as laid down by the Cabinet Office guide (see next paragraph).

Standards

A23. CoRWM is set up by, and answerable to Ministers and is funded by the taxpayer. It must therefore comply with the Cabinet Office guide "Public Bodies: a Guide for Departments" (http://www.civilservice.gov.uk/other/agencies/publications/pdf/public_bodies_2006/1_case_assessment.pdf).

A24. These and other relevant procedural requirements will be set out in CoRWM's Code of Practice which Members will agree to, prior to appointment.

Resources

A25. Sponsoring Ministers will provide CoRWM with resources – both staff and financial – to enable it to carry out its agreed programme of work. These will include a secretariat which will help CoRWM carry out its work programme including, at the outset, providing reading material and arranging for any further briefings and visits. The Chair and Members will have a collective responsibility for delivering the work programme within the agreed budget, although the Chair may request sponsoring Ministers for adjustment to this budget should this be considered necessary.

Payments

A26. The Chair and Members will be paid for their work for CoRWM at agreed daily rates. They will also be fully reimbursed for all reasonable travel and subsistence costs incurred during the course of their work.

ANNEX B MEMBERSHIP OF CoRWM AND ITS TASK GROUPS

Members of CoRWM

Robert Pickard (Chair)

Bill Lee (Deputy Chair)

David Broughton
Margaret Burns
Brian Clark
Mark Dutton
Fergus Gibb
Simon Harley
Marion Hill
Francis Livens
Rebecca Lunn
Les Netherton
John Rennilson
Andrew Sloan
Lynda Warren

CoRWM's Task Groups for 2010-11

Group 1: Interim storage and related R&D

- Group lead: Marion Hill.
- Members: David Broughton, Simon Harley, Bill Lee, Les Netherton.
- Other member interests: Mark Dutton, Francis Livens.

Group 2: Scottish Government policy

- Group lead: Andrew Sloan
- Members: Margaret Burns, Simon Harley, John Rennilson, David Broughton, Brian Clark.
- Other member interests: Rebecca Lunn, Les Netherton, Marion Hill, Lynda Warren.

Group 3: Voluntarism and partnership

- Group lead: Mark Dutton.
- Members: John Rennilson, Les Netherton, Brian Clark, Margaret Burns, Lynda Warren, Rebecca Lunn.
- Other member interests: David Broughton.

Group 4: Site assessment and geological disposal R&D

- Group lead: Simon Harley
- Members: Andy Sloan, Fergus Gibb, Francis Livens, Rebecca Lunn, Mark Dutton, Bill Lee.
- Other member interests: Marion Hill

Group 5: New build wastes (see note 1)

- Group lead: Marion Hill.
- Members: David Broughton, Margaret Burns, Mark Dutton, Fergus Gibb, Bill Lee, Lynda Warren.
- Other member interests: Simon Harley.

Group 6: Public and stakeholder engagement

- Group lead: Brian Clark
- Members: Francis Livens, John Rennilson, Lynda Warren.
- Other member interests: Margaret Burns, Les Netherton.

Group 7: Web site (see note 2)

- Task group lead: Les Netherton
- Members: Marion Hill, David Broughton.

Group 8: Work programme

- Task group lead: Les Netherton

Members: Marion Hill, David Broughton, Lynda Warren.

Notes

1. As yet Task Group 5 has no specific tasks for 2010-11. It will be disbanded during the year if no specific tasks on new build wastes arise.
2. Task Group 7 will be disbanded when the rebuilt website is up and running.

ANNEX C PROPOSED FORMAT OF CoRWM ANNUAL REPORT

1. **Introduction** by Chairman of CoRWM: to include potential overall statement on UK progress in the management of its HAW.

2. **Overview and conclusions:** (a) Key high level outcomes of CoRWM work from previous year, including any specific highlights (e.g. results of major PSE event). To include new recommendations (made in this report) and recommendations made during the year (in other documents). (b) Comment on UK progress in HAW management overall and by specific topics.

3. **Overview of CoRWM ways of working:** development of documents, evidence gathering, PSE etc.

4. **Chapters on topics from CoRWM work programme for the year:** each chapter to cover main tasks, approach to work and outcomes with any conclusions and recommendations (new or made previously during year). Evidence base for new recommendations will be given. Examples of topic headings from proposed work programme 2010-2013: UK Government Policy implementation, Scottish Government Policy, NDA Strategy II, NDA work on implementation of geological disposal, other work including PSE.

5. **Review of progress on actions taken by others in response to recommendations in CoRWM Reports to Government and other documents:** Reports to date are those on Interim Storage, Geological Disposal, R&D. (This could overlap with earlier chapters and therefore may need to be an overview referring back to evidence in chapters on topics.)

6. **Summary of agreed programme for the following year.**

7. **How to get further information.**

8. **Annexes:**

- **Terms of Reference**
- **Who we are** (with reference to website for further details and Members' declarations of interest)
- **Expenditure for the year**
- **Extracts from key CoRWM documents** (if appropriate)
- **List of meetings** (with relevant document number)
- **List of CoRWM documents produced during year** (with relevant document number)

ANNEX D CoRWM PROCEDURES FOR FORMULATING ADVICE

Type of advice	Evidence base	PSE	Comments
1: Informal verbal	Based on evidence and information from general meetings, documents, correspondence, international experience, professional knowledge and experience.	None usually	Typically advice given during meetings, usually by individual members. Not a CoRWM view.
2: Informal written	Based on evidence and information from general meetings, documents correspondence, international experience, professional knowledge and experience.	None usually	Views from task group or individual members, not a CoRWM view. Could involve members of CoRWM outside task group. Example: informal comment on draft Government proposals to promote invitation to communities.
3. Formal written: responses to consultations	Meetings and correspondence with specific stakeholders where appropriate. Evidence and information from general meetings, documents, correspondence, international experience, professional knowledge and experience.	Mainly with a limited range of stakeholders to check scope, collect evidence and check accuracy of facts.	Extent of PSE may depend on time frame. All formal responses to consultations are approved by CoRWM plenary and are a CoRWM view.

Type of advice	Evidence base	PSE	Comments
4. Formal written: position papers	Meetings and correspondence with specific stakeholders where appropriate. Evidence and information from general meetings, correspondence, documents, international experience, professional knowledge and experience.	Mainly with a limited range of stakeholders to collect evidence, check accuracy of facts and seek views on proposed conclusions.	Position papers have conclusions but not recommendations to Government. When approved by plenary position papers are a CoRWM view.
5. Formal written: reports to Government on specific topics, with recommendations	Meetings and correspondence with wide range of stakeholders and public. Review of published documents, international experience etc.	Wide range of PSE including website, e-bulletin, specific PSE events (workshops), bilateral meetings. PSE may take place at a number of stages during development of draft report and proposed conclusions and recommendations. It includes factual checking with selected stakeholders.	Most extensive staged process. Final version of report is approved by plenary and is a CoRWM view. Government responds to reports, if possible within 3 months of receipt.
6. Formal written: documents with recommendations to Government, other than reports	Any of those shown for items 1-5.	Wide range of PSE including website, e-bulletin, specific PSE events (workshops), bilateral meetings. PSE may take place at a number of stages during development of draft document and proposed conclusions and recommendations. It includes factual checking with selected stakeholders.	Most extensive staged process. Final version of document is approved by plenary and is a CoRWM view. Government expected to respond.
7. Formal written: urgent recommendations to Government	Evidence already available to Committee.	None.	Document containing recommendation published after submission to Government. Government expected to respond.

Type of advice	Evidence base	PSE	Comments
8. Annual Report	Evidence collected during year by any of the methods shown for items 1-5.	As 6 if report contains new recommendations. As 4 if report does not contain new recommendations.	As 6 if report contains new recommendations. As 4 if report does not contain new recommendations.
9. Proposed Work Programme	Review of issues from previous programme, key organisations' work programmes, meetings with selected stakeholders.	Draft proposals circulated by website and e-bulletin for public and stakeholder comment. PSE at draft and second draft stages.	Extensive staged process. Final version of proposed work programme is agreed at plenary before submission to Government for approval to proceed.

Note
Public and stakeholder engagement (PSE) is undertaken to gather the views of others and thus inform the Committee. The views expressed in CoRWM's documents are the Committee's own.

Committee on Radioactive Waste Management

COMMITTEE ON RADIOACTIVE WASTE MANAGEMENT

SIXTH ANNUAL REPORT
2009-10

JUNE 2010

CONTENTS

INTRODUCTION BY THE CHAIR

I am pleased to present CoRWM's annual report for 2009-10 to sponsor Ministers, the Secretary of State for Energy and Climate Change and Environment Ministers in Scotland, Wales and Northern Ireland.

This is the sixth CoRWM Annual Report but the first in a revised format. It summarises the outcomes of CoRWM's scrutiny and advice work during the year. It also contains the Committee's views on the current status of arrangements and plans for the long-term management of higher activity radioactive wastes in the UK.

2009-10 was a busy year for CoRWM. The Committee submitted two major reports to Government, one on geological disposal and one on research and development. It responded to two Government consultations: the UK Government consultation on its draft National Policy Statements for energy infrastructure and the Scottish Government consultation on its policy for the management of higher activity wastes. In addition, CoRWM gave evidence to the House of Lords Science and Technology Committee during its inquiry into CoRWM's performance since its reconstitution in 2007 and the appropriateness of its current remit.

CoRWM has begun its work for 2010-11. Its priorities for scrutiny and advice this year are:

- UK Government work to implement its policy on the long-term management of higher activity wastes
- Scottish Government development of its policy on the management of higher activity wastes and of proposals for its implementation
- Nuclear Decommissioning Authority development of its second Strategy (NDA Strategy II)
- NDA work on the implementation of geological disposal.

I am grateful to Marion Hill for compiling this report and to all my colleagues on the Committee and in the Secretariat for their contributions. This has been a particularly difficult year but everyone has fulfilled their responsibilities in a professional and unselfish manner.

Robert Pickard
30 June 2010

EXECUTIVE SUMMARY

1. This is the sixth annual report of the Committee on Radioactive Waste Management (CoRWM) but the first in a revised format. It covers the Committee's work during the period April 2009 to March 2010. The report describes how CoRWM works and summarises its activities during the year and their outcomes.

CoRWM's Remit and How it Fulfils It

2. CoRWM's remit is to provide independent scrutiny and advice on the long-term management of radioactive wastes. It focuses on higher activity wastes (HAW), *i.e.* intermediate level wastes (ILW) and high level waste (HLW). Its work also includes spent nuclear fuels, plutonium and uranic materials that are not considered to be wastes at present but may be in the future.

3. The Committee scrutinises the work of the Nuclear Decommissioning Authority (NDA) and other organisations on all the steps necessary for the long-term management of HAW in the UK. These steps will typically include treatment, storage, transport and disposal. One of its main tasks is to scrutinise UK Government and NDA plans and programmes for geological disposal of HAW. It also scrutinises the work of the Scottish Government on developing and implementing its policy of near-surface, near-site storage and disposal of HAW. Much of the work that the Committee scrutinises is within the Government's Managing Radioactive Waste Safely (MRWS) programme.

4. CoRWM has a set of five guiding principles that it applies in its work. These principles are about:
   - openness and transparency
   - upholding the public interest
   - fairness
   - a safe and sustainable environment
   - working efficiently and effectively.

5. CoRWM carries out its scrutiny by holding meetings with NDA, Government officials, regulators and various groups of stakeholders, and by reviewing documents that these organisations produce. It visits one or more nuclear sites each year, where it sees radioactive waste management facilities, has discussions with site staff and holds a public meeting.

6. The Committee provides both formal and informal advice to Government. In the case of formal advice it usually consults its stakeholders to gather and check evidence, to inform itself of their views and to obtain their comments on its proposed advice. Such consultations are part of the public and stakeholder engagement (PSE) that CoRWM carries out to support its work programme. Its PSE is aimed at promoting understanding of radioactive waste management issues, as well as seeking and discussing views.

7. During 2009-10 CoRWM carried out its first review of its own effectiveness. Based on views from its stakeholders and other evidence, the Committee judged that it had

performed reasonably well on criteria of being a trusted and authoritative source of advice, and of delivering its work programme to a high standard and to time and budget. On the criterion of having a demonstrable, positive effect on the management of the UK's HAW, the view of most stakeholders was that it was too soon after CoRWM's reconstitution in late 2007 to form a judgement.

Scrutiny and Advice on Interim Storage

8. CoRWM's work under the heading of interim storage covers the treatment, packaging, storage and transport of HAW and the management of spent fuels, plutonium and uranium. In 2009-10 its main tasks on interim storage were:
   - to scrutinise the NDA's development of its Topic Strategies for HAW, spent fuels, plutonium and uranic materials
   - to advise the Scottish Government on development of its policy for the management of HAW
   - to monitor actions taken in response to CoRWM's 2009 report to Government on interim storage (CoRWM doc. 2500).

9. The NDA's Topic Strategies are at various stages of development and, in some cases, implementation. Although progress is being made on the HAW Topic Strategy, CoRWM notes that there are issues, such as consolidation of storage and treatment on fewer sites, that seem to lack strategic direction from NDA. For spent fuels there are key decisions to be made over the next few years on how much AGR fuel to reprocess and on how and where to treat the many types of exotic fuels (*i.e.* non-standard fuels, mainly from long-closed research reactors).

10. CoRWM gave the Scottish Government informal advice during the preparations for the public consultation on its HAW management policy, then responded formally to the consultation. The informal advice contributed to the Scottish Government decision to lengthen the preparatory period, allowing fuller consideration of the outcomes of the Strategic Environmental Assessment (SEA). The Scottish Government is at present (June 2010) considering the consultation responses.

11. CoRWM's 2009 report to Government on interim storage (CoRWM doc. 2500) contained a recommendation about improving strategic co-ordination, which Government accepted. However, over a year after the report was published, Government has yet to make any specific proposals for improvement. There has also been little action on CoRWM's recommendations about making appropriate information available to the public about HAW management and about how the security of storage facilities is assured. After discussion with the regulators, CoRWM itself published information about how new stores for spent fuel are being designed to mitigate the consequences of 9/11 style terrorist attacks.

Scrutiny and Advice on Geological Disposal

12. CoRWM's 2009-10 tasks on geological disposal included:
   - completion of its report to Government on geological disposal and monitoring of actions taken on the recommendations in the report

- scrutiny and advice on the voluntarism and partnership approach to siting of a geological disposal facility (GDF)
- scrutiny and advice on identifying and assessing potential GDF sites
- scrutiny of NDA's work on implementation of geological disposal and development of a generic safety case for a geological disposal system.

13. CoRWM's report to Government on geological disposal (CoRWM doc. 2550) was submitted in July 2009. Government responded in November 2009. The response stated that Government largely agreed with CoRWM's recommendations and set out the work in progress and planned to address them.

14. During the year CoRWM encouraged the UK Government to increase the awareness amongst local authorities of its invitation to express an interest in entering without commitment discussions about the possibility of hosting a GDF. The Government carried out various actions to increase awareness, including attending local government conferences and sending a Ministerial letter.

15. In the one area that has so far expressed an interest, CoRWM attended meetings of the West Cumbria MRWS Partnership, as an observer. It noted that some of the recommendations in CoRWM's 2009 report on geological disposal (CoRWM doc. 2550) are being addressed by Government as part of its input to the work of the Partnership. CoRWM advised the Partnership on the peer review of the study to be carried out by the British Geological Survey (BGS) to screen out rock volumes in West Cumbria that are unsuitable for a GDF.

16. CoRWM discussed with NDA the methodology that might be used to identify sites for desk-based study after the BGS screening has been completed and if an area decides to participate further in the geological disposal siting process. The Committee commented on an early draft of NDA's "Geological Disposal: Steps Towards Implementation" document. It followed up its recommendation about the need to assess a wide range of geological disposal concepts by learning more about NDA's assessment of generic concepts and plans for site specific optimisation.

Scrutiny and Advice on Research and Development

17. CoRWM's main work on research and development (R&D) was to complete its report to Government on national R&D for interim storage and geological disposal of HAW and management of nuclear materials (CoRWM doc. 2543). The report contains six recommendations, including one on the need for strategic co-ordination of UK R&D for HAW management between NDA, the rest of the nuclear industry, the regulators and the Research Councils. The report was submitted to Government in October 2009; a response is awaited.

18. During the year CoRWM also held discussions with NDA about all its R&D relevant to HAW management and scrutinised the development of the NDA geological disposal R&D programme. In addition, the Committee had contacts with the Natural Environment Research Council (NERC) about its plans for future funding of research on radioactive waste management. CoRWM visited BGS, which is funded by NERC, to

learn about its research and discuss its plans for the screening work in West Cumbria (para. 15) and any other area that may express an interest in hosting a GDF.

Scrutiny and Advice on Radioactive Wastes from New Nuclear Power Stations

19. Most of CoRWM's work on HAW from new nuclear power stations ("new build wastes") was related to the radioactive waste aspects of the Government's draft National Policy Statement (NPS) on energy infrastructure. The Committee made informal comments on drafts of documents for the public consultation on the NPS; these were confined to factual accuracy and clarity of expression. It then responded formally to the consultation and concurrently issued a separate statement of its position on new build wastes.

20. CoRWM's response to the NPS consultation covered issues including whether there will be effective arrangements for managing new build wastes and the possible impact of the NPS on the long-term management of existing HAW. The CoRWM position statement reiterated that the Committee is neither for nor against new nuclear power stations. It stated that CoRWM's future work on new build wastes will consist of scrutiny and advice on plans to ensure that, if new build wastes are created, they are safely and securely managed, and on minimising adverse impacts of new build waste management on the management of existing wastes.

Scrutiny and Advice on Public and Stakeholder Engagement

21. CoRWM scrutinises the PSE activities of Government, NDA, other nuclear industry organisations and the regulators related to the long-term management of HAW. It holds discussions with various organisations about their PSE and observes PSE in practice by attending events such as stakeholder workshops on particular topics. It also monitors co-ordination of PSE related to radioactive waste management amongst the organisations involved.

22. Early in 2010, CoRWM sent a questionnaire to Government, NDA and other organisations about their PSE activities. This included questions about how each organisation draws up an engagement strategy and reviews its effectiveness. The responses to the questionnaire will be evaluated in 2010-11 and included in a position paper on PSE. This paper will include the results of CoRWM's scrutiny of PSE in 2009 and 2010, and the results of its monitoring of Government action on CoRWM's recommendation to improve co-ordination of PSE.

Status of UK Arrangements and Plans for Management of Higher Activity Wastes

23. Based on its scrutiny work in 2009-10, CoRWM has the following observations about the status of plans for managing HAW in the UK.

24. Only about 30% of existing UK ILW has been treated and packaged to make it suitable for longer term storage and eventual disposal. Of the remaining 70%, some is held in old facilities and some of that is not in stable forms. It is important that such ILW is retrieved as soon as is practicable, and is treated, packaged and placed in modern

stores. CoRWM welcomes NDA statements about the priority it is giving to retrieval of ILW from high hazard legacy facilities, especially at Sellafield. However, the Committee has not yet seen any speeding up of retrieval projects and there are indications that some may be slowing down.

25. Although the current plans for HAW storage are adequate, the approach to storage is fragmented and too few sites have contingency plans. A more strategic approach is required.

26. The implementation of geological disposal is proceeding at an appropriate pace. The rate of progress of the voluntary approach to GDF siting must be determined by the willingness of the volunteering communities to proceed. It is also important to allow sufficient time for technical work, particularly site characterisation, GDF design and R&D.

1. INTRODUCTION

1.1. This is the sixth CoRWM Annual Report but the first in a revised format. It covers the Committee's work in the period from April 2009 to March 2010.

1.2. CoRWM's remit is given in its Terms of Reference (Annex A). These state that:

"... The role of the reconstituted Committee on Radioactive Waste Management (CoRWM) will be to provide independent scrutiny and advice to UK Government and devolved administration Ministers on the long-term management, including storage and disposal, of radioactive waste. CoRWM's primary task is to provide independent scrutiny on the Government's and Nuclear Decommissioning Authority's proposals, plans and programmes to deliver geological disposal, together with robust interim storage, as the long-term management option for the UK's higher activity wastes."

1.3. The current membership of CoRWM is given in Annex B. Its sponsors are the Department for Energy and Climate Change (DECC) for the UK Government, the Scottish Government, the Welsh Assembly Government and the Department of the Environment in Northern Ireland.

1.4. The Committee's work programme for 2009-10 (CoRWM doc. 2515.2) was agreed with its sponsors early in 2009-10. It was carried out within CoRWM's agreed budget (Annex C).

1.5. Section 2 of this report is about CoRWM's working methods. Sections 3-6 describe the results of CoRWM's scrutiny and advice work during 2009-10. Section 7 of the report is about the inquiry carried out by the House of Lords Science and Technology Committee to assess how CoRWM has performed since its reconstitution in 2007 (House of Lords, 2010a). Section 8 gives the Committee's views on the current status of arrangements and plans for the long-term management of higher activity wastes (HAW) in the UK. Section 9 contains information about CoRWM's work programme for 2010-11.

2. HOW CoRWM WORKS

CoRWM's Principles

2.1. CoRWM has five guiding principles that it applies in its work (CoRWM doc. 2248). These principles are about:

- openness and transparency
- upholding the public interest
- fairness
- a safe and sustainable environment
- working efficiently and effectively.

2.2. The Committee also has a transparency policy and a publication scheme (CoRWM doc. 2249).

Scrutiny

2.3. CoRWM scrutinises the work of the Nuclear Decommissioning Authority (NDA), and other organisations that own or produce HAW, on all the steps necessary for the long-term management of these wastes. These steps will typically include treatment, storage, transport and disposal, either in a geological disposal facility (GDF) or a near-surface disposal facility. The Committee scrutinises the work of the UK Government and NDA on the delivery of geological disposal and the work of the Scottish Government on developing its policy for the management of HAW. Much of the work that the Committee scrutinises is within the Government's Managing Radioactive Waste Safely (MRWS) programme (Defra *et al.*, 2008).

2.4. CoRWM carries out its scrutiny by holding meetings with NDA, Government officials, regulators and various groups of stakeholders, and by reviewing documents that these organisations produce. The Committee visits one or more nuclear sites each year, where it holds discussions with site managers and staff and sees radioactive waste management facilities. During the visit it usually holds a meeting with local people. These meetings are open to the public and participants typically include members of the Site Stakeholder Group (or its equivalent), elected representatives and local residents. CoRWM also monitors developments in other countries, with the objective of checking that the UK is making full use of international experience.

Formulation of Advice

2.5. All CoRWM's formal advice is to Government. It is mostly given in reports on particular topics (*e.g.* CoRWM doc. 2550) but can also be in shorter documents such as position papers (*e.g.* CoRWM docs. 2420, 2558) and responses to consultations (*e.g.* CoRWM docs. 2748, 2795). Members of the Committee also give informal advice, both verbally and in writing, to Government, NDA and others.

2.6. The procedures CoRWM uses to formulate its advice are summarised in a document produced in March 2010 (CoRWM doc. 2806). The methods it uses to gather and check the evidence that underlies its advice depend on whether the advice is formal or

informal. In the case of formal advice CoRWM usually consults its stakeholders, firstly to inform itself of their views and secondly to obtain their comments on its proposed advice (CoRWM doc. 2806). The views expressed in CoRWM's documents are always the Committee's own. It has a quality control procedure for its documents (CoRWM doc. 2771).

Public and Stakeholder Engagement

2.7. CoRWM undertakes public and stakeholder engagement (PSE) to support its work programme. In 2009-10 its PSE focused on stakeholders. It included meetings with various groups and consultation on draft documents, *via* the website and an e-bulletin. In general, the Committee uses PSE to:

- assemble evidence on particular topics
- obtain the views of stakeholders and the public on these topics
- check the factual accuracy of its draft documents
- seek comments on its proposed advice.

2.8. In addition, CoRWM asks stakeholders and the public for their views on the Committee's performance and ways of working (para. 2.18).

2.9. In 2009-10 CoRWM held two stakeholder workshops, one to discuss the draft of its report to Government on geological disposal and one to discuss the draft report to Government on research and development (CoRWM docs. 2543, 2550, 2593, 2677). It held discussions with a range of stakeholders during its work on the Scottish Government policy for HAW management (para. 3.3). It met local stakeholders when it visited the nuclear power stations at Hunterston and Hinkley Point (CoRWM docs. 2802, 2809).

2.10. CoRWM had considered convening a Citizen's Panel as part of its engagement of the public on progress with the implementation of geological disposal (Task 14 in CoRWM doc. 2515.2). It became clear during 2009-10 that this would not be appropriate at this early stage.

2.11. The CoRWM web site (*www.corwm.org.uk*) was redesigned in 2008 after the Committee was reconstituted. However, user feedback and developments in peer sites led to a decision to improve the site further and ensure that it met all current standards for accessibility and usability. In addition, the DECC MRWS website and the NDA website now contain extensive background information on radioactive waste management, so the CoRWM site needs to concentrate on the Committee's work.

2.12. CoRWM worked with specialist website experts from DECC, the Government's Central Office of Information (COI) and an external company. An expert review of the existing site and seven other peer sites was carried out, which was followed by detailed interviews with ten stakeholders from a variety of backgrounds. Draft wireframes and content of key web pages were developed and again tested with stakeholders. the content was then reviewed by a specialist copy editor to ensure that the copy was

clear, accessible and met content writing guidelines. The new website will be launched in summer 2010.

Use of International Experience

2.13. CoRWM uses several means to keep in touch with international developments. Through the literature and websites it monitors progress in various countries on the long-term management of HAW, especially progress in implementing geological disposal. It also monitors the relevant work of the European Commission, the Nuclear Energy Agency (NEA) and the International Atomic Energy Agency (IAEA). CoRWM members gather information when they visit other countries in the course of their non-CoRWM work. In addition, CoRWM has discussions with representatives of other countries' Governments, regulators and waste management organisations (*e.g.* CoRWM docs. 2664, 2823).

2.14. In 2009 CoRWM held a meeting in London with the USA's Nuclear Waste Technical Review Board (NWTRB) (CoRWM doc. 2725). NWTRB is an independent agency that reports to Congress on Department of Energy work on the long-term management of high level waste (HLW) and spent fuels. CoRWM's discussions with NWTRB covered the pre-disposal management and geological disposal of HLW and spent fuels. CoRWM was particularly interested in lessons learned at the Waste Isolation Pilot Plant (WIPP), an operating GDF for "transuranic" (TRU) wastes[1], and at Yucca Mountain, a site that was investigated for a GDF to hold all US spent fuel. It also heard about NWTRB work since the cancellation of the Yucca Mountain project and about the appointment of a "Blue Ribbon Commission" (CoRWM doc. 2725). The Commission is conducting a comprehensive review of policies for managing the back end of the nuclear fuel cycle, including all the alternatives for the storage, processing and disposal of civil and defence spent fuel, HLW and materials derived from nuclear activities.[2]

2.15. CoRWM has followed developments in the European Union COWAM (Community Waste Management) in Practice project. This is about sharing good practice in involving local communities in radioactive waste management (*www.cowam.com*). CoRWM attended the September 2009 meeting of UK participants in the project, which discussed community benefits packages, a national case study of community involvement and needs for further research.

2.16. CoRWM has also followed developments in China, which has plans to build more than 20 new nuclear power stations in the next decade or so and to reprocess spent fuel. A CoRWM member visited China twice (once with the IAEA and once with a UK team including NDA and National Nuclear Laboratory participants) to examine the Government's waste management strategy and plans. Several potential sites for a GDF have been identified, including one in granite in the Gobi desert where borehole drilling sections have already been taken. An underground rock laboratory is being

[1] TRU waste is a term used mainly in the USA. In UK terminology TRU wastes are long-lived, actinide-containing intermediate level wastes, such as plutonium contaminated materials.
[2] There is further information on the Commission's website *http://brc.gov*. It is due to produce an interim report in mid-2011 and a final report early in 2012.

designed and is planned to be in operation by 2020. While this site is the most advanced, the Chinese Government desires another site (with different rock, probably clay) to also undergo full sub-surface characterisation so that the sites can be compared and a decision on which to use taken on technical grounds. The intention is that a GDF will be operational by about 2050.

CoRWM Review of Its Effectiveness

2.17. In March 2009 CoRWM agreed a process to review its effectiveness (CoRWM doc.2555) and adopted the following criteria by which it would judge its success:

- CoRWM is a trusted and authoritative source of advice
- CoRWM has carried out its work to a high standard and to time and budget
- CoRWM has had a demonstrable positive effect on the management of the UK's HAW.

2.18. Evidence for the review of effectiveness was gathered during the year. It took the form of programme progress reports and budget reports to plenary meetings, feedback from questionnaires circulated to stakeholders and consideration of Government responses to recommendations in the Committee's reports on interim storage (CoRWM doc. 2500) and geological disposal (CoRWM doc. 2550). Account was also taken of evidence submitted by various organisations to the House of Lords Science and Technology Committee inquiry (Section 7) and the findings of that inquiry (House of Lords, 2010a). The impacts of CoRWM's scrutiny and advice are dealt with in Section 6.

2.19. CoRWM reviewed its effectiveness at its plenary meeting in April 2010 (CoRWM doc.2798). The key points from the review were:

- Feedback from questionnaires was generally positive. However, a number of stakeholders stated that it was too soon to assess whether CoRWM has had a demonstrable positive effect on the management of HAW. This was reflected in evidence to the House of Lords inquiry (House of Lords, 2010a).
- The work programme for 2009-10 was largely completed and this was done within budget. There is a need, however, for better detailed work programming to ensure that adequate time is always allowed for factual checking and PSE on draft documents.
- The proposed 2010-13 work programme (CoRWM doc. 2800) was submitted to Government for approval in March 2010 and is more focused than previous years. This reflected experience of previous year's programmes and feedback from stakeholders that programmes had been too broad and resources somewhat stretched.
- CoRWM had improved its working practices during the year, particularly by devising and applying quality control procedures for documents (CoRWM docs. 2539, 2771) and clarifying how it formulates its various types of advice (paras 2.5-2.6; CoRWM doc. 2806).

- Assessing the effectiveness of an advisory and scrutiny committee will always be difficult, especially in the case of one concerned with long-term activities such as the management of HAW.
- CoRWM will be looking at the assessment processes used by similar advisory bodies in other countries, in order to identify best practice.
- The improved CoRWM web site and the use of modern survey techniques will extend the opportunities for obtaining feedback on the Committee's performance.

3. SCRUTINY AND ADVICE ON INTERIM STORAGE

The Interim Storage Tasks and CoRWM's Approach

3.1. CoRWM's report to Government on interim storage (CoRWM doc. 2500) was published at the end of 2008-09. The tasks on interim storage set out in CoRWM's 2009-10 work programme (CoRWM doc. 2515.2) were:

Task 1: Scrutinise and advise on interim storage issues for HAW and materials that may be declared to be wastes, including:

a) monitoring actions taken in response to the recommendations in CoRWM's March 2009 Interim Storage Report (CoRWM doc. 2500)
b) scrutinising the NDA's development of its Topic Strategy for HAW, including its work on management options for short-lived intermediate level wastes (ILW)
c) following NDA progress in the development of its Topic Strategies for spent fuels, plutonium and uranium
d) keeping a watching brief on waste transport issues (with a view to undertaking a major piece of work in 2010-11).

Task 2: Scrutinise the development of Scottish Government policy for the management of higher activity wastes, including the associated Strategic Environmental Assessment (SEA) and advise accordingly.

3.2. CoRWM's scrutiny work for Task 1 was carried out largely through meetings with NDA and regulators. These meetings dealt with progress on the various NDA Topic Strategies[3], and with actions being taken in response to the recommendations in CoRWM's report on interim storage (CoRWM doc. 2500).

3.3. For Task 2 CoRWM drew up a detailed plan of action that had six main strands, as follows.

i) Scrutinising the development of the consultation proposals, including attending meetings organised by the Scottish Government and offering informal comments on early drafts of its consultation material.

ii) Meeting a range of stakeholders to learn their views on the Scottish Government's proposals. The purpose of these meetings was to inform CoRWM's view of the policy and what the implications of its implementation might be.

iii) Holding meetings with British Energy, Dounreay Site Restoration Ltd, the Highland Council, Magnox North, NDA, the Health and Safety Executive (HSE), and the Scottish Environment Protection Agency (SEPA). Members also attended a Scottish Government stakeholder workshop on 29 January 2010, to observe the Government's engagement process and hear the views of a range of stakeholders including local government, NGOs, nuclear site operators and

[3] Details are at www.nda.gov.uk/strategy/overview.cfm

others. Members also met with a number of NGOs and local site stakeholders at Dounreay and Hunterston.

iv) At its February 2010 plenary meeting CoRWM discussed the key issues emerging from bilateral meetings (CoRWM doc. 2779), and its own review of the consultation documents. This informed the preparation of CoRWM's response to the consultation

v) CoRWM discussed and agreed a formal response to the Scottish Government at its March 2010 plenary, which was then submitted (CoRWM doc. 2795).

vi) CoRWM proposes to scrutinise the process whereby the Scottish Government finalises and adopts its policy and this will be the subject of a position paper to be produced, probably towards the end of 2010.

Management of Higher Activity Wastes UK-Wide

Nuclear Decommissioning Authority

3.4. CoRWM discussed NDA progress on its HAW Topic Strategy at meetings with NDA in June 2009 and March 2010 (CoRWM docs. 2624, 2792) and at a meeting with HSE, the Environment Agency (EA) and SEPA in March 2010 (CoRWM doc. 2811). The NDA's existing and planned Integrated Project Teams (IPTs) on various aspects of HAW management were also discussed at these meetings.

3.5. For topic strategy purposes, NDA divides HAW into several categories:

- UK-owned high level waste (HLW)
- overseas-owned HLW
- overseas-owned ILW
- wet ILW (*e.g.* sludges, ion exchange resins)
- solid ILW (*e.g.* metals, concrete)
- graphite.

3.6. For each category there is a baseline strategy and, where appropriate, NDA is exploring alternative strategies, with a view to changing the baseline strategy if it would be optimum to do so. In exploring alternative strategies, account is taken of the need to achieve passive safety as soon as is reasonably practicable and of opportunities to improve HAW management in various ways (*e.g.* by reducing the quantities of HAW destined for geological disposal). There are two categories of alternative strategies: those that mitigate risks and those that provide a step change in benefits, compared to the baseline.

3.7. The IPTs are NDA-led projects that will underpin strategy development or provide better management methods for particular wastes. They are partnerships between NDA and one or more of its Site Licence Companies (SLCs). At present there are IPTs on reactor decommissioning wastes, interim storage and thermal treatment.

3.8. CoRWM notes that the present NDA topic strategy development process does not deal with some strategic issues in a very transparent way. In particular there are a number of issues that NDA considers as "opportunities" that CoRWM regards as requiring strategic direction. These issues include:

- consolidation of storage of HAW on fewer sites (so that not every NDA site has to have a HAW store)
- consolidation of HAW treatment (by moving wastes from one site to another for treatment or by using mobile treatment plant)
- treatment of some HAW to make it suitable for near-surface disposal (*e.g.* decontamination, segregation*).*

3.9. CoRWM has been monitoring progress in the Letter of Compliance (LoC) process carried out by NDA's Radioactive Waste Management Directorate (RWMD) (CoRWM doc. 2792). LoC assessments are an integral part of the management of HAW on nuclear-licensed sites and support site operators' safety cases for HAW conditioning, packaging, storage and geological disposal (Radioactive Waste Management Cases). LoC assessments are also requested by waste owners and operators as part of their exploration of alternative conditioning methods.

3.10. In its March 2009 report on interim storage (CoRWM doc. 2500), CoRWM raised the question of whether RWMD needed more resources in order to speed up new LoC assessments and reviews of existing LoCs. As far as the Committee is aware, NDA has not yet addressed this question.

Regulatory Developments

3.11. In addition to its bilateral meetings with regulators, CoRWM attended an EA workshop on approaches to assuring the disposability of HAW packages (CoRWM doc. 2637). The workshop was part of a project on the monitoring and inspection regimes and techniques that could be used to determine whether packages of ILW and HLW remain disposable during interim storage, on arrival at a GDF and during any period that a GDF remains open before backfilling and sealing.

3.12. A notable regulatory development during the year was the publication of revised and new modules of the joint regulatory guidance on the management of HAW on nuclear licensed sites (HSE *et al.*, 2010). The regulators informed us (CoRWM doc. 2811) that some nuclear site licensees are already complying with the guidance but others are not and are requiring encouragement to do so.

Strategic Co-ordination

3.13. In its 2009 report on interim storage (CoRWM doc. 2500), CoRWM recommended that there should be greater UK-wide strategic co-ordination of the conditioning, packaging and storage of HAW. In its response to the report (DECC *et al.*, 2009), Government accepted this recommendation and stated that it was exploring the best means of implementing it and would invite CoRWM to provide input to and scrutinise proposals as they developed.

3.14. As yet, CoRWM has not been invited to provide any input to proposals. The Committee notes that there appears to be greater co-ordination at the technical level than when its report was published (*e.g. via* the IPTs). It has also been told that the Radioactive Waste Policy Group (RWPG), which is made up of Government and regulators, has new members and new terms of reference, which may enable it to encourage strategic co-ordination (CoRWM doc. 2811). For NDA, the Strategy Development and Delivery Group (SDDG) has existed for about 18 months and now involves the Ministry of Defence (MoD), as well as Government and regulators. It is not clear to CoRWM whether the SDDG can play a role in UK-wide strategic coordination.

Management of Spent Fuels, Plutonium and Uranium

Spent Fuels

3.15. CoRWM discussed NDA progress in developing topic strategies for spent fuels at meetings with NDA and regulators in June 2009 and March 2010 (CoRWM docs. 2624, 2793, 2811). The current strategy for Magnox fuel is to complete the reprocessing programme but that work is in hand to develop an alternative to reprocessing, as a contingency.

3.16. NDA is likely to decide over the next year or two how much AGR fuel to reprocess because this is linked to key investment decisions at Sellafield. Work on the management of AGR fuel that is not to be reprocessed is progressing but as yet there is no safety case for longer-term storage of the fuel at Sellafield (in existing ponds or in a new dry storage facility) and no detailed assessment of the disposability of AGR fuel.

3.17. For the "exotic" fuels[4], two types of decision are needed: how to treat them (either to condition them for disposal or to recover useful materials) and where to treat them (at the sites where they are now kept or at Sellafield). The issues are complex and involve safety and financial considerations and the views of stakeholders at various NDA sites and near potential transport routes.

3.18. CoRWM has also been monitoring progress by British Energy on the management of spent fuel at Sizewell B. British Energy has carried out a number of local consultations and will submit a Planning Application and Environmental Statement for a dry storage facility for Sizewell B fuel in 2010 (British Energy, 2009). There will then be a public consultation on British Energy's proposals.

Plutonium

3.19. In 2009-10 CoRWM attended a DECC workshop on the long-term management of the UK's separated civil plutonium (Environment Council, 2009) and sent informal comments to DECC on two pre-consultation discussion papers on long-term plutonium management (CoRWM docs. 2690, 2718). It discussed long-term plutonium management at its November 2009 plenary meeting (CoRWM docs. 2723, 2729). This discussion was intended to be a pre-cursor to considering whether, and if so how, to

[4] NDA uses the term "exotic fuels" for non-standard fuels, mainly from research reactors that were closed many years ago.

respond to a DECC consultation on the long-term management of plutonium. This DECC consultation was delayed; CoRWM understands that it will begin later in 2010.

3.20. NDA cannot progress with its topic strategy for plutonium until DECC has held its consultation and decided on a UK strategy. Meanwhile, NDA is carrying out R&D on plutonium immobilisation. There is also work on disposability of MOX fuel (as input to consideration of plutonium recycling) (CoRWM doc. 2793).

Uranium

3.21. NDA work on its topic strategy for uranic materials is progressing (CoRWM doc. 2793). Work is in progress on options for the management of the uranium hexafluoride at Capenhurst. Options being considered include continued storage as hexafluoride in new containers, deconversion to oxide at Capenhurst and deconversion to oxide elsewhere. NDA's RWMD is considering the disposability of uranic materials.

Strategic Co-ordination

3.22. CoRWM recommended in its 2009 report on interim storage (CoRWM doc. 2500) that there be greater UK-wide strategic co-ordination of the management of spent fuels, plutonium and uranium. By this it meant greater strategic co-ordination between the owners of these materials (NDA, MoD, British Energy and Urenco UK Ltd), with the involvement of Government and regulators. Government accepted this recommendation (DECC *et al.*, 2009) but has not put forward any proposals. Nevertheless, it appears that co-ordination between NDA and MoD is improving. In addition, the remit of RWPG has been expanded to cover spent fuels, plutonium and uranium (CoRWM doc. 2811).

Transport

3.23. CoRWM met with Department for Transport (DfT) in January 2010 (CoRWM doc. 2764) and briefly discussed transport with NDA in March 2010 (CoRWM doc, 2792). It was found that there are extensive interactions between waste producers and DfT on HAW packaging issues. In view of this, and the prescriptive nature of the transport regulations, it was concluded that there would be no value in CoRWM carrying out any major work on packaging for transport.

3.24. CoRWM also concluded from these meetings that there is a lack of strategic planning for transport of existing, committed and new build wastes. In particular, it is not clear to CoRWM who will co-ordinate the identification of the current infrastructure that needs to be maintained or the new infrastructure that will be needed for transport of HAW and spent fuels for treatment, storage and disposal (CoRWM doc. 2764). The Committee notes that NDA's Topic Strategy for transport and logistics deals only with current arrangements.

Provision of Information to the Public

Information on HAW Management

3.25. CoRWM recommended in its 2009 report on interim storage (CoRWM doc. 2500) that appropriate information be made publicly available on the management of higher activity wastes, spent fuels, plutonium and uranium. It considered that there was a need to summarise, for a variety of readerships, the progress to date, the management options under consideration for the future, and the issues involved in choosing between alternative options.

3.26. In its response to this recommendation (DECC *et al.*, 2009), Government mentioned various pieces of work that NDA had in hand. CoRWM discussed these with NDA in March 2010 (CoRWM doc. 2792). While what NDA is doing is valuable, it does not really address the key issue in CoRWM's recommendation. In particular the NDA's Radioactive Waste Management Information Strategy is about information management by waste producers and owners, not provision of information to the public. There is still a need for information on plans for the management of the various types of HAW, to complement the information in the UK Radioactive Waste Inventory (Defra & NDA, 2008) about waste quantities and characteristics.

Security Information

3.27. CoRWM discussed its 2009 recommendation about making security information publicly available (CoRWM doc. 2500) with the Office of Civil Nuclear Security (OCNS) (CoRWM doc. 2746). CoRWM's understanding is that planned enhancements to the OCNS website have been delayed pending the formation of the Office for Nuclear Regulation, of which OCNS will be a part.

3.28. After the meeting with OCNS, CoRWM took further action on the specific issue of information about designing HAW stores and spent fuel stores to resist 9/11 style terrorist attacks. It wrote to OCNS and to the Nuclear Installations Inspectorate (NII) summarising its current understanding of the assessment and mitigation of aircraft impact risks and asking some questions. It then produced a note based on that summary and the NII and OCNS response (CoRWM doc. 2740). The key point is that regulators will require new stores to be designed so as to mitigate the consequences of 9/11 style attacks.

Development of Scottish Government HAW Management Policy

3.29. The proposed Scottish Government Policy is to *"support long-term near surface, near site storage and disposal facilities so that the waste is monitorable and retrievable and the need for transporting it over long distances is minimal*" (Scottish Government, 2010).

3.30. CoRWM presented a detailed response (CoRWM doc. 2795) to each of the questions posed in the consultation. It also made the general comment that it felt that, while it was clear that a great deal of effort and work had gone into producing the consultation documents and the evidence that underpinned the development of the policy, there were areas where they could have been significantly improved.

3.31. CoRWM presented a list of principal comments on the policy proposals (CoRWM doc. 2795) and these are reproduced below.

i) CoRWM considers that the policy would benefit from having more information on the physical and chemical nature of the waste being produced in Scotland. The Policy Statement needs to bring out that, within the definition of HAW that is included, there is a sizeable portion of waste (the Environmental Report suggests approximately 25% by volume) that will not be suitable for near-surface disposal. The Policy Statement should be clear about the process for arriving at an end-state for this waste.

ii) The policy is general and enabling, and places responsibility for developing an implementation strategy with owners and producers. The policy does not ensure optimisation and co-ordination. CoRWM believes the Scottish Government needs to give more explicit guidance about what the implementation strategy is aiming to achieve. For example, is there a preference, where possible, for disposal? What are the full ranges of criteria for arriving at siting decisions? There also needs to be more guidance about the process for developing the implementation strategy and the likely timelines.

iii) The Policy Statement needs to make it clear that the NDA will lead the development of an Implementation Strategy. Scottish Government will have to direct and enable the NDA to take on this lead role.

iv) The Policy Statement needs to spell out how considerations of cost, affordability and best value will be taken into account in developing an implementation strategy.

v) The final policy statement needs to be stand-alone. Consequently, information and detailed definitions that are currently within the Environmental Report need to be brought into the Policy Statement. For example, it is stated in the Environmental Report that the preference is for disposal but this is not reflected in the Policy Statement.

3.32. CoRWM will scrutinise how these principal comments and the other important issues raised in its response to the consultation (CoRWM doc. 2795) are addressed in the development of the final policy.

4. SCRUTINY AND ADVICE ON GEOLOGICAL DISPOSAL

The Geological Disposal Tasks and CoRWM's Approach

4.1. The tasks on geological disposal set out in CoRWM's 2009-10 work programme (CoRWM doc. 2515.2) were:

Task 3: Complete CoRWM's 2009 report to Government on geological disposal.

Task 4: Scrutinise and advise on the voluntarism and partnership approach to geological disposal facility siting, including:

a) scrutinise Government work to increase awareness of the invitation to communities and monitor responses
b) scrutinise Government and NDA engagement with communities that have expressed an interest.

Task 5: Scrutinise and advise on site assessment, including:

a) scrutinise the British Geological Survey's screening out of unsuitable areas
b) scrutinise the NDA's and others' approaches to the assessment of skills and infrastructure requirements for desk-based studies and surface-based investigations (stages 4 and 5 of the siting process).
c) scrutinise NDA preparations for stage 4 of the siting process (desk-based studies).

Task 6: Scrutinise and advise on NDA implementation and safety case work, including:

a) scrutinise NDA's continuing development of its Provisional Implementation Plan
b) scrutinise NDA's continuing development of its Generic Disposal System Safety Case.

Task 7: Monitor actions taken in response to the recommendations in CoRWM's July 2009 Geological Disposal report.

Task 8: Maintain a watching brief on decision making, funding, risk management and regulatory developments.

4.2. A draft of CoRWM's report to Government on geological disposal was sent out to stakeholders for comment and placed on the CoRWM website. The comments received were logged and published with CoRWM's responses to them (CoRWM doc. 2592). A stakeholder event was held in Cumbria in May 2009 to discuss the draft report (CoRWM doc. 2593). All the comments received were considered during finalisation of the report.

4.3. CoRWM had regular contacts with DECC in order to scrutinise Government work to increase awareness of the invitation to communities to express an interest in entering discussions about becoming involved in the process of siting a GDF (Task 4a). Only one part of the UK has so far expressed an interest, namely West Cumbria. CoRWM scrutinised Government and NDA engagement in Cumbria (Task 4b) mainly by attending meetings of the West Cumbria Managing Radioactive Waste Safely (MRWS) Partnership (*www.westcumbriamrws.org.uk*) as an observer. At CoRWM's plenary meeting in December 2009, the leader of Copeland Borough Council gave a

presentation to Committee about the work of the Partnership (CoRWM docs. 2743, 2744). CoRWM kept in contact with the Nuclear Legacy Advisory Forum (NuLeAF) about the GDF siting process and other aspects of the management of HAW. The Executive Director of NuLeAF gave a presentation to CoRWM at a plenary meeting (CoRWM docs. 2734, 2743).

4.4. It is planned that NDA's RWMD will become the delivery organisation for geological disposal. CoRWM's scrutiny of work for identification and assessment of possible sites for a GDF (Task 5) was carried out through meetings with RWMD, EA, the British Geological Survey (BGS), and written and telephone communications with DECC and the West Cumbria MRWS Partnership.

4.5. CoRWM's scrutiny of NDA work on implementation of geological disposal (Task 6a) was carried out through written comment on RWMD documents relating to implementation, followed by a meeting with RWMD focused on the processes it is putting in place to facilitate implementation. There was no specific scrutiny work on RWMD's development of its generic Disposal System Safety Case (DSSC), although CoRWM maintained awareness of RWMD plans (*e.g.* CoRWM doc. 2766). This scrutiny will take place in 2010-11, after RWMD publishes a first version of the DSSC.

2009 Report to Government on Geological Disposal

4.6. CoRWM's report to Government on geological disposal was issued at the end of July 2009 (CoRWM doc. 2550). The report covers:

- voluntarism and partnership in the GDF siting process
- decision making, funding and managing risks in the implementation of geological disposal
- international experience
- PSE
- the regulatory framework for geological disposal
- land use planning and SEA
- developing concepts and designs for geological disposal.

4.7. The report contains five recommendations, which are given in full in Annex D. The recommendations are about:

- developing the principles to be used in deriving Community Benefits Packages
- explaining how local stakeholders would have the opportunity to influence the planning process for a GDF if the planning application is referred to the Infrastructure Planning Commission[5]
- discussing with communities that have expressed an interest the advantages and disadvantages of single and two staged planning applications for underground investigations and construction of a GDF

[5] Current Government policy is that the Infrastructure Planning Commission will be abolished and replaced by a different fast-track planning procedure for major projects.

- carrying out options assessments in which a wide range of geological disposal concepts is considered and stakeholders are involved
- the need for an integrated process for GDF design, site assessments and safety case development.

4.8. Government responded to the report in November 2009 (DECC & DoENI, 2009). The response stated that Government largely agreed with CoRWM's recommendations and set out the work in progress or planned to address them. Some specific pieces of work are noted in the relevant sub-sections below; further details are in Section 6.

Voluntarism and Partnership

Increasing the Awareness of Communities to the Invitation to Participate

4.9. Government worked throughout 2009-10 to increase community awareness of the invitation to express an interest in entering without commitment discussions about hosting a GDF. DECC and NDA staff attended local authority conferences, offering the opportunity for elected members and officials to obtain more information on the issues. In the autumn of 2009 the DECC Minister of State wrote to the chief executives of local authorities reminding them of the invitation. As of now (June 2010), no other community has expressed an interest.

Government and NDA Engagement in West Cumbria

4.10. Various members of CoRWM attended meetings of the West Cumbria MRWS Partnership as observers during 2009-10. Progress in the work of the Partnership is a standing item at CoRWM's plenary meetings and CoRWM provides information and advice to the Partnership when it is appropriate to do so.

4.11. In March 2010 CoRWM met with the Partnership's Steering Group to obtain their views on Government and NDA support for the Partnership's work (CoRWM doc. 2790). The Steering Group told CoRWM that the Partnership had received all the support it needed from DECC but that it thought the importance of the Partnership merited greater recognition in Government, in particular it would be helpful if it was recognised at Ministerial level. The Steering Group was also very pleased with how individuals from NDA had worked with the Partnership. It had some concerns about whether the level of NDA support in the future would be sufficient to meet all the Partnership's needs and whether NDA appreciated that the Partnership required time to do its work.

4.12. The topics covered in the first three of CoRWM's recommendations in its 2009 report to Government on geological disposal (CoRWM doc. 2550) are being addressed in the work of the Partnership, with input from the Government and regulators. There is a Partnership workstream on Community Benefits Packages (Recommendation 1), in which DECC participates. Planning applications (Recommendations 2 and 3) are to be covered in a workstream on safety, security, environment and planning (West Cumbria MRWS Partnership, 2010a).

Site Assessment

Application of Sub-Surface Exclusion Criteria

4.13. Stage 2 of the MRWS geological disposal siting process is to identify those volumes of rock, within an area that has expressed an interest, that would clearly not be suitable to host a GDF. This is to be done by applying sub-surface exclusion criteria (SSEC), which were derived by a panel of experts and were subject to public consultation (Defra *et al.*, 2008). The screening on the basis of the SSEC is to be carried out by the British Geological Survey (BGS), working under contract to DECC. The draft BGS report will be made available, for discussion and peer review, to the relevant communities and local authorities, NDA, the regulators and CoRWM.

4.14. Preparations for Stage 2 in West Cumbria took place in 2009-10. CoRWM provided advice and comments to the West Cumbria MRWS Partnership on the peer review of the screening process and on CoRWM's role with respect to the process and the peer review (CoRWM doc. 2711).

4.15. The points made about CoRWM's role were:

- CoRWM could provide advice on and scrutiny of the site screening process. It could scrutinise the BGS screening process and its appropriateness, the robustness of the peer review arrangements put in place, and the quality of engagement with the Partnership on the peer review process and its co-ordination.
- CoRWM would not act in the role of peer reviewer of the BGS report. Whilst CoRWM would receive the BGS report and develop a view on it, this would be focused on scrutiny of the BGS screening process as a whole and within the context of MRWS Stage 2.

4.16. With respect to co-ordination of the peer review for the BGS screening process, CoRWM provided the following advice:

- It is reasonable that Government (via DECC) works with the Partnership and BGS to develop a coordinated peer review process.
- Co-ordination would include definition of the planned timescale for review, avenues for submission of reviews, style of reviews, deadlines for completion, rules regarding use of data, and rules regarding attribution of sources and use of third parties.
- All the relevant material should be available to all reviewers equally.
- The process for considering the reviews should be open, transparent and fair.
- Reviews must be independent and technically credible.
- Cost and value for money are important but secondary considerations to the provision of clearly independent professional reviews. However, parties with shared interests may jointly wish to commission or utilise a single peer review.

4.17. Additional informal advice was provided on specific detailed aspects of peer review, including terms of reference, independence and objectivity, and credibility and competence.

4.18. The status of BGS processes and plans in relation to the screening on the basis of the SSEC was discussed in a meeting between CoRWM and BGS in February 2010 (CoRWM doc. 2801). A key point from this meeting was that the provisional timetable gave BGS 10 weeks to undertake its study and submit a final report to the West Cumbria MRWS Partnership. This included a fortnight for the peer review of the draft report and for BGS amendments in the light of the review. During discussion at the February 2010 plenary (CoRWM doc. 2788), it was suggested that CoRWM contact both the Partnership and DECC with advice to extend the time period allowed for peer review and amendment of the BGS report.[6]

4.19. CoRWM emphasised to BGS the importance of stating clearly in its screening report that, for the volumes of rock that remain after application of the SSEC, there is no implication that they are suitable to host a GDF. The Committee's view was that how this point was presented, both in words and in figure or map form, would be critical to the engagement with the communities in West Cumbria.

Identifying Sites for Desk-Based Assessment

4.20. Desk-based studies are Stage 4 of the MRWS GDF siting process, after the screening on the basis of the SSEC (Stage 2) and the community's Decision to Participate (Stage 3) (Defra *et al.*, 2008). There are two parts to Stage 4, both of which only involve the use of existing information: identification of sites for study and assessment of these sites. RWMD carried out work on developing a proposed methodology for site identification in 2009 and discussed it with CoRWM at a meeting in January 2010 (CoRWM doc. 2782).

4.21. RWMD had considered the situation in which a Community Siting Partnership asks NDA to develop and apply a site identification methodology in consultation with stakeholders. CoRWM advised on the need to be very cautious, especially with respect to how different administrative bodies are to be involved. These need to be given the opportunity to participate and support the siting process. Maintenance of partnership confidence requires a clear strategy of support, education and information, especially if the process appears to be 'stop-start' or have gaps between stages.

4.22. CoRWM noted that the relationship between application of objectives, exclusion criteria and timing of geological assessment needs to be made clear before desk-based studies begin. It suggested that a possible approach would be to assess in parallel potential host rock volumes for a GDF and potential locations for its surface facilities. Maps could be produced to illustrate these and the two maps could be overlain to see the relationships between them. During this assessment it would be important not to introduce arbitrary constraints on the depths of underground facilities or on the distances between surface and underground facilities. CoRWM also advised that the possible relationships between excluded rock volumes, locations for GDF surface facilities and rock volumes for GDF underground facilities needed to be carefully explained to stakeholders and the public at an early stage.

[6] This was later overtaken by events. The screening study in West Cumbria began in early June 2010 and a longer period will be allowed for peer review and finalisation of the BGS screening report.

Site Characterisation

4.23. CoRWM attended an Environment Agency (EA) workshop on "Assessing the Characterisation of Geological Environments for Repository Implementation" in September 2009 (CoRWM doc. 2707; Quintessa, 2009). The workshop was designed to contribute to developing EA work on understanding uncertainties in desk-based studies and surface-based characterisation and the role of underground investigations, and to provide comment on the MRWS timeline and its relationship with staged regulation. The workshop was broken down into thematic sessions: desk-based studies (MRWS Stage 4), surface-based characterisation (Stage 5), underground characterisation (Stage 6) and management issues.

4.24. Some general conclusions of the workshop were:

- at present it is not possible to define in detail the activities within each MRWS stage
- the permitting process for all characterisation work needs to be flexible
- hold points imposed by regulators should not be 'stop' points
- MRWS Stage 5 should include time for re-processing data from the MRWS Stage 4 prior to detailed investigations
- work under MRWS Stage 6 should be in two parts: underground research and underground characterisation
- an underground research facility would be required at each prospective GDF site
- the management of the process has to recognise that the project will change from a predominantly science-based project to an engineering project through its life cycle and this should be central to implementation planning.

NDA Implementation Planning

4.25. In summer 2009 CoRWM commented on a draft of an RWMD document titled "Geological Disposal: Planning for Implementation". It then met with RWMD to discuss the document and the RWMD implementation planning process in general (CoRWM doc. 2714).

4.26. RWMD indicated that the Provisional Implementation Plan (PIP), which is in effect the Lifetime Plan for a GDF up to and beyond its closure, would not be developed further in 2009-10. RWMD was focusing on developing a 5-year plan that would cover in detail the steps in the MRWS GDF siting process leading towards a Government decision on surface-based investigation. The 5-year plan was also required for assessment in the Government's Public Value Programme, which aimed to identify spending priorities in preparation for the next Comprehensive Spending Review.

4.27. Discussion of the Planning for Implementation document included the transition from generic to more site specific studies and the need for options assessments covering a wide range of geological disposal concepts (the fourth recommendation in CoRWM doc. 2550). CoRWM understands that the final version of the document, which has been retitled "Geological Disposal: Steps Towards Implementation", will be published later in 2010. It will provide a first point of reference for the public on RWMD's early planning for the implementation of geological disposal.

4.28. The PIP might become the definitive Implementation Plan if and when a community took a Decision to Participate in the siting process, but this change to the PIP would depend on many factors, including regulatory requirements that are also evolving. RWMD also explained that the PIP would, when developed, indicate what might happen on a range of assumptions not all of which would prove valid. Once site-specific work began, the generic work undertaken so far could be "banked" and subsequent work tailored to the site.

4.29. R&D needs and gaps would be identified as part of the process of developing a site-specific design and this would involve discussions with the local community. If an area wanted to see how the process might develop after any Decision to Participate, a set of "bounding" assumptions could be agreed with the Partnership and the PIP could then be made specific to the area. The generic PIP could be used for any other communities expressing an interest.

4.30. The delay in publishing the NDA Planning for Implementation document meant that CoRWM was unable to carry out scrutiny on this topic in late 2009 and early 2010.

5. SCRUTINY AND ADVICE ON OTHER TOPICS

Research and Development

The R&D Tasks and CoRWM's Approach

5.1. The tasks on research and development (R&D) set out in CoRWM's 2009-10 work programme (CoRWM doc. 2515.2) were:

Task 9: Complete CoRWM's 2009 report to Government on R&D
Task 10: Scrutinise the implementation of the high-level RWMD R&D Strategy
Task 11: Scrutinise the development of the RWMD R&D work programme
Task 12: Monitor actions taken in response to the recommendations in CoRWM's 2009 report to Government on R&D.

5.2. Completion of the 2009 CoRWM report to Government on R&D (CoRWM doc. 2543) involved addressing and responding to comments received (CoRWM doc. 2630) when the draft report was sent out for consultation to stakeholders and placed on the CoRWM website. It also involved taking into account points made at a stakeholder event held in September 2009 to discuss the draft report (CoRWM doc. 2677).

5.3. Tasks 10 and 11 were taken together because much of the implementation of the RWMD R&D Strategy (NDA, 2009a) will take place *via* the development, and the carrying out, of the RWMD R&D Work Programme. CoRWM received drafts of RWMD R&D work programme documents for comment and held a meeting with RWMD in January 2010 to discuss the programme (CoRWM doc. 2776).

5.4. Government has yet to respond to CoRWM's 2009 report on R&D (CoRWM doc. 2543), so it has not been possible to carry out much work on Task 12. However, a meeting was held with NDA to discuss all its R&D relevant to CoRWM's remit at which the recommendations in the report were discussed (CoRWM doc. 2766). In addition, CoRWM has been following developments at the Research Councils.

5.5. In September 2009, CoRWM responded to a call for evidence for an inquiry on setting priorities for publicly funded research by the House of Lords Science and Technology Committee. In order to meet the House of Lords Committee's deadline it was necessary to respond before the 2009 R&D report was finalised. CoRWM then revised its evidence (CoRWM doc. 2719) following publication of its R&D report.

2009 Report to Government on R&D

5.6. CoRWM's report to Government on R&D was issued at the end of October 2009 (CoRWM doc. 2543). The report covers:

- the UK's process for providing R&D in the management of HAW
- the skills requirements to support R&D in the MRWS programme, in particular those R&D skills needed to enable implementation of geological disposal

- the infrastructure requirements, in particular those facilities supporting R&D on highly radioactive materials and facilities for R&D that will need to be carried out underground
- PSE on the above topics.

5.7. The report contains six recommendations, which are given in full in Annex D. These are about:

- the need for strategic co-ordination of UK R&D for the management of HAW (within the NDA, between the NDA and the rest of the nuclear industry, amongst the Research Councils and between the whole of the nuclear industry, its regulators and the Research Councils)
- ensuring that EA and SEPA obtain the resources they need to access and commission additional independent research
- assigning to a single organisation the responsibility for providing leadership and strategic direction for the provision of R&D skills relevant to HAW management
- improving and enhancing the capabilities of UK facilities for research with highly radioactive materials and making them more accessible to researchers
- establishing an underground research facility at any site in the UK where it is proposed to construct a GDF.

5.8. In the letter explaining why the Government's response to the R&D report had been delayed, Lord Hunt, the DECC Minister of State, stated that:

"This report is wide ranging and raises a number of interesting and inter-connected points that cut across the work of several Government departments, Devolved Administrations and delivery agencies. Officials from CoRWM's sponsor departments are currently working together with these bodies to examine the report and recommendations jointly to ensure that issues raised are considered, as far as possible, in a joined up manner."

NDA R&D

R&D on Management of HAW

5.9. A meeting with NDA on R&D in January 2010 (CoRWM doc. 2766) provided CoRWM with an overview of the R&D being carried out by NDA and its SLCs that is relevant to CoRWM's interests. The meeting began with a brief discussion of the recommendations in CoRWM's 2009 report to Government on R&D (CoRWM doc. 2543), which NDA broadly supported. NDA then described how its own R&D, particularly the Direct Research Portfolio, is managed. NDA re-emphasised that it would only fund research that it designates as needs-driven.

5.10. Most of the R&D that NDA pays for is funded through the SLCs (CoRWM doc. 2543). NDA stated that it cannot direct the SLCs as to which R&D to fund but can only advise. CoRWM asked about strategic oversight of all the R&D and who in NDA has an overview. This led to a discussion of the role of the NDA Research Board on

Decommissioning and Clean Up (NDARB) and the Nuclear Waste Research Forum (NWRF), which reports to the NDARB.

5.11. The NDARB is primarily concerned with NDA's own research and co-ordinating this with other organisations. The NWRF provides a forum for SLCs, other nuclear site licensees and regulators to talk to each other. Neither the NDARB in its present form nor the NWRF is an appropriate mechanism for carrying out the strategic co-ordination of R&D that CoRWM considers is needed (CoRWM doc. 2543). CoRWM has been invited to attend NWRF meetings as an observer and has accepted the invitation.

5.12. In March 2010 NDA published its business plan for 2010-13 (NDA, 2010). This indicates that NDA's own spend on R&D in 2010-11 will be £6 million, compared to £34 million in 2009-10. It is not yet clear to CoRWM how NDA R&D on HAW management will be affected by the budget reduction. Nor is it clear to the Committee how SLC funding of R&D will change in 2010-11.

R&D on Geological Disposal

5.13. CoRWM met RWMD in January 2010 (CoRWM doc. 2776) to discuss a draft of the document that contains an overview of the geological disposal R&D programme, diagrams describing the programme and prioritisation tables. The Committee recognised that it is difficult for RWMD to set out a highly focussed R&D programme in advance of the identification of possible sites for a GDF and hence the types of geological formations and geological disposal concepts that need to be studied.

5.14. There was also discussion of the need to identify skills gaps and ensure that the programme leads to the development of UK R&D skills on the timescale on which they will be needed. It was noted that there is likely to be strong competition for geoscience and geo-engineering R&D skills from other technical areas (*e.g.* carbon capture, oil and gas exploration).

5.15. CoRWM has been invited to attend meetings of RWMD's Research Advisory Panel as an observer. It has accepted this invitation and expects to provide input to discussions, where appropriate, and update the Panel on CoRWM's work, as well as observing proceedings. At a meeting with the Chief Executive of NDA in March 2010 (CoRWM doc. 2797), CoRWM learnt that RWMD spend on R&D will increase in future years, as implementation of geological disposal progresses.

5.16. CoRWM notes that EA is scrutinising RWMD R&D in detail. This is part of EA's scrutiny of all RWMD work relating to geological disposal (EA, 2010).

Research Councils

5.17. In March 2010 the Chair of CoRWM wrote to the Chief Executive of the Natural Environment Research Council (NERC) expressing concern that, although radioactive waste disposal is identified explicitly in NERC's current strategic plan ("Next Generation Science for Planet Earth"), it is not yet recognised in any of the Theme Action Plans that will deliver the strategy. This may mean that research projects on radioactive waste disposal will not be included in NERC's developing thematic

programmes until 2011-12, after the next Comprehensive Spending Review, when budgets may be more limited.

5.18. In his reply, the Chief Executive of NERC emphasised NERC's current support for relevant research and the flexibility of NERC's strategy and programmes, which would allow expansion if required. He also stated that, subject to approval by its Council, a NERC activity was being developed on radioactivity in the environment. In addition, he invited CoRWM to meet the relevant NERC staff to explore these issues further.

5.19. CoRWM is also concerned about the uncertainty in the timing of the Engineering and Physical Sciences Research Council's (EPSRC) call for research proposals on geological disposal. This concern was prompted by an EPSRC-convened workshop in summer 2009; it is still unclear when the programme will be initiated.

5.20. One of the questions asked by the House of Lords Science and Technology Committee in its inquiry about setting priorities for publicly funded research (House of Lords, 2010b) was about the balance of funding between "targeted" and "responsive-mode" research. In its evidence (CoRWM doc. 2719), CoRWM expressed the view that much more curiosity-driven research is needed for HAW management, in addition to the targeted research sponsored at present by the nuclear industry and the Research Councils. This point was also made in the 2009 report on R&D (CoRWM doc. 2543), which noted that, in the nuclear area, EPSRC makes much more use of "managed calls" for targeted research than it does of "responsive-mode" funding for curiosity-driven research. EPSRC recognises the need to increase responsive-mode funding and hopes to attract more proposals from researchers in future.

5.21. In its report on its inquiry about setting priorities for publicly funded research (House of Lords, 2010b), the Science and Technology Committee stated:

"It goes without saying that an appropriate balance needs to be maintained between the different types of research. We were told that, in the light of its inherent unpredictability, responsive-mode research is likely to fare less well in challenging economic circumstances than targeted research. With this in mind, ***we urge Research Councils, in determining the appropriate balance, to give due consideration to the role and importance of responsive-mode research in meeting the broader objectives of research****."*

New Build Wastes

The New Build Wastes Task and CoRWM's Approach

5.22. The task on wastes from new nuclear power stations set out in CoRWM's 2009-10 work programme (CoRWM doc. 2515.2) was:

Task 13: Advise on interim storage and geological disposal issues for ILW and spent fuels from new build nuclear power stations.

5.23. CoRWM began work on this task in June 2009 when it commented informally on a first draft of the summary of evidence on radioactive waste management that DECC had prepared to accompany the draft National Policy Statement (NPS) for new nuclear power stations. These informal comments were from the points of view of factual accuracy and clarity of expression.

5.24. In early autumn 2009 CoRWM made informal comments on a further draft of the evidence summary and on a draft chapter for the NPS consultation document and a draft section for the nuclear NPS. Again these comments were only about factual accuracy and clarity of expression.

5.25. The DECC public consultation on the energy infrastructure NPSs began in November 2009. CoRWM discussed the preparation of its response to the consultation at its December 2009 plenary meeting (CoRWM doc. 2743). It agreed that it would prepare a response to those parts of the nuclear NPS consultation that dealt with ILW and spent fuel and issue a separate statement of CoRWM's current position on new build wastes. It also agreed the structure of its response and its approach to the consultation questions (CoRWM doc. 2733). The response (CoRWM doc. 2748) and position statement (CoRWM doc. 2749) were prepared over the period from late December 2009 to early March 2010. Drafts were discussed at the January 2010 and February 2010 plenary meetings (CoRWM docs. 2770, 2788).

5.26. To obtain information for use in its response to the NPS consultation, CoRWM held meetings with regulators and with prospective reactor vendors and operators (CoRWM docs. 2746, 2747, 2764, 2765, 2767). It also invited stakeholders, *via* its e-bulletin and website, to send it any information about new build wastes that they wished to draw to the Committee's attention (CoRWM doc. 2755). All the information received at meetings and by other means was taken into account in preparing the NPS consultation response.

CoRWM's Position on New Build Wastes

5.27. The March 2010 statement of CoRWM's position on new build wastes (CoRWM doc. 2749) starts from the statements made in the Committee's 2006 Recommendations to Government (CoRWM doc. 700). It reiterates that the Committee's position on the desirability or otherwise of building new nuclear power stations remains neutral, *i.e.* CoRWM is neither for nor against new build.

5.28. The statement then deals with consideration of wastes in the new build assessment process and with the testing and validation of proposals for management of new build wastes. It ends by stating that CoRWM's future work on new build wastes will consist of carrying out scrutiny and providing advice on:

- consideration of waste issues in the public assessment process for new build power stations
- formulation of plans to ensure that, if new build wastes are created, they are safely and securely managed

- prevention and, where that is not possible, minimisation of adverse impacts on the management of existing and committed wastes
- maintenance of public confidence in plans for the long-term management of new build wastes, in addition to existing and committed wastes.

CoRWM's Response to the NPS Consultation

5.29. CoRWM responded to seven questions in the NPS consultation document. The principal question for the Committee was Question 19, which was:

Do you agree with the Government's preliminary conclusion that effective arrangements exist or will exist to manage and dispose of waste that will be produced by new nuclear power stations in the UK?

5.30. In its response (CoRWM doc. 2748) CoRWM agreed that some arrangements exist that would be effective for the management of HAW from new nuclear power stations. It went on to state that whether there will be effective arrangements for all the steps in the management, including the disposal, of new build HAW is a matter of judgement, and it is for the Government to make this judgement, based on the information available to it.

5.31. The response then said that CoRWM considers that the Government should take into account when making this judgement that, while the current UK process for siting a GDF for HAW is sound, it is at an early stage. Its success depends on finding a combination (or combinations if more than one GDF is needed) of a willing host community and a site that is technically suitable to hold enough HAW. At present, it is uncertain whether the appropriate combination (or combinations) of community and site can be found in this country. This uncertainty applies to existing and committed HAW, as well as to new build HAW, and is likely to persist for many years.

5.32. In addition, the response stated that CoRWM considers that the Government should recognise the need for optimisation of the management, including the disposal, of new build HAW. To meet legal and regulatory requirements, it is necessary for prospective operators of new nuclear power stations, with the assistance of NDA, to identify, assess and compare options for the management of new build spent fuel, including the design and location of stores, the storage period and a range of possible geological disposal concepts.

5.33. The response also made the point that CoRWM considers that it is essential for the public to have confidence in the management of new build HAW. The need for public confidence is being taken into account in the implementation of geological disposal. To date, insufficient attention has been paid to it in planning for storage of new build spent fuel. This needs to be rectified in future, particularly by prospective operators of new nuclear power stations.

5.34. In answer to the general consultation question, CoRWM's response made a number of points about the possible impact of the NPS on the long-term management of existing and committed HAW. CoRWM emphasised to Government the importance of the

voluntarist approach to the siting of a GDF (or GDFs) and reiterated its view (CoRWM doc. 2550) that it would be helpful if Government were to restate its commitment to this approach and indicate that it would consult stakeholders before adopting any other approach. CoRWM also stated that there is a need for greater integration in planning for the long-term management of existing, committed and new build wastes.

Scrutiny of the PSE of Various Organisations

The PSE Scrutiny Tasks and CoRWM's Approach

5.35. In 2009-10 CoRWM had two tasks relating to carrying out scrutiny and providing advice on public and stakeholder engagement (CoRWM doc.2515.2):

Task 15: Liaise with other organisations on ways to provide information to the public about the MRWS programme and radioactive waste management in general.

Task 16: Scrutinise the PSE activities of Government, NDA and the regulators related to the MRWS programme.

5.36. For Task 15 CoRWM took opportunities as they arose, rather than convening specific meetings or requesting documents. For Task 16 CoRWM wrote to Government, NDA, regulators and operators of nuclear sites asking a series of questions about their PSE. Members of CoRWM also observed the PSE practices of various organisations when attending meetings of their stakeholders. In addition, CoRWM monitored the PSE activities of organisations through their literature and websites.

Liaison on Providing Information to the Public

5.37. CoRWM discussed the provision of information to the public about interim storage related topics with NDA in March 2010 (CoRWM doc. 2792). As noted above in the context of interim storage (para. 3.25), the work carried out so far by NDA on the management of information about radioactive wastes does not address CoRWM's main concerns (CoRWM doc. 2500).

5.38. When rebuilding CoRWM's website (para. 2.11), the decision was taken to focus the site on the Committee's work, leaving other websites to provide general information about the management of higher activity wastes. Three websites were examined to find out whether, between them, they contained the necessary information. These were the main DECC website, the DECC MRWS website and the NDA website[7]. It was noted that there were some gaps and overlaps. These were drawn to the attention of DECC and NDA. There will be further work on this topic during CoRWM's scrutiny of the rationalisation of these three websites that is to take place in 2010-11.

5.39. CoRWM learnt in June 2009 that EA, HSE and DfT intended to set up joint web pages on regulating geological disposal (CoRWM doc. 2550). The web pages went "live" in

[7] *www.decc.gov.uk, http://mrws.decc.gov.uk, www.nda.gov.uk.*

December 2009[8]. EA has also revised and expanded its own web pages on geological disposal[9].

Questionnaire on PSE

5.40. In January 2010 CoRWM put a number of questions (CoRWM doc. 2750) to Governments, NDA, regulators and site operators about their PSE activities. These included how they identified their stakeholders, drew up an engagement strategy and reviewed its effectiveness, and how they made relevant information more accessible. CoRWM asked for comments and observations. A number of responses have been received. These will be evaluated in 2010-11 and the results included in a position paper on PSE to be published in December 2010, with the outcomes of other CoRWM PSE scrutiny activities in 2009 and 2010.

Scrutiny of PSE Related to Geological Disposal

5.41. The results of CoRWM's initial scrutiny of Government and NDA PSE related to geological disposal are given in the 2009 report to Government (CoRWM doc. 2550). Since then NDA' RWMD has published its Public and Stakeholder Engagement and Communications Strategy for geological disposal (NDA, 2009b). It is currently developing stakeholder engagement plans.

5.42. As previously mentioned (para. 4.10), CoRWM is an observer at meetings of the West Cumbria MRWS Partnership[10]. The Partnership is carrying out a wide range of public engagement activities and has independent facilitation for its meetings. The UK Government and NDA are providing support when requested to do so. CoRWM is impressed by the extensive nature and inclusivity of the PSE activities in West Cumbria.

Scrutiny of PSE on Various Aspects of HAW Management

5.43. CoRWM observes the work of the Government's Nuclear Engagement Group, where the UK Government, the Devolved Administrations, NDA and the regulators share their engagement plans on legacy and new nuclear issues and discuss lessons learned. One of its outputs is the "nuclear consultations" page and map on the DECC website[11]. The Group is independently facilitated.

5.44. CoRWM attends meetings of the NDA National Stakeholder Group[12] (*e.g.* CoRWM doc. 2803). This also has an independent facilitator. Its effectiveness is reviewed periodically and another review is due in 2010.

5.45. Meetings at which CoRWM observed the PSE practices of organisations in 2009-10 included:

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[8] *www.environment-agency.gov.uk/business/sectors/111766.aspx*
[9] For example, *www.environment-agency.gov.uk/business/sectors/37483.aspx*
[10] *www.westcumbriamrws.org.uk*
[11] *www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/consultations/consultations.aspx*
[12] *www.nda.gov.uk/stakeholders*

- DECC workshop on the long-term management of plutonium (Environment Council, 2009)
- Scottish Government workshops for the development of its policy on the long-term management of HAW[13]
- EA workshop on site characterisation (Quintessa, 2009)

5.46. CoRWM noted British Energy PSE on the proposed dry store for spent fuel at Sizewell B (British Energy, 2009) and some of the DECC and the regulators' PSE related to waste management aspects of new nuclear power stations[14]. In addition, CoRWM took the opportunity during its visits to Hinkley Point and Hunterston to ask site operators and stakeholders about the PSE undertaken and their views on its effectiveness (CoRWM docs. 2802, 2809).

[13] *www.scotland.gov.uk/Topics/Environment/waste-and-pollution/16293/higheractivitywastepolicy*
[14] *https://www.energynpsconsultation.decc.gov.uk/home/events, www.hse.gov.uk/newreactors/stakeholderengagement.htm*

6. IMPACTS OF CoRWM's SCRUTINY AND ADVICE

6.1. This section of the report sets out the impacts that CoRWM considers its scrutiny and advice has had in 2009-10 on the work of Government, NDA and others. It includes actions taken in response to the recommendations in CoRWM's three 2009 reports to Government (CoRWM docs. 2500, 2543, 2550). It also covers the effects of other CoRWM work on the development and implementation of Government policy on the management of HAW and on promoting understanding of radioactive waste management issues.

Actions taken in Response to CoRWM Recommendations

Recommendations in CoRWM's 2009 Report on Interim Storage

6.2. The 2009 CoRWM report on interim storage (CoRWM doc. 2500) made four recommendations to Government. The text of these is given in full in Annex D.

6.3. The first recommendation was about strategic co-ordination of conditioning, packaging and storage of HAW and of management of spent fuels, plutonium and uranic materials. Government accepted this recommendation (DECC *et al.*, 2009) and indicated that it would explore the best means of implementing it and invite CoRWM to comment on its proposals. To date, Government has not put any specific proposals to CoRWM. However, CoRWM has observed that some actions have been taken that may lead to better strategic co-ordination in some areas (paras. 3.14, 3.22).

6.4. The second recommendation was about making appropriate information available to the public about the management of HAW, spent fuels, plutonium and uranic materials. The Government response (DECC *et al.*, 2009) noted the range of information that was already available and that was planned to be made available, and the NDA work in hand on a radioactive waste information management system. CoRWM does not consider that any of the actions taken to date meet the need it identified in its recommendation. It has made its views known to NDA (CoRWM doc. 2792) and to regulators (CoRWM doc. 2811).

6.5. The third recommendation in the 2009 report on interim storage was about making information available to the public about how the security of storage and transport of radioactive wastes and nuclear materials is assured. In its response (DECC *et al.*, 2009) Government recognised the importance of being open and transparent and stated that work was underway to make existing information more accessible and to raise its profile. This work was subsequently delayed as a result of planned changes to regulatory organisations (para. 3.27). In the meantime, CoRWM itself has made information available to the public about designing stores to mitigate the consequences of terrorist attacks (para. 3.28; CoRWM doc. 2740).

6.6. The fourth recommendation was about co-ordination of PSE between NDA and other UK industry organisations at national, regional and local levels. Government accepted the need for such co-ordination and stated that it would be looking to improve co-ordination wherever possible (DECC *et al.*, 2009). CoRWM has monitored co-

ordination during the year and will report its findings in its position paper on PSE late in 2010 (para. 5.40).

Recommendations in CoRWM's 2009 Report on Geological Disposal

6.7. There were five recommendations in CoRWM's 2009 report to Government on geological disposal (CoRWM doc. 2550). The text of these is given in full in Annex D.

6.8. The first recommendation was about Community Benefits Packages. In its response (DECC & DoENI, 2009) Government reaffirmed the commitment to providing benefits packages given in the 2008 MRWS White Paper (Defra *et al.*, 2008). It stated that it believed that any benefits package must be developed jointly between local communities and Government as discussions about hosting a GDF progressed, and that final agreement on a package would take time, possibly some years (DECC & DoENI, 2009). DECC, as an observer at the meetings of the West Cumbria MRWS Partnership, is helping to take forward the Partnership's workstream on community benefits. Any other area that expressed an interest in entering discussions with Government about hosting a GDF could draw on this work.

6.9. The second and third recommendations were about the procedure for making a planning application for a GDF. The second recommendation was about the involvement of local stakeholders in the event that a planning application is referred to the Infrastructure Planning Commission (IPC). The third recommendation was about the stages and hold points in planning applications. Government responded positively to both recommendations (DECC & DoENI, 2009).

6.10. Government stated that public consultation and participation would be at the heart of the planning process, whether or not a planning application was referred to the IPC. It further stated that the advantages and disadvantages of single- and two-stage planning applications would form part of the discussions that Government and NDA would have with potential host communities and that there would be appropriate hold points and associated opportunities for stakeholder engagement (DECC & DoENI, 2009). CoRWM welcomes these commitments which, if translated into actions, would largely meet its recommendations.

6.11. The fourth recommendation was that Government should ensure that NDA carries out options assessments in which a wide range of geological disposal concepts is considered and that stakeholders are involved in these assessments. The Government response (DECC & DoENI, 2009), a draft RWMD document on optimisation of a GDF (NDA, 2009c) and CoRWM discussions with RWMD (CoRWM docs. 2714, 2776) have shown that RWMD is considering a range of geological disposal concepts at a generic level. However, RWMD does not intend to carry out much of the necessary optimisation work until more is known about potential GDF sites. CoRWM will be following RWMD work closely. It will take a particular interest in whether RWMD is considering a sufficiently wide range of geological disposal concepts for each potential site and whether enough stakeholders are being involved in comparisons of these concepts.

6.12. The final recommendation in the 2009 report on geological disposal was about the need for NDA to have an integrated process for GDF design, site assessments and safety case development. Government agreed (DECC & DoENI, 2009) that it was essential for NDA to have such an integrated process. CoRWM will be examining documents published by RWMD in 2010, for example the Steps Towards Implementation document and the documents describing the DSSC, to determine the extent to which a suitable process is in place.

Recommendations in CoRWM's 2009 Report on R&D

6.13. The six recommendations in CoRWM's 2009 report to Government on R&D (CoRWM doc. 2543) are given in full in Annex D. As explained by the DECC Minister of State (para. 5.8), the scale and breadth of the issues covered in the report have led to a significant delay in producing the Government response (which was due at the end of January 2010). The report was well received by the House of Lords Science and Technology Committee (House of Lords, 2010a). In oral evidence Lord Jenkin of Roding commented, *"...the R&D report contains fairly clear and specific and, it seemed to me, quite wise recommendations".* In his oral evidence, Lord Hunt of Kings Heath (the DECC Minister of State), explaining the delay in Government responding to the R&D report, said *"...an important report like that deserves a lot of work in terms of responding..."*. CoRWM has taken every opportunity to raise its R&D recommendations in meetings with sponsors, NDA and stakeholders and looks forward to action in response to them in due course.

Other Impacts of CoRWM's Scrutiny and Advice

Influence on Development of Government Policy

6.14. The main policy area in which CoRWM had influence in 2009-10 was that of development of Scottish Government policy on the management of HAW (paras. 3.29-3.32). Early scrutiny of the Scottish Government development process led to the advice that the process be slowed down to allow full consideration of the outcomes of the SEA when drafting the policy documents. The Scottish Government also received this advice from others and delayed the start of its consultation by several months, so that it began in early 2010, not in autumn 2009 as originally planned. The Scottish Government took into account a number of CoRWM's comments in preparing its draft policy documents. CoRWM anticipates that the Scottish Government will consider the Committee's response to the consultation (CoRWM doc. 2795) when finalising its HAW policy.

6.15. Other examples of CoRWM work in 2009-10 that could influence future Government policy are:

- the Committee's response to the DECC consultation on the energy infrastructure NPS (paras. 5.29-5.34; CoRWM doc. 2748)
- the Committee's responses to the pre-consultation discussion papers on the long-term management of plutonium (paras. 3.19-3.20; CoRWM docs. 2690, 2718).

Influence on the Implementation of Government Policy

6.16. Examples of where CoRWM's work in 2009-10 influenced the implementation of Government policy related to the management of HAW are as follows.

- CoRWM encouraged Government to increase the awareness of the invitation to communities to express an interest in entering discussions about hosting a GDF (CoRWM doc. 2550). Government carried out a number of actions to do this (para. 4.9).
- EA, HSE and DfT agreed in principle to set up a Joint Regulatory Office for geological disposal, as advised by CoRWM (CoRWM doc. 2550). As a first step, these regulators have set up joint web pages (para. 5.39).
- NDA took into account CoRWM advice (CoRWM doc. 2550) in finalising its PSE and communications strategy for geological disposal (NDA, 2009b) and its strategy for sustainability appraisal and environmental assessment (NDA, 2009d).
- CoRWM advised the West Cumbria MRWS Partnership on the peer review of the BGS Geological Sub-Surface Screening Report (paras. 4.13-4.19; CoRWM doc. 2711). The Partnership's draft specification for the peer review reflected this advice (West Cumbria MRWS Partnership, 2010b).
- CoRWM advice is being used by RWMD in developing its proposed process for identifying sites for desk-based assessment (paras.4.20-4.22; CoRWM doc. 2782).
- CoRWM understands that its comments on an early draft of the document (paras. 4.25-4.27; CoRWM doc. 2714) are being used by RWMD in producing "Geological Disposal: Steps Towards Implementation".

Promoting Understanding of Issues

6.17. CoRWM considers that several of its activities in 2009-10 have contributed to stakeholder and public understanding of HAW management issues. These activities include:

- the stakeholder event to discuss the draft 2009 report to Government on geological disposal (CoRWM doc. 2593) and the publication of that report (CoRWM doc. 2550)
- the stakeholder event to discuss the draft 2009 report to Government on R&D (CoRWM doc. 2677) and the publication of that report (CoRWM doc. 2543)
- publication of CoRWM's evidence (CoRWM docs. 2756, 2789) to the House of Lords Science and Technology Committee inquiry on radioactive waste management (House of Lords, 2010a)
- holding public meetings at Hunterston (CoRWM doc. 2802) and Hinkley Point (CoRWM doc. 2809).

7. HOUSE OF LORDS INQUIRY

7.1. In January 2010 the House of Lords Science and Technology Committee launched an inquiry into CoRWM. The purpose of the inquiry was to assess how CoRWM had performed since its reconstitution in 2007, to consider whether CoRWM's remit had proved to be appropriate and to gauge CoRWM's impact on the implementation of the MRWS programme (House of Lords, 2010a).

7.2. CoRWM submitted written evidence to the inquiry (CoRWM docs. 2756, 2789) and gave oral evidence. The inquiry also received written and oral evidence from DECC and NDA, and written evidence from EA, the Geological Society of London, Greenpeace and the Nuclear Industry Association (House of Lords, 2010a).

7.3. The report of the inquiry was published in March 2010 (House of Lords, 2010a). It states that:

"The existence of an independent and effective scrutiny body plays an important part in maintaining public trust and confidence in the Government's strategy for radioactive waste disposal. CoRWM must be able to show, therefore, that it is proactively scrutinising Government policy and the NDA's progress in implementing the MRWS programme. In this report, we make a series of recommendations designed to strengthen CoRWM, enabling it to better hold the Government to account on their progress in developing a geological disposal facility. Without on-going external pressure, it is possible that the MRWS programme may not be implemented as rapidly as is needed."

7.4. Government has stated that it will respond to the report. It would not be appropriate for CoRWM to respond but it will publish its comments on the House of Lords' recommendations (CoRWM doc. 2821).

8. STATUS OF ARRANGEMENTS AND PLANS FOR THE MANAGEMENT OF HAW

Treatment, Packaging, Storage and Disposal

Treatment and Packaging

8.1. The latest available figures from NDA indicate that about 9% of the total volume of ILW expected to arise from the current nuclear programme has been conditioned and packaged for longer term storage and eventual disposal. For HLW the figure is 48% (NDA, 2009e). If only existing wastes are considered, the figure is about 30% for ILW. There is about 800 cubic metres of highly active liquor in tanks at Sellafield awaiting vitrification (Defra & NDA, 2008).

8.2. As noted in CoRWM's report to Government on interim storage (CoRWM doc. 2500), some existing ILW is in relatively inert and stable forms and is not a high priority for immobilisation. Other ILW, particularly that in some legacy facilities, is in much less stable forms. It is important that such legacy wastes are retrieved as soon as is practicable. Ideally, these wastes would be conditioned as soon as they had been retrieved, so as to achieve the greatest hazard reduction in the shortest time. However, there are some cases where retrieving the wastes and placing them in a buffer store is likely to be the best option, because it achieves substantial short-term hazard reduction while allowing time to sort and characterise the wastes and to carry out R&D on conditioning methods.

8.3. CoRWM welcomes NDA statements about the priority being given to retrieving ILW from legacy facilities, especially at Sellafield (NDA, 2010). However, the Committee has not yet seen any speeding up of retrieval projects or of the rates of conditioning and packaging of ILW in general. At Magnox sites more centralised project management is leading to better use of effort and funds (CoRWM doc. 2809) but does not seem to be speeding up ILW retrieval or conditioning overall. There are indications that some retrieval projects at Sellafield may be slowing down (CoRWM doc. 2811; HSE, 2010).

Storage

8.4. CoRWM concluded in its March 2009 report (CoRWM doc. 2500) that:

At all nuclear sites the current plans for storage of higher activity wastes are adequate to meet the CoRWM 2006 recommendation, and the subsequent Government commitment, that there should be arrangements for safe and secure storage for at least 100 years. However, the present UK approach to storage lacks robustness: it is fragmented and too few sites have contingency plans. A more strategic approach is required.

8.5. As far as CoRWM is aware, this is still the situation. The setting up of the NDA's IPT on interim storage is a welcome development but it appears that it has yet to make any practical impact. Furthermore, it is unclear to CoRWM how NDA intends to tackle strategic issues such as the possible consolidation of HAW storage on fewer sites, and the possible use of shared storage facilities for NDA and British Energy ILW at sites where there are stations owned by both organisations.

Transport

8.6. There is almost no transport of HAW in the UK at present. This situation could change in the next few years if it is decided to move HAW for treatment, packaging or storage. It will be essential to involve stakeholders and the public in such decisions, including people who live near transport routes, as well as those who live near the dispatching and receiving nuclear sites.

8.7. Eventually there will be a need to move a large volume of HAW (including any spent fuel, plutonium and uranium that has been declared to be waste) to a GDF (or GDFs). It appears to CoRWM that insufficient attention has been paid to planning for such transport. There is a need to co-ordinate the identification of the current infrastructure that must be maintained for future use and to set out plans for establishing the new infrastructure that will be required.

Disposal

Geological Disposal

8.8. The rate of progress in implementing geological disposal was raised during the House of Lords Science and Technology Committee's inquiry into radioactive waste management (House of Lords, 2010a). The House of Lords Committee expressed concern that neither the Government nor CoRWM was conveying any sense of urgency.

8.9. CoRWM's view is that, in general, the implementation of geological disposal is proceeding at an appropriate pace. The process for establishing a GDF is founded on a voluntary approach and its speed of progress must be determined by the willingness of the potential volunteer community or communities to proceed. Any attempt to try to impose time constraints on deliberations is likely to be counter-productive.

8.10. It is also important to allow sufficient time for technical work, in particular site characterisation, GDF design and R&D. As the programme progresses, it is possible that scientific and technical developments will allow it to be speeded up in some respects. However, CoRWM considers that there will be a need for long-term underground observations and experiments at any prospective GDF site and that time must be allowed for these (CoRWM doc. 2543).

8.11. Time is also needed for RWMD to develop into an organisation that can deliver a project of the size, duration and complexity of establishing a GDF. To date, geological disposal has been a science-based concept and there are many challenges in progressing it to an engineering project.

Near-Surface Disposal

8.12. In the UK, consideration of near-surface disposal as an option for some HAW is at an early stage. NDA has work in hand on the possible near-surface disposal of reactor decommissioning wastes, including R&D on treatment of graphite. However, it is now clear that there are operational wastes for which near-surface disposal could be an appropriate option, *e.g.* ion exchange resins and filters from Sizewell B and new

PWRs. The inclusion of near-surface disposal in the Scottish Government policy on HAW may lead to the identification of further wastes that could be disposed of by this method.

8.13. Near-surface disposal of some ILW has been practised in many other countries for decades and technologies are well-established. The challenges for the UK are likely to be in deciding where to site disposal facilities, including whether there should be facilities that will hold both LLW and ILW. Early stakeholder and public involvement will be essential.

9. 2010-11 WORK PROGRAMME

9.1. CoRWM submitted its proposed work programme for 2010-13 to Government in March 2010 (CoRWM doc. 2800). Its priorities for scrutiny and advice in 2010-11 are:

- UK Government work to implement its policy on the long-term management of higher activity wastes
- Scottish Government development of its policy on the management of HAW and of proposals for its implementation
- NDA Strategy II
- NDA work on the implementation of geological disposal.

9.2. The Committee proposed to submit a formal response to the NDA consultation on its Strategy II and to prepare position papers on:

- the development of Scottish Government HAW policy
- BGS screening out of areas in Cumbria unsuitable for geological disposal
- NDA preparations for Stage 4 of the geological disposal facility siting process
- PSE by all organisations involved in the management of HAW.

9.3. Government approval of the 2010-13 work programme is awaited.

10. REFERENCES

CoRWM Documents

CoRWM doc. no.	*Title*
700	CoRWM Recommendations to Government 2006.
2248	CoRWM's Guiding Principles, January 2008.
2249	CoRWM Publication Scheme and Transparency Policy, January 2008.
2420	Coherence and Coordination of Regulatory Processes, September 2008.
2515.2	CoRWM Work Programme 2009-12, March 2009.
2500	Interim Storage of Higher Activity Wastes and the Management of Spent Fuels, Plutonium and Uranium. CoRWM Report to Government. March 2009.
2539	Quality Control for CoRWM Documents, September 2009.
2543	Report on National Research and Development for Interim Storage and Geological Disposal of Higher Activity Radioactive Wastes and Management of Nuclear Materials. October 2009.
2550	Geological Disposal of Higher Activity Wastes. CoRWM Report to Government. July 2009.
2558	Decision Making and Responsibilities in the Implementation of Geological Disposal, March 2009.
2592	Log of Responses to Consultation on Full Draft of CoRWM's Geological Disposal Report, April-May 2009.
2593	Report of Stakeholder Workshop on Draft Geological Disposal Report, Workington, 15 May 2009.
2624	Meeting with NDA on CoRWM Interim Storage Tasks for 2009-10, Warrington, 11 June 2009.
2630	Log of Responses to Consultation on CoRWM's Report on National Research and Development for Interim Storage and Geological Disposal of Higher Activity Radioactive Wastes and Management of Nuclear Materials. October 2009.
2637	Note on Environment Agency Workshop on Approaches to Assuring the Disposability of Radioactive Waste Packages, Warrington, 14 July 2009.
2664	Meeting with Delegation from Japan, August 2009.
2677	Report of CoRWM 9 September 2009 Stakeholder Workshop on Draft R&D Report.
2690	CoRWM Informal Comments on DECC Pre-Consultation Discussion Paper on the Key Factors that could be used to Compare One Option for Long-Term Plutonium Management with Another. September 2009.

CoRWM doc. no.	*Title*
2707	EA Workshop 29-30 September 2009, Assessing the Characterisation of Geological Environments for Repository Implementation, CoRWM Report, November 2009.
2711	BGS Screening Peer Review: CoRWM Advice to the West Cumbria MRWS Partnership, December 2009.
2714	Geological Disposal: Planning for Implementation. Meeting with NDA, 23 October 2009.
2718	CoRWM Informal Comments on DECC Pre-Consultation Discussion Paper on Decision Methodology and Timetable for Decision Making on Long-Term Plutonium Management. November 2009.
2719	Response from Members of CoRWM to the House of Lords Science and Technology Committee Call for Evidence on Setting Science and Technology Research Funding Priorities, revised November 2009.
2725	Meeting with US Nuclear Waste Technical Review Board, London, 12 November 2009.
2729	Minutes of CoRWM Plenary Meeting, York, 19 November 2009.
2723	Options for the Long-Term Management of the UK's Separated Plutonium: Recent History and the Current Situation. November 2009.
2733	New Build Wastes: Preparation of CoRWM Response to DECC Consultation on Draft National Policy Statement, Draft 4, January 2010.
2734	NuLeAF and the MRWS Process: presentation to CoRWM by Fred Barker, Executive Director of NuLeAF, December 2009.
2740	CoRWM's Understanding of the UK Requirements for the Assessment and Mitigation of the Risks of Aircraft Impact on Stores for Higher Activity Wastes and Spent Fuel. February 2010.
2743	Minutes of Plenary Meeting 16-17 December 2009, London.
2744	West Cumbria MRWS Partnership: presentation to CoRWM by Elaine Woodburn, Leader of Copeland Borough Council, December 2009.
2746	CoRWM Meeting with the Office for Civil Nuclear Security, Harwell, 7 December 2009.
2747	CoRWM Meeting with Regulators' Generic Design Assessment Team, London, 8 December 2009.
2748	Response from the Committee on Radioactive Waste Management to the Government Consultation on the Draft National Policy Statements for Energy Infrastructure, March 2010.
2749	CoRWM's Statement of its Position on New Build Wastes, March 2010.
2750	Brian Clark Letter and Questionnaire on PSE, January 2010.

CoRWM doc. no.	*Title*
2755	Information on New Build Wastes Submitted to CoRWM by Stakeholders, February 2010.
2756	Evidence from the Chair of CoRWM to the House of Lords Science and Technology Committee Call for Evidence on Radioactive Waste Management, January 2010.
2764	CoRWM Meeting with Department for Transport, London, 15 January 2010.
2765	CoRWM Meeting with Westinghouse, Preston, 20 January 2010.
2766	CoRWM Meeting with NDA on R&D, Warrington, 19 January 2010.
2767	CoRWM Meeting with EDF and AREVA, London, 22 January 2010.
2770	Minutes of Plenary Meeting 27 January 2010, London.
2771	Quality Control for CoRWM Documents, February 2010.
2776	CoRWM Meeting with NDA on RWMD R&D Programme to Support Geological Disposal, 28 January 2010.
2779	Issues for Plenary Discussion on Scottish Government Higher Activity Waste Policy Consultation Documents, February 2010.
2782	Task Group 4 Meeting with RWMD on Moving from Areas to Sites, 28 January 2010.
2788	Minutes of Plenary Meeting 25 February 2010, Nottingham.
2789	Addendum to Evidence from the Chair of CoRWM to the House of Lords Science and Technology Committee Call for Evidence on Radioactive Waste Management, March 2010.
2790	Notes of the Meeting between the Steering Group of the West Cumbria MRWS Partnership and CoRWM, 23 February 2010.
2792	CoRWM Meeting with NDA on HAW Topic Strategy and Related Matters, Warrington, 1 March 2010.
2793	CoRWM Meeting with NDA to Discuss Topic Strategies for Spent Fuels and Nuclear Materials and Related Matters, Manchester, 3 March 2010.
2795	Response from CoRWM to the Scottish Government Consultation on Scotland's Higher Activity Radioactive Waste Policy, April 2010.
2797	CoRWM Chair's Meeting with NDA Chief Executive Officer, London, 4 March 2010.
2798	Reviewing the Effectiveness of the Committee, April 2010.
2800	CoRWM Proposed Programme of Work 2010-2013, March 2010.
2801	CoRWM Visit to BGS, Keyworth, 24 February 2010.
2802	CoRWM Visit to Hunterston A&B Sites, 9-10 March 2010.
2803	NDA National Stakeholder Meeting, Manchester, 16-18 March 2010.

CoRWM doc. no.	*Title*
2806	CoRWM Procedures for Formulating Advice, March 2010.
2809	CoRWM Visit to Hinkley Point A&B Sites, 9-10 March 2010.
2811	Meeting with NII, EA and SEPA to Discuss Progress by NDA and Others in Developing Strategies for the Management of Higher Activity Wastes, Spent Fuels and Nuclear Materials, Manchester, 26 March 2010.
2821	CoRWM Comments on Recommendations in the 2nd Report of Session 2009-10 by the House of Lords Science and Technology Committee, Radioactive Waste Management: a further update (HL Paper 95), June 2010.
2823	Risk and Challenges Associated with Recycling and Waste Disposal: Korean Perspective: presentation by Yongsoo Hwang, Korean Energy Research Institute, September 2009.

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- *Fundamentals*
- *Overview and Glossary*
- *Part 1: The Regulatory Process*
- *Part 2: Radioactive Waste Management Cases*
- *Part 3a: Waste Minimisation, Characterisation and Segregation*
- *Part 3b: Conditioning and Disposability (for trial use and comment)*
- *Part 3c: Storage of Radioactive Waste (for trial use and comment).*
- *Part 3d: Managing Information and Records relating to Radioactive Waste.*

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ANNEX A CoRWM TERMS OF REFERENCE

Introduction

A.1. Following the announcements by UK Government and the devolved administrations (Government), on 25 October 2006, a new Committee on Radioactive Waste Management (CoRWM) will be appointed under these revised terms of reference designed to meet the future needs of the Government's Managing Radioactive Waste Safely (MRWS) programme. The Committee will be jointly appointed by UK Government and relevant devolved administration Ministers. Details of its roles, responsibilities and membership are outlined below.

CoRWM's Role and Responsibilities

A.2. The role of the reconstituted Committee on Radioactive Waste Management (CoRWM) will be to provide independent scrutiny and advice to UK Government and devolved administration Ministers on the long-term management, including storage and disposal, of radioactive waste. CoRWM's primary task is to provide independent scrutiny on the Government's and NDA's proposals, plans and programmes to deliver geological disposal, together with robust interim storage, as the long-term management option for the UK's higher activity wastes.

A.3. Sponsoring Ministers (from Defra, DTI and the devolved administrations) will agree a three-year rolling programme and budget for CoRWM's work on an annual basis. Any in-year changes will be the subject of agreement by sponsoring Ministers.

A.4. CoRWM will provide appropriate and timely evidence-based advice on Government and Nuclear Decommissioning Authority (NDA) plans for the delivery of a geological disposal facility for higher activity wastes under the Managing Radioactive Waste Safety programme. The work programme may include review of activities including waste packaging options, geological disposal facility delivery programmes and plans, site selection processes and criteria, and the approach to public and stakeholder engagement. Testing the evidence base of the plans for the delivery of a geological disposal facility will be a key component of the work. As well as ongoing dialogue with Government, the implementing body, local authorities and stakeholders, CoRWM will provide an annual report of its work to Government.

A.5. CoRWM shall undertake its work in an open and consultative manner. It will engage with stakeholders and it will publish advice (and the underpinning evidence) in a way that is meaningful to the non-expert. It will comply, as will sponsoring departments, with Guidelines on Scientific Analysis in Policy Making as well as other relevant Government advice and guidelines. Government will respond to all substantive advice. Published advice and reports will be made available in respective Parliaments/Assemblies, as will any Government response. CoRWM's Chair will attend Parliamentary / Assembly evidence sessions as and when required.

A.6. With the agreement of CoRWM's sponsoring Ministers, other parts of Government, the NDA and the regulatory bodies may request independent advice from CoRWM. Relevant Parliamentary / Assembly Committees may also propose work to sponsoring Ministers, for consideration in the work programme. CoRWM's priority role is set out in

paragraph 2 although sponsoring Ministers may also ask the Committee to provide advice on other radioactive waste management issues as necessary.

A.7. In delivering its annual work programme, and where there is a common interest, the Committee will liaise with appropriate advisory bodies including Health and Safety Commission advisory bodies, and any advisory bodies established by the environment agencies.

A.8. CoRWM shall consist of a Chair and up to fourteen members, one of whom will be appointed by Ministers as Deputy Chair on the recommendation of the Chair. Seats will not be representative of organisation or sectoral interests and the skills and expertise which will need to be available to the Committee will vary depending on the programme of work. For example, the relevant skills may include: radioactive waste management, nuclear science, radiation protection, environmental law, environment issues, social science (including public and stakeholder engagement), geology / geochemistry / hydrogeology, finance / economics, civil engineering / underground construction technology, geological disposal facility performance / safety issues, materials science, environmental impact assessment, local Government, planning, regulatory processes and ethics. Sponsoring Ministers may review the membership of the Committee, and the skills and expertise required.

A.9. Appointments will be made following the Office of the Commissioner for Public Appointments (OCPA) code of practice. Initial appointments will be for three years and sponsoring Ministers retain the right to terminate appointments at any time in light of individual members' performance, changes in CoRWM's work requirements, or completion of the work required of CoRWM.

A.10. The Committee, as agreed in the annual plans, may co-opt additional expertise to form or support temporary sub-groups set up to examine specific and defined problems.

Programme of work

A.11. To support its work, CoRWM will need to familiarise itself with Government policy in this area, including ongoing meetings with relevant Government departments and the NDA. The outline framework within which CoRWM is then expected to work is:

(i) *recognising the policy framework within which it will operate including* the roles and responsibilities of Government and the NDA in relation to CoRWM's own advisory role;

(ii) *scrutinising Government and NDA proposals, plans and programmes* to implement geological disposal and other radioactive waste management issues on which Government might seek advice as agreed in CoRWM's work plan;

(iii) *formulation of advice and reporting to Government* based on the best available evidence and informed by the views of stakeholders and the public.

A.12. CoRWM will prepare its draft work programme, within this outline framework, in conjunction with Government, the NDA and regulators, taking account of work by other

advisory bodies (see paragraph 7 above). The programme will include details of specific areas of work, reports which it intends to produce, the proposed use of sub-groups and any other activities or events, including proposals for public and stakeholder engagement. CoRWM will submit its first draft three-year work programme proposal to its sponsoring Ministers for discussion and agreement at an appropriate early stage following appointment of the full Committee. Subsequent three-year work programmes will be agreed annually on a rolling basis.

A.13. In familiarising themselves with the relevant background and issues, Members will make themselves aware, and take account, of previous engagement and reports in the Managing Radioactive Waste Safely programme, the UK Radioactive Waste Inventory and the nature of current and expected future UK holdings of plutonium, uranium and spent nuclear fuel. CoRWM will take account of existing technical assessments and research into radioactive waste management in the UK and elsewhere. In particular, it is recognised that CoRWM will need to engage with the NDA given that the Committee's advice will directly impinge on the long-term responsibilities of the NDA. CoRWM will also take account of other relevant policy developments.

A.14. The Chair will submit a report to Ministers by 30 June each year on the delivery of the agreed work programme. This will be made available in the UK and Scottish Parliament, the National Assembly for Wales and the Northern Ireland Assembly.

Access to other sources of expertise

A.15. Members of CoRWM itself will not have all the skills and expertise necessary to advise Government. The Committee will need to decide how best to secure access to other appropriate sources of expert input during the course of its work. Within this, it will have the option of setting up expert sub-groups containing both Members of CoRWM itself and other appropriate co-opted persons. A member of CoRWM will chair any sub-group of this nature and ensure its effective operation, as well as provide a clear line of responsibility and accountability to the main Committee, and hence to Ministers. This approach will enable the Committee to draw on a broad range of expertise in the UK and elsewhere.

A.16. The number of such sub-groups will be kept to the minimum necessary. Their role will be that of providing advice for the main Committee to consider and assess as it sees fit, and managing any activity which CoRWM delegates to them. It will be for the main Committee to assess and decide upon the advice it receives from such sub-groups. CoRWM may also utilise other appropriate means of securing expert input, such as sponsored meetings and seminars. The Chair will ensure that sub-group work and all other activities are closely integrated.

Public and stakeholder engagement

A.17. CoRWM must continue to inspire public confidence in the way in which it works. In order to secure such confidence in its advice it will work in an open and transparent manner. Hence, its work should be characterised by:

- a published reporting and transparency policy;
- relevant public and stakeholder engagement as required;

- clear communications including the use of plain English, publishing its advice (and the underpinning evidence) in a way that is meaningful to the non-expert;
- making information accessible;
- encouraging people to ask questions or make their views known and listening to their concerns;
- providing opportunities for people to challenge information, for example by making clear the sources of information and points of view on which the Committee's advice is based;
- holding a number of its meetings in public.

Responsibilities of the committee and its members

A.18. CoRWM will have a corporate responsibility to deliver its advice to sponsoring Ministers in accordance with agreed work plans. It will be for Ministers, with appropriate reference to their respective Parliaments and Assembly, to take decisions on the advice it receives and to give directions to the NDA as necessary on any subsequent changes required in the delivery of geological disposal of the UK's solid radioactive waste.

A.19. All members will need to be effective team workers, with good analytical skills and good judgement besides a strong interest in the process of decision-making on difficult issues. A number of them will need experience of project management, advising on scientific and technical issues directly relating to radioactive waste management, public and stakeholder engagement, excellent drafting and communication skills, or business experience and knowledge of economics.

A.20. The Chair, in addition, will be capable of successfully and objectively leading committee-based projects, grasping complex technical issues, and managing a diverse group effectively and delivering substantial results, presenting progress and outcomes in public. He or she will be a person with appropriate stature and credibility.

Role of the Chair

A.21. The Chair will be responsible for supervising the CoRWM work programme and ensuring that the Committee's objectives are achieved. The Chair will be responsible for advising Ministers promptly if he or she anticipates that the Committee will not complete its agreed work programme indicating what remedial action might be taken. He or she will be the main point of contact with the public and the media, in presenting progress and answering questions. The Chair will meet Ministers on appointment, and then at least annually along with other members as appropriate. Notes of these meetings will be published. The Chair will ensure CoRWM submits its annual written report to Ministers, by 30 June of each year. The Chair may be required to present the position of CoRWM to Parliament or Assembly committees and representatives as appropriate. The report will set out, among other things, CoRWM's progress with the agreed work programme, advice deriving from it and costs incurred. Ministers will also appoint a Deputy Chair who can assist the Chair as the latter sees fit.

Role of Members

A.22. Members will work, under the Chair's supervision, to the programme agreed with sponsoring Ministers, so as to ensure its satisfactory delivery. Members will have a collective responsibility to ensure achievement of CoRWM's objectives and delivery of its work programme. Individual Members may be appointed by the Chair to undertake specific, active roles, for example chairing sub-groups or in representing CoRWM in meetings with the public, organisations who are contributing to the work, or the media. All members will abide by CoRWM's Code of Practice and will be subject to individual performance appraisal as laid down by the Cabinet Office guide (see next paragraph).

Standards

A.23. CoRWM is set up by, and answerable to Ministers and is funded by the taxpayer. It must therefore comply with the Cabinet Office guide "Public Bodies: a Guide for Departments" (http://www.civilservice.gov.uk/other/agencies/publications/pdf/public_bodies_2006/1_case_assessment.pdf).

A.24. These and other relevant procedural requirements will be set out in CoRWM's Code of Practice which Members will agree to, prior to appointment.

Resources

A.25. Sponsoring Ministers will provide CoRWM with resources – both staff and financial – to enable it to carry out its agreed programme of work. These will include a secretariat which will help CoRWM carry out its work programme including, at the outset, providing reading material and arranging for any further briefings and visits. The Chair and Members will have a collective responsibility for delivering the work programme within the agreed budget, although the Chair may request sponsoring Ministers for adjustment to this budget should this be considered necessary.

Payments

A.26. The Chair and Members will be paid for their work for CoRWM at agreed daily rates. They will also be fully reimbursed for all reasonable travel and subsistence costs incurred during the course of their work.

ANNEX B CoRWM MEMBERS

Robert Pickard (Chair) – is Emeritus Professor of Neurobiology at the University of Cardiff, Visiting Professor at the Royal Agricultural College, Cirencester, and Fellow of the Institute of Biology and the Royal Society of Medicine. Formerly he was Chairman of the Consumers' Association *Which?* and Director-General of the British Nutrition Foundation. For the Department of Health and the Royal Society for the Promotion of Health, Professor Pickard was also Chairman of the national NGO Forum, which facilitated the interface between government policymakers and 104 NGOs working for health improvements. He is an international authority on the biology of honeybees and pioneered the development of solid-state, neural microbiosensors in the UK.

William Lee (Deputy Chair) – is until August 2010 Head of Materials at Imperial College London. He has a Physical Metallurgy BSc from Aston, a DPhil in Radiation Damage Studies from Oxford and has held academic positions in the USA (Case Western Reserve University, Cleveland and Ohio State University) and in the UK, notably at Sheffield University where he was Director of BNFL's University Research Alliance on Waste Immobilisation. He is a member of the International Commission on Glass Technical Committee on Nuclear and Hazardous Waste Vitrification and Chair of the International Ceramic Federation Technical Committee on Ceramics in Nuclear Applications. He is a Fellow of the American Ceramic Society, the City and Guilds Institute and the Institute of Materials.

David Broughton – is a Chartered Engineer and a Member of the Institution of Mechanical Engineers. He has 26 years experience in professional engineering and management of complex nuclear projects. Now retired, he worked at UKAEA Dounreay, Caithness from 1981 until 2007, where he was responsible for Dounreay's major radioactive waste management projects. These included new low level waste disposal facilities, new intermediate level waste encapsulation and storage facilities, the future retrieval of waste from the Dounreay shaft and the shaft isolation project. He is experienced in both engaging stakeholders in projects that have many options and technical issues to consider, and guiding projects through the regulatory and planning processes.

Margaret Burns – is Chair of Health Scotland and a part-time teaching fellow in the Law Department of the University of Aberdeen. She was a member of the Health and Safety Commission for nine years, representing the public interest and the devolved administrations. As a Commissioner she chaired HSC's Rail Industry Advisory Committee and the Partnership for Health and Safety in Scotland and had particular responsibility for the offshore oil industry and the nuclear industry. In 2003 she was awarded the CBE for services to health and safety. She has extensive experience of working with consumer organisations, such as the Scottish Consumer Council and Consumers' Association, and is presently a member of the National Consumer Council's Advisory Group.

Brian D Clark – is Professor of Environmental Management and Planning at Aberdeen University. He was a Board Member of the Scottish Environment Protection Agency (SEPA) and Chairman of the North Region Board and the Planning & Finance Committee of SEPA from 2000 to 2008. He has served on CoRWM since 2003. With forty years experience, he is a specialist in environmental impact assessment (EIA), strategic environmental assessment (SEA) and urban and rural planning. He was honoured in 1987 by being made a founder

member of UNEP's Global 500 Award. He is a governor of the Macaulay Land Use Research Institute, a member of the Scottish Government Local Boundary Commission and a founder member of the Institute of Environmental Assessment (IEA), now the Institute of Environmental Management and Assessment (IEMA) and chairs its Technical Committee.

Mark Dutton – has a doctorate in high energy physics and a 38 year career based at the National Nuclear Corporation. Specialising in design and safety case issues associated with radiological protection, nuclear safety and radioactive waste management, he continues to work as a nuclear consultant. He has served on CoRWM since 2003. He is a Fellow of the Institution of Nuclear Engineers, co-author of two Safety Guides published by the International Atomic Energy Agency and has reviewed the safety of reactors in Iran and Pakistan on behalf of the Agency. He is a member of the Defence Nuclear Safety Committee of the Ministry of Defence and a member of the Presidential Nuclear Safety Committee of Armenia.

Fergus Gibb – is Emeritus Professor of Petrology & Geochemistry in the Department of Engineering Materials, University of Sheffield. He has over 40 years' teaching and research experience in mineralogy, petrology, geochemistry and other areas of geoscience. A specialist on igneous intrusions, he is a former Vice-President of the Mineralogical Society and an Elected Fellow of the Mineralogical Society of America. A long-standing research interest in the geological disposal of nuclear wastes has led to over 25 papers on the subject and national and international recognition as an authority on deep borehole disposal. On the strength of the potential strategic importance of this research work, Professor Gibb's post at the University of Sheffield was part-funded for a period by the Nuclear Decommissioning Authority but the conduct of the work was, and remains, independent of the NDA and the nuclear industry.

Simon Harley – is Professor of Lower Crustal Processes in the School of Geosciences at the University of Edinburgh. An international expert on the evolution of continental crust, his research integrates geological mapping with experimental and microanalytical studies of the stabilities of minerals and their behaviour at high temperatures and pressures. He has conducted geological mapping projects in diverse and complex basement areas in Australia, India, Norway, Greenland, Scotland and Antarctica. Professor Harley is a Fellow of the Royal Society of Edinburgh and in 2002 was awarded the Imperial Polar Medal in recognition of his contributions to Antarctic Earth Science.

Marion Hill – is an independent consultant with 35 years' experience in standards for and assessments of the radiological impact of the nuclear industry on the public and the environment. She specialises in policies, strategies and standards for the management of radioactive wastes and radioactively contaminated land. Her early career was at the National Radiological Protection Board (now part of the Health Protection Agency), from where she moved into consultancy. Her experience includes national and international work on policy and regulatory topics, and environmental impact assessments for nuclear installations in the UK and overseas. She was a member of the Health and Safety Commission's Nuclear Safety Advisory Committee (NuSAC) from 2006 to 2008, when it was suspended.

Francis Livens – has held a radiochemistry position at the University of Manchester since 1991. He worked for over 25 years in environmental radioactivity and actinide chemistry,

starting his career with the Natural Environment Research Council, where he was involved in the response to the Chernobyl accident. At the University of Manchester, he has worked in many aspects of nuclear fuel cycle research, including effluent treatment, waste immobilisation and actinide chemistry. He was the founding director of the Centre for Radiochemistry Research, established in Manchester in 1999 and is now Research Director of the Dalton Nuclear Institute and Director of the EPSRC-funded, Manchester/Sheffield Nuclear Fission Doctoral Training Centre. He has acted as an advisor to the nuclear industry both in the UK and overseas.

Rebecca Lunn – is a Reader in Civil Engineering at the University of Strathclyde. She has over 15 years of research experience in hydrogeology, with a particular focus on deep flow systems, hydromechanics and the spatial and temporal evolution of rock permeability. Her research experience is multi-disciplinary and she currently collaborates closely with structural geologists, seismologists, mathematicians and, more recently, microbiologists, psychologists and statisticians. Current research interests include: development of computer models to simulate changes in rock permeability over time surrounding geological faults, with a view to improving flow predictions for deep radioactive waste disposal and carbon dioxide sequestration; understanding the relationship between subsurface groundwater flow and earthquakes; and exploring public understanding of uncertain science, such as flood prediction, to inform the regulators' approach to public information and decision making.

Leslie Netherton – has over 30 years local government experience, where he specialised in health and safety, food safety, environmental protection and emergency planning. As Head of Service with Plymouth City Council from 1998-2007 he had responsibility for civil protection, waste management, cemeteries, building control, consumer protection, sustainability and environmental health. As lead Authority officer for the nuclear submarine refitting facility at Devonport Royal Dockyard, he was involved with major planning applications, discharge consent consultations, offsite emergency planning and extensive stakeholder engagement. He is Chair of the Ministry of Defence Advisory Group for its Submarine Dismantling Project and sits on the project Steering Group. He currently runs an environmental health consultancy company and has been an active member of the Chartered Institute of Environmental Health.

John Rennilson – is a Chartered Town Planner and a Chartered Surveyor with over 37 years' experience in local government. He served as County Planning Officer of North Yorkshire County Council (1984-1996) and as Director of Planning & Development for Highland Council (1996-2008). His career has involved balancing development needs and environmental issues at a strategic, as well as at a local, level. He has had considerable experience of the energy industry, including development of the Selby Coalfield, coal-fired electricity generation at Drax and Eggborough, and decommissioning Dounreay, as well as renewable electricity generation and transmission issues across the Highlands.

Andrew Sloan – is a chartered engineer, a Fellow of the Institution of Civil Engineers and a Visiting Professor in the Department of Civil Engineering of the University of Strathclyde. He is a director of the specialist consulting engineering firm Donaldson Associates Ltd. He graduated in geology from the University of Edinburgh and has an MSc in Engineering Geology from the University of Leeds. With over 20 years' experience, he is a specialist in geotechnical engineering with particular emphasis on the development of underground

space. He has experience in the management and delivery of technically challenging and complex ground engineering projects in a range of regulated industries. He led the independent technical check of the grouting aspects of the Shaft Isolation Project at Dounreay and has worked on underground engineering projects in North America, Europe, Africa and South East Asia.

Lynda Warren – is Emeritus Professor of Environmental Law at Aberystwyth University and a member of the Royal Commission on Environmental Pollution. She has postgraduate degrees in marine biology and law and has pursued an academic career first in biology and latterly in environmental law. She has over 100 academic publications, including a number on radioactive waste management law and policy. Lynda has 15 years experience of radioactive waste management policy. She has been a member of CoRWM since 2003 and, before that, was a member of the Radioactive Waste Management Advisory Committee (RWMAC), chairing its working group on Dounreay. She is currently a member of the Board of the British Geological Survey and an associate of IDM, a consultancy engaged in environmental policy advisory work, mainly in the nuclear sector.

ANNEX C CoRWM EXPENDITURE 2009-10

The following is CoRWM's budget out-turn for the year, broken down by main spending areas. The budget was set at £525k.

Budget Item	Budget (£k)	Out-turn(£k)
Member fees and expenses	350	349*
Plenary meetings	70	65
Website	45	46
Technical support and supplementary member time allocation	30	24
Printing and publication	10	11
Public and stakeholder engagement	15	7
Visits	5	2
Total	**525**	**504**

*This figure includes tax paid to HMRC on Members' fees and expenses.

CoRWM is not required to report what individual Members were paid, but it publishes this information in the interests of transparency. The fees paid to individual Members who served during 2009-10 are below.

Name	Fees (£k)
Robert Pickard (Chair)	35.1
William Lee (Deputy Chair)	19.7
David Broughton	15.6
Margaret Burns	14.4
Brian D Clark	14.7
Mark Dutton	15.6
Fergus Gibb	15.6
Simon Harley	15.6
Marion Hill	15.6
Francis Livens	13.2
Rebecca Lunn	15.6
Leslie Netherton	13.3
John Rennilson	15.6
Andrew Sloan	15.4
Lynda Warren	15.6

ANNEX D RECOMMENDATIONS IN CoRWM's 2009 REPORTS TO GOVERNMENT

Recommendations in CoRWM's Report on Interim Storage

The recommendations in CoRWM's March 2009 report to Government on interim storage (CoRWM doc. 2500) are as follows.

Recommendation 1

CoRWM recommends to Government that there should be greater UK-wide strategic co-ordination of:

- the conditioning, packaging and storage of higher activity wastes
- the management of all spent fuels
- the management of plutonium
- the management of uranic materials
- future transport arrangements for radioactive wastes and nuclear materials.

The co-ordination should include agreement on priorities.

Recommendation 2

CoRWM recommends to Government that appropriate information be made publicly available on the management of higher activity wastes, spent fuels, plutonium and uranium. There is a need to summarise, for a variety of readerships, the progress to date, the management options under consideration for the future, and the issues involved in choosing between alternative options. The information should complement that on waste quantities and characteristics given in the various documents about the UK Radioactive Waste Inventory.

Recommendation 3

CoRWM recommends to Government that more information be made available to the public about how the security of the storage and transport of radioactive wastes, spent fuels, plutonium and uranium is assured. The objective should be to give the public more insights into security issues, without compromising security in any way. In deciding what information should be made available, account should be taken of existing and proposed practices in countries with similar security needs to the UK and a strong freedom of information culture (for example, the USA*).*

Recommendation 4

CoRWM recommends to Government that there be more co-ordination of PSE between the NDA and other UK nuclear industry organisations, at national, regional and local levels. The objective should be to ensure that there is sufficient stakeholder participation in decision-making processes for the conditioning, packaging, storage and transport of higher activity wastes, and the management of spent fuels, plutonium and uranium, without incurring "stakeholder fatigue".

Recommendations in CoRWM's Report on Geological Disposal

The recommendations in CoRWM's July 2009 report to Government on geological disposal (CoRWM doc. 2550) are as follows.

Recommendation 1
CoRWM recommends to Government that it begins work now to develop the principles to be used in deriving Community Benefits Packages and the process by which Packages would be agreed. This should include work on providing confidence that, once agreed, such packages will be delivered.

Recommendation 2
CoRWM recommends to Government that it should explain how local stakeholders would have an opportunity to influence the outcome of the planning application process for a GDF if the application is referred to the Infrastructure Planning Commission.

Recommendation 3
CoRWM recommends to Government that the NDA and the Government should discuss with communities, that have expressed an interest, the advantages and disadvantages of single- and two-stage planning applications for underground investigations and construction of a GDF. In particular, the discussions should cover the hold points, that could be subject to conditions attached to approval of a single application, and opportunities for local stakeholder engagement at such hold points.

Recommendation 4
CoRWM recommends to Government that it should ensure that the NDA carries out option assessments in which a wide range of geological disposal concepts is considered. These should include disposal in facilities constructed using various techniques, at depths ranging from about 200m to more than 1km, disposal of all higher activity wastes in a single facility, separate facilities for various types of higher activity wastes, and facilities incorporating different degrees of retrievability. A wide range of stakeholders should be involved in these assessments.

Recommendation 5
CoRWM recommends to Government that it should ensure that the NDA has an integrated process in place for geological disposal facility design, site assessments and safety case development. The process should be described in publicly available documents that have been reviewed by independent experts and the regulators.

Recommendations in CoRWM's Report on R&D
The recommendations in CoRWM's October 2009 report to Government on R&D (CoRWM doc. 2543) are as follows.

Recommendation 1
CoRWM recommends to Government that it ensures that there is strategic co-ordination of UK R&D for the management of higher activity wastes. Such co-ordination is required within the NDA, between the NDA and the rest of the nuclear industry, amongst the Research Councils and between the whole of the nuclear industry, its regulators and the Research Councils.

Recommendation 2
CoRWM recommends to Government that it ensures that the Environment Agency and the Scottish Environment Protection Agency obtain the resources that they need to access and commission the additional independent research required to support them fully in their regulation of the management of higher activity wastes.

Recommendation 3
CoRWM recommends to Government that it assigns to a single organisation the responsibility for providing national leadership and strategic direction for provision of R&D skills relevant to the long-term management of radioactive wastes.

Recommendation 4
CoRWM recommends to Government that it ensures that facilities for research with highly radioactive materials are improved and their capability enhanced so that they can be used for the full spectrum of research relevant to the long-term management of higher activity wastes. These facilities should be accessible to all researchers who need them.

Recommendation 5
CoRWM recommends to Government that an underground research facility be constructed at any site where it is proposed to construct a geological disposal facility.

Recommendation 6
CoRWM recommends to Government that mechanisms are put in place to ensure that a wider range of stakeholders than to date will be involved in establishing R&D requirements for the long-term management of higher activity wastes and that accessible information will be made available to the public about R&D needs, plans and progress.

ANNEX E GLOSSARY AND ACRONYM LIST

Glossary

Active facility	A facility where radioactive materials can be used. [*Such facilities are subject to safety, security and environmental regulation*.]
Advanced Gas-Cooled Reactor (AGR)	A UK designed, gas-cooled reactor with a graphite moderator. [*It uses enriched uranium oxide fuel with steel cladding and graphite sleeves. The primary coolant is carbon dioxide*.]
Applied research	Investigation directed primarily towards a specific practical aim or objective, which can involve using existing knowledge and understanding or acquiring new knowledge.
Basic research	See "Fundamental research".
Benefits Package	See "Community Benefits Package".
Committed waste	Radioactive waste that will arise in future from the operation or decommissioning of existing nuclear facilities. [*As distinct from existing waste, which already exists, and new build waste, which will only arise if new facilities are built.]*
Community Benefits Package	A set of measures to enhance the social and economic well-being of a community that hosts a geological disposal facility, to recognise that the community is performing an essential service to the country.
Community Siting Partnership	A partnership of organisations with interests in the community that has expressed an interest in hosting a geological disposal facility. [*The partnership is expected to involve the host community, the "Decision Making Body" (or Bodies) and "Wider Local Interests". It will work with the Nuclear Decommissioning Authority and other relevant organisations to ensure local concerns are addressed during the geological disposal facility siting process and will advise the Decision Making Body (or Bodies)*.]
Conditioning	Any process used to prepare waste for long-term storage and/or disposal. [*Usually by converting it into a suitable solid form e.g. incorporation in glass (vitrification), encapsulation in cement*.]
Decision Making Body	The Local Authority that will make the decisions for a host community in the geological disposal facility siting process.
Decision to Participate	A decision by a community to participate in the geological disposal facility siting process, without commitment to eventually host a facility.

Desk-based studies	Review, summary, collation or evaluation of existing knowledge, information, facts and research outcomes. *[In the context of the UK geological disposal siting process, assessing the suitability of sites using existing knowledge about the geology, surface environment, communities etc.]*
Development	Progressive, systematic use of knowledge and understanding gained from research directed towards the production or improvement of materials, devices, systems or methods. [*Includes the design and development of processes.*]
Disposal	Emplacement of waste in an appropriate facility without the intention of retrieving it. [*Retrieval may be possible but if intended the appropriate term is "storage".*]
Disposable	A waste package is disposable if it can be safely removed from a store, transported to a disposal facility and emplaced in that facility, and if it will play its planned role in ensuring the post-closure safety of that facility.
Encapsulation	A process in which radioactive waste is physically enclosed in a material with the aim of preventing radionuclides from escaping. [*For intermediate level waste encapsulation is a type of "conditioning"; the most commonly used encapsulants are types of cement and others include polymers. For spent fuel encapsulation is likely to entail placing the fuel in an inner canister that is then placed in an outer, disposal canister. The canisters could be made of different metals and might be filled with metal.*]
Environmental Permit	A permit issued by the Environment Agency under the Environmental Permitting Regulations. [*When the Environmental Permitting Regulations 2010 come into force, Environmental Permits will replace registrations and authorisations under the Radioactive Substances Act 1993 in England and Wales.*]
Exotic fuel	Term used for any type of nuclear fuel that is not from a commercial nuclear power reactor. [*Mainly fuels from research reactors and nuclear powered submarines.*]
Expression of Interest	A notification to Government by a community that it is interested in entering discussions about involvement in the geological disposal facility siting process, without commitment.
Fundamental research	Original, exploratory investigation involving experimental or theoretical work undertaken primarily to acquire new knowledge and understanding of phenomena and observable facts without necessarily having any immediate application or use in view.

Generic Design Assessment (GDA)	The generic assessment being undertaken by the Health and Safety Executive and the Environment Agency of the suitability of new reactor designs for use in the UK.
Geological disposal	Generally, emplacement in the Earth's crust with no intent to retrieve. Used specifically in the MRWS programme to mean "disposal" of radioactive waste in an underground facility, where the geology (rock structure) provides a barrier against escape of radioactivity and where the depth, taken in the particular geological context, substantially protects the waste from disturbances arising at the surface.
Geological disposal concept	Any variant of geological disposal, including the use of a "mined repository", "deep boreholes" and more than one "geological disposal facility".
Geological disposal facility (GDF)	Any facility used for geological disposal. [*Includes mined repositories, natural caverns, disused man-made caverns or mines, and deep boreholes.*]
Geological disposal facility design	The detailed drawings and specifications that will allow construction of a "geological disposal facility". [*Includes nuclear, civil, mechanical, electrical, materials, chemical, geotechnical and geological engineering aspects.*]
Geological repository	See "mined repository".
Higher activity waste (HAW)	Radioactive waste with activity above the thresholds for low level waste (LLW), *i.e.* above 4 GBq/tonne alpha activity or above 12 GBq/tonne beta gamma activity. [*It is usually also taken to include LLW unsuitable for near-surface disposal.*]
High level waste (HLW)	Radioactive waste in which the temperature may rise significantly as a result of its radioactive content, so that this factor has to be taken into account in the design of waste storage or disposal facilities. [*In practice the term is only used in the UK for the nitric acid solutions arising from reprocessing spent fuels and for the vitrified form of the solutes in these solutions.*]
Historic waste, historical waste	See "legacy waste".
Host community	A community in which a geological disposal facility will be built. [*It is a community in a small geographically well-defined area, such as town or village, and includes the population of that area and the owners of the land.*]

Immobilisation	A conditioning process in which radioactive waste is chemically incorporated into a material with the aim of preventing radionuclides from moving. [“*Vitrification” and incorporation in ceramics are types of immobilisation processes*.]
Interim storage	Storage of radioactive waste prior to implementing a final management step, such as “geological disposal”.
Intermediate level waste (ILW)	Radioactive waste exceeding the upper activity boundaries for “low level waste” (*i.e.* over 4 GBq/tonne alpha activity or 12 GBq/tonne beta gamma activity) but for which its heat output need not be taken into account in the design of storage or disposal facilities.
Legacy facility	A nuclear facility constructed several decades ago where waste has been generated or stored.
Legacy waste	Radioactive waste that arose several decades ago. [*A subset of existing waste; sometimes called “historic waste” or “historical waste”. The term is usually reserved for wastes kept in, or that have arisen in, legacy facilities*.]
Long-term storage	Storage for more than about 100 years.
Low level waste (LLW)	“Radioactive waste” with activity levels that do not exceed 4 GBq/tonne alpha activity or 12 GBq/tonne beta gamma activity. [*Subsets of LLW include “very low level waste” (VLLW) and exempt waste (i.e. “radioactive waste” with activity levels below those in the various Exemption Orders made under the Radioactive Substances Act)*.]
Magnox reactor	A UK designed gas-cooled reactor with a graphite moderator. [*It uses uranium metal fuel with a magnesium alloy cladding*.]
Mined repository	A facility specifically excavated and constructed for the “geological disposal” of radioactive waste. [“*Mined and engineered repository” is a more correct description. Most designs consist of shafts or adits leading to tunnels and vaults*.]
Near-surface disposal	Disposal at or close to the surface of the Earth. [*Includes underground disposal in the Earth’s crust at depths less than a few tens of metres, and emplacement in engineered structures at or just below ground level. Formerly called “shallow land burial” or emplacement in a “near surface repository”*.]

Optimisation	A process of showing that risks have been reduced to a level beyond which, on a balance of factors, no further reduction would be worthwhile. [*The optimisation principle encompasses various principles and concepts used in health and safety regulation, environmental protection and radiological protection (e.g. "as low as reasonably practicable" (ALARP), "best available techniques" (BAT), "as low as reasonably achievable" (ALARA). In the context of radioactive waste management it always implies a need to identify, assess and compare options for achieving an objective or carrying out an operation.*]
Overpack	An additional container for a waste package. [*Usually to make it more suitable for storage, handling, transport or disposal.*]
Package	See "Waste package".
Packaging	Placing waste into a container for long-term storage and/or disposal. [*In most cases this includes conditioning but sometimes waste is simply placed in containers, with or without compaction to reduce its volume.*]
Primary research	The obtaining of knowledge, facts and data that did not previously exist. [*All fundamental and much applied research is primary.*]
Pond	A water-filled structure in which nuclear fuel is stored. [*Usually made of concrete, the water provides cooling and shielding.*]
Pressurised water reactor (PWR)	A nuclear reactor in which water is used as the coolant and moderator. [*The fuel is enriched uranium oxide with "zircaloy" cladding. PWRs operate above atmospheric pressure to prevent the water boiling.*]
Public	People who have no particular interest in, and are not affected by, radioactive waste management. [*CoRWM distinguishes between "stakeholders" and the public.*]

Radioactive waste	Radioactive waste is defined in the Radioactive Substances Act 1993 and the Environmental Permitting (England and Wales) Regulations 2010. In essence it is any substance for which there is no further use and in which artificial radionuclides are present at any level and/or natural radionuclides are present above the levels given in Schedule 1 of the Act and the corresponding schedule in the Regulations. [*Note that spent fuels, plutonium and uranium are not radioactive wastes unless it has been decided that there is no further use for them and they are declared to be wastes. This legal definition of radioactive waste is under review and it is expected that a revised definition will be put in place in 2010-2011.*]
Radioactive waste management	All the activities involved in managing radioactive wastes. [*Includes minimising arisings, all types of treatment (e.g. decontamination, sorting, segregation), "conditioning", "packaging" and "disposal".*]
Raw waste	Waste that has not been conditioned.
Repository	A facility where waste is emplaced for disposal. [*Often used as shorthand for "mined repository", but also used in other contexts, e.g. the UK's Low Level Waste Repository (LLWR).*]
Requesting Parties	The organisations that have requested that their reactor designs be considered in the Generic Design Assessment of new reactors by the Health and Safety Executive and the Environment Agency. [*The current Requesting Parties are Westinghouse and EDF/AREVA.*]
Research	An investigation directed to the discovery of some fact or principle by a course of study or scientific enquiry.
Retrievability	An ability to withdraw wastes from a disposal facility that is achieved by means designed into the facility other than simply reversing waste emplacement. [*See also "reversibility" and "recoverability".*]
Safety assessment	An assessment of whether a nuclear facility or operation is or, if particular actions are taken, will be safe.
Safety case	The complete set of arguments that demonstrates that a nuclear facility or operation is or, if particular actions are taken, will be safe.
Spent fuel	Fuel that has been used in a nuclear reactor and for which there is no further use as fuel.

Stakeholder	A person or organisation who has an interest in or is affected by radioactive waste management. [*In the context of CoRWM's work, stakeholders include waste producers, regulators, non-governmental organisations, local authorities and communities near existing nuclear sites and potential disposal sites.*]
Stakeholder fatigue	A situation in which stakeholders are overwhelmed by communications and consultations on a particular topic, and do not respond to requests for their views.
Storage	Placing wastes or other materials in a facility with the intention of retrieving them at a later date.
Strategy II	The name being given by the Nuclear Decommissioning Authority to its second Strategy. [*The first NDA Strategy was published in 2006. There will be a public consultation on Strategy II in the autumn of 2010 and the final version will be published by early April 2011, after approval by Government.*]
Surface-based investigations	Investigations of a potential geological disposal site that are carried out from the surface, rather than underground. [*For example, seismic investigations and boreholes.*]
Topic Strategy	A strategy developed by the Nuclear Decommissioning Authority for a particular topic within its remit. [*For example, topic strategies are being developed for higher activity wastes and for various types of spent fuels.*]
Treatment	Any process used to make radioactive wastes suitable for the next step in their management. [*Treatment processes include sorting, decontamination, volume reduction and all types of "conditioning".*]
Underground research facility (URF)	A site or host rock specific underground facility for characterisation and R&D related to "geological disposal".
Vitrification	The process of converting wastes into a glass or glass-like form.
Voluntarism	An approach to siting geological disposal facilities that involves communities voluntarily expressing an interest in holding discussions with Government, then deciding whether to participate any further.
Waste package	A container and all its contents . [*Includes the waste, any encapsulating material, any capping grout, etc.*]

Wider Local Interests	Communities outside the "host community" that have an interest in the development of a geological disposal facility. [*For example, nearby villages, communities on transport routes to the "host community".*]

Acronym List

AGR	advanced gas cooled reactor (A type of reactor with a graphite core, and uranium oxide fuel in steel cladding with a graphite sleeve.)
BERR	Department for Business, Enterprise and Regulatory Reform (now part of the Department for Business, Innovation and Skills)
BGS	British Geological Survey
COI	Central Office of Information (of the UK Government)
CoRWM	Committee on Radioactive Waste Management
COWAM	Community Waste Management (an EU project)
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DoENI	Department of the Environment Northern Ireland
DSSC	disposal system safety case (being developed by NDA)
EA	Environment Agency, England and Wales
EDF	Electricité de France
EIA	environmental impact assessment
EPSRC	Engineering and Physical Sciences Research Council
EU	European Union
GDA	Generic Design Assessment (of new nuclear reactors, carried out by the regulators)
GDF	geological disposal facility

GRA	Guidance on Requirements for Authorisation (for disposal of solid radioactive wastes, produced by the environment agencies)
HAW	higher activity waste
HLW	high level waste
HSE	Health and Safety Executive
IAEA	International Atomic Energy Agency (a United Nations agency)
ILW	intermediate level waste
IPC	Infrastructure Planning Commission (to be replaced by different fast-track procedure for major projects)
IPT	Integrated Project Team (an NDA team for addressing a particular HAW management issue)
LLW	low level waste
LoC	Letter of Compliance (previously Letter of Comfort)
MoD	Ministry of Defence
MOX	mixed oxide fuel (contains uranium and plutonium oxides)
MRWS	Managing Radioactive Waste Safely (the UK programme for the management of higher activity wastes)
NDA	Nuclear Decommissioning Authority
NDARB	Nuclear Decommissioning Authority Research Board on nuclear decommissioning and waste clean-up
NEA	Nuclear Energy Agency (part of the Organisation for Economic Cooperation and Development)
NERC	Natural Environment Research Council
NGO	non-governmental organisation
NIEA	Northern Ireland Environment Agency
NII	Nuclear Installations Inspectorate (part of HSE)
NNL	National Nuclear Laboratory
NPS	National Policy Statement

NuLeAF	Nuclear Legacy Advisory Forum
NuSAC	Nuclear Safety Advisory Committee (now disbanded, advised HSE)
NWRF	Nuclear Waste Research Forum (a group convened by the NDA)
NWTRB	Nuclear Waste Technical Review Board (in the USA)
OCNS	Office of Civil Nuclear Security (part of HSE)
OECD	Organisation for Economic Cooperation and Development
ONR	Office for Nuclear Regulation (An organisation to be set up within HSE, incorporating NII, OCNS, UKSO, RMTT and TRANSEC. It is expected to be fully operational by April 2011.)
PCM	plutonium contaminated material
PIP	provisional implementation plan (the NDA plan for implementation of geological disposal)
PSE	public and stakeholder engagement
PWR	pressurised water reactor
R&D	research and development
RMTT	Radioactive Materials Transport Team (part of DfT)
RWMAC	Radioactive Waste Management Advisory Committee
RWMD	Radioactive Waste Management Directorate (of NDA)
RWPG	Radioactive Waste Policy Group (a UK Government group)
SDDG	Strategy Development and Delivery Group (for NDA, chaired by DECC)
SEA	strategic environmental assessment
SEPA	Scottish Environment Protection Agency
SLC	site licence company (a company that runs an NDA site, under contract to the NDA, and holds the nuclear site licence)
SSEC	sub-surface exclusion criteria (used in the UK geological disposal siting process)
SSG	Site Stakeholder Group (at NDA sites)

TRU	transuranic (in the USA the term TRU wastes is used for long-lived, actinide-containing ILW, such as PCM)
TRANSEC	Transport Security and Contingencies Directorate (part of DfT)
UKAEA	United Kingdom Atomic Energy Authority (now used only as an acronym, mainly as part of the names of the organisations into which the Authority was split)
UKSO	United Kingdom Safeguards Office (part of HSE)
WAG	Welsh Assembly Government
WIPP	Waste Isolation Pilot Plant (a geological disposal facility in New Mexico, USA)

FURTHER INFORMATION

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CoRWM Comments on Recommendations in the 2nd Report of Session 2009-10 by the House of Lords Science and Technology Committee, Radioactive Waste Management: a further update (HL Paper 95)

The Committee on Radioactive Waste Management (CoRWM) agreed at its plenary meeting in April 2010 (CoRWM doc. 2820) that, while it would not be appropriate for it to respond to the report of the House of Lords Science and Technology Committee, it did wish to publish some comments on the recommendations in the report. This document contains those comments. Paragraphs in italics are the recommendations from the House of Lords Science and Technology Committee report. The paragraphs that follow them are CoRWM's comments on those recommendations.

Recommendation 1
Whilst we welcome the Government's positive response to many of the recommendations in CoRWM's reports on geological disposal and interim storage, it is important that effective action is taken to ensure that these recommendations are taken forward. We urge the Government to do so.

CoRWM Comment on Recommendation 1
CoRWM welcomes this recommendation.

Recommendation 2
We welcome the Government's assurance that they regard research and development as important, and that it should be appropriately funded. We look forward to such assurance being reflected in the Government's response to CoRWM's report on research and development.

CoRWM Comment on Recommendation 2
CoRWM also welcomes the Government's assurance about research and development (R&D). CoRWM has been told that the delay in publishing Government's response to the report on R&D (CoRWM doc. 2543) has occurred because of the need for different government departments to work together in preparing it. We are encouraged by the involvement of different parties and look forward to receiving the response.

Recommendation 3
We believe that CoRWM's monitoring activity should be put on a more formal basis, so that stakeholders and the public can see clearly whether the Government is putting CoRWM's advice into practice. We therefore recommend that the Government should publish an annual report setting out what action has been taken towards meeting CoRWM's recommendations, so as to enable CoRWM effectively to monitor the Government's progress in implementing its recommendations.

CoRWM Comment on Recommendation 3
CoRWM welcomes any initiative that would enhance its ability to monitor Government's progress in implementing its recommendations and that would enable stakeholders and the public to see more clearly whether the Government is acting on CoRWM's advice. However, an annual report on the whole of the MRWS programme would be more appropriate than a report that dealt only with actions taken towards meeting CoRWM's recommendations.

Recommendations 4, 5 and 6

4. We believe it is essential that the MRWS programme continues to progress as rapidly as possible.

5. We are concerned that the Government and CoRWM are failing to convey any sense of urgency to move the programme forward with all possible speed.

6. We urge the Government to consider ways of speeding up the MRWS programme as plans for a geological disposal facility become more defined, and as scientific and technical improvements provide ways of increasing the rate of progress.

CoRWM Comments on Recommendations 4, 5 and 6

CoRWM agrees that it is desirable to proceed with the Managing Radioactive Waste Safely (MRWS) programme as rapidly as possible. However, the current process for establishing a geological disposal facility (GDF) is founded on a voluntary approach and its speed of progress must be determined by the willingness of the potential volunteer community or communities to proceed. Any attempt to try to impose time constraints on deliberations is likely to be counter-productive. It is also important to allow sufficient time for technical work, in particular site characterisation, GDF design and R&D.

The process of developing a GDF will inevitably take many years and CoRWM does not believe that it is appropriate to try to shorten the early stages of the programme. CoRWM agrees with the statement in the House of Lords Science and Technology Committee's 1999 report (Session 1998-1999 3rd Report, HL Paper 41), which was:

"We strongly recommend that the Government starts work promptly and proceeds in a steady and measured way without interruption. The programme for repository development is a long one and cannot be rushed. Delay in starting the programme will increase the likelihood that extensive refurbishment and replacement of surface stores will be required."

It is possible that scientific and technical developments will allow the geological disposal programme to be speeded up in some respects. However, CoRWM considers that there will be a need for long-term underground observations and experiments at any prospective GDF site and that time must be allowed for these (CoRWM doc. 2543).

CoRWM is, however, of the view that more urgency is required in retrieving legacy wastes from old facilities, conditioning and packaging these wastes, and placing them in modern, safe and secure stores. CoRWM welcomes the statements by the Nuclear Decommissioning Authority (NDA) that it is giving high priority to the retrieval of legacy wastes (NDA, 2010) but notes that this prioritisation does not seem to have led to faster rates of progress (CoRWM doc. 2811; HSE, 2010). It appears that the NDA's statements about priorities have not yet been translated into actions.

Recommendation 7

We believe that CoRWM could help drive forward the MRWS programme more rapidly by scrutinising, and if necessary reporting on, the Government's progress.

CoRWM's Comments on Recommendation 7

CoRWM's role is to scrutinise and advise; this includes reporting on progress by Government, NDA and others in making arrangements for the long-term management of higher activity wastes. It is not CoRWM's role to drive the MRWS programme forward but, if it considers that the programme is not progressing at an appropriate rate, it will advise Government accordingly and publish its advice.

Recommendation 8
We recommend that the Government publish clear policy milestones for all aspects of the MRWS programme, including for issues such as interim storage and the disposal of waste generated by new nuclear power stations. We recommend further that the Government should assist CoRWM in its scrutiny of the Government's progress with regard to the MRWS programme by including in the annual report a statement of the extent to which these milestones have been achieved.

CoRWM's Comments on Recommendation 8
CoRWM would welcome any initiative that would assist it in carrying out its scrutiny function. Further clarity on the Government's expectations for all aspects of the MRWS programme including, in particular, how they are inter-related, would be desirable. Regular statements of the extent to which various policies have been implemented and milestones achieved would be welcomed. It would be particularly useful if actions to mitigate the risk of failure to meet policy milestones were also included.

Recommendation 9
We believe that an annual report to CoRWM setting out the Government's progress towards meeting both CoRWM's recommendations and the Government's own policy milestones would improve the transparency of the MRWS programme. We believe also that this would help maintain public trust and confidence in the MRWS programme by strengthening CoRWM's scrutiny role.

CoRWM's Comments on Recommendation 9
CoRWM would welcome improvement of the transparency of the MRWS programme and agrees that such improvement would help to maintain public trust and confidence in the programme. If an annual report on the MRWS programme is produced (see comment on Recommendation 3), it should be written for all stakeholders and the public, not only for CoRWM.

Recommendation 10
We believe that CoRWM should provide independent advice to Government on any draft (as well as established) policies that have implications for the management of radioactive waste.

CoRWM has already provided independent advice to Government on draft policy documents and believes that this is an important part of its remit. In the case of established policies, CoRWM provides advice on implementation. Where comments on draft policies have to be made in confidence, which is often the case, CoRWM cannot follow its usual open and transparent processes. This issue is addressed in the comments on recommendations 11 and 12.

Recommendations 11 and 12
11. We are concerned that CoRWM was not asked formally by the Government to comment on the draft National Policy Statement for Nuclear Power Generation, despite the significance of the claims it contains about the future management of radioactive waste. Although we welcome CoRWM's decision to respond to the public consultation on the National Policy Statement anyway, we are concerned that it will not in these circumstances be providing advice based on its usual comprehensive consultation and evidence-gathering processes.
12. We recommend therefore that, in future, the Government should ensure that CoRWM is able to respond to Government consultations on policies with an impact on the MRWS programme with formal reports based on its usual rigorous approach.

CoRWM's Comments on Recommendations 11 and 12
CoRWM has recently clarified its procedures for evidence-gathering and consultation in the formulation of advice (CoRWM doc. 2806, reproduced in Annex A). It uses its fullest procedures for its formal reports to Government that contain recommendations. Responses to Government consultations are in a different category. In these cases, CoRWM seeks to inform itself so that it can formulate and express its own view, leaving other consultees to express theirs. It does not aim to represent the views of others, nor is it seeking comments on any proposed recommendations to Government.

In addition, CoRWM wishes to avoid the "stakeholder fatigue" that would undoubtedly occur if it consulted organisations and individuals about its response to a Government consultation at a time when they were preparing their own responses. A further consideration is that CoRWM would not be able to apply its fullest evidence gathering and engagement procedures within the standard 12 week period allowed for Government's public consultations.

In the case of the consultation documents for the draft National Policy Statement, Government asked CoRWM for its views at an early stage, when the draft documents had not been widely disseminated. CoRWM could not consult widely before commenting on these drafts, nor could it publish its comments, because the documents were given to it in confidence. CoRWM therefore told Government that it would only comment informally at that stage and would confine itself to matters of factual accuracy and clarity of expression; it would respond formally and openly to the public consultation in due course. A similar procedure was followed for the Scottish Government consultation on its higher activity waste policy. CoRWM considers that this approach achieves the best balance between meeting the needs of Government, maintaining openness and transparency, and limiting demands on stakeholders.

Recommendation 13
We commend CoRWM's rigorous approach to evidence gathering and stakeholder engagement in its published reports to date.

CoRWM's Comments on Recommendation 13
CoRWM welcomes this commendation.

Recommendation 14
We believe that the same high standard which is applied in developing CoRWM's formal advice to Government should apply to all documents published by CoRWM. While we commend CoRWM's commitment to transparency, extreme caution should be taken to ensure that its working papers are not published until it is satisfied they are accurate and evidence based.

CoRWM's Comments on Recommendation 14
CoRWM considers that it is not feasible to apply to all the documents published on the Committee's website the same procedures as it uses in developing its formal reports to Government. CoRWM uses an approach that takes account of the type of document and the time available to prepare it. The approach includes the following features:

- for all documents that will contain recommendations to Government, the procedure (Annex A) is to send a draft to selected stakeholders for factual checking, before any version of the document is published

- this is also the procedure for CoRWM documents that do not contain recommendations but that rely extensively on evidence from, or the views of, some stakeholders
- all draft documents contain a prominent disclaimer (Annex B)
- CoRWM's quality control procedures (CoRWM doc. 2771) are applied to all its documents
- all documents except the simplest are circulated within the Committee for comment prior to publication.

Recommendation 15
We believe that, at present, the membership of CoRWM includes an appropriate range of geoscience expertise to enable it to scrutinise effectively the current stage of the MRWS programme. However, we take the view that CoRWM would benefit from more members with experience of business and practical on-site operations and engineering on the main Committee, and we recommend that the Government and CoRWM arrange for this additional expertise to be recruited at an early stage. More generally, we welcome the Government's commitment to keep the Committee's skill set under review as the MRWS programme progresses.

CoRWM's Comments on Recommendation 15
CoRWM is satisfied that it has sufficient experience of business and practical on-site operations and engineering in its membership for its current activities. CoRWM does not only consider technical matters and much of its strength rests in its ability to address issues in the round. It is able to ask appropriate questions of appropriate persons, so as to formulate sound advice and recommendations and to carry out effective scrutiny.

If CoRWM finds that it needs additional expertise in any area, it can obtain it by commissioning work from outside experts. It has already done this on some occasions.

Recommendation 16
We recommend that CoRWM ensures its future work programmes are focused on specific issues relevant to the current stage of the MRWS programme.

CoRWM's remit is wider than the MRWS programme. Its Terms of Reference (CoRWM doc. 2235) state that its role is "to provide independent scrutiny and advice to UK Government and devolved administration Ministers on the long-term management, including storage and disposal, of radioactive waste. CoRWM's primary task is to provide independent scrutiny on the Government's and NDA's proposals, plans and programmes to deliver geological disposal, together with robust interim storage, as the long-term management option for the UK's higher activity wastes".

In developing its future work programme, CoRWM focuses on those aspects of the long-term management of the UK's higher activity radioactive wastes that it considers are of highest priority for its scrutiny and advice in the coming year. It consults Government, NDA, regulators, other stakeholders and the public about its proposed work programme and takes account of their views. Thus it ensures that its proposed work programme always deals with specific issues that are relevant to the current plans and programmes for the management of higher activity wastes in the UK.

Recommendation 17
We recommend that CoRWM should be free to set its work programme and that it should not be subject to the agreement of sponsoring ministers, although ministers should continue to be able to request advice from CoRWM on specific topics as necessary.

CoRWM's Comments on Recommendation 17
As noted above, before submitting its proposed work programme to sponsors, CoRWM consults widely with stakeholders and invites public comment. In CoRWM's experience to date, sponsors have provided useful comments and advice on priorities for CoRWM but have not sought to restrict its activities. CoRWM sees no reason, therefore, to change the present arrangements.

Recommendation 18
We feel it is appropriate for CoRWM to keep a watching brief on technological alternatives to design and engineering solutions within the context of a geological disposal programme, so that it can advise the Government in the event of the evidence base underlying Government policies changing.

CoRWM's Comments on Recommendation 18
CoRWM also feels that this watching brief is appropriate and will endeavour to maintain it, within the constraints of its resources.

Recommendation 19
We take the view that CoRWM should primarily concentrate on providing evidence-based comment on technical issues.

CoRWM's Comments on Recommendation 19
Most major decisions on the management of radioactive wastes are multi-faceted, involving a wide range of issues that extend beyond those of a technical nature. Government recognised this when the present members of CoRWM were appointed, which is why they have expertise beyond science and engineering (CoRWM doc. 2235). Concentrating only on technical issues would entail neglecting key parts of the UK programmes for the long-term management of higher activity wastes, particularly the voluntarism and partnership approach to the siting of a GDF. Further, CoRWM would not be able to engage effectively with stakeholders or the public if it confined itself to technical aspects.

References
CoRWM doc. 2235. *Terms of Reference for the Committee on Radioactive Waste Management*. October 2007.

CoRWM doc. 2543. *Report on National Research and Development for Interim Storage and Geological Disposal of Higher Activity Radioactive Wastes and Management of Nuclear Materials.* CoRWM Report to Government, October 2009.

CoRWM doc. 2771. *Quality Control for CoRWM Documents.* February 2010. (Second version, replaces CoRWM doc. 2539, September 2009.)

CoRWM doc. 2806. *CoRWM Procedures for Formulating Advice.* March 2010.

CoRWM doc. 2811. *Meeting with NII, EA and SEPA to Discuss Progress by NDA and Others in Developing Strategies for the Management of Higher Activity Wastes, Spent Fuels and Nuclear Materials, Manchester, 26 March 2010.*

CoRWM doc. 2820. *Minutes of Plenary Meeting, 27-28 April 2010, Manchester*.

Health and Safety Executive, 2010. *West Cumbria Site Stakeholder Group: Sellafield, Calder Hall and Windscale. Quarterly Report for 1 January 2010 – 31 March 2010.* (www.hse.gov.uk/nuclear/llc/2010)

Nuclear Decommissioning Authority, 2010. *Business Plan 2010-13.*

ANNEX A

CoRWM Procedures for Formulating Advice

Type of advice	Evidence base	PSE	Comments
1: Informal verbal	Based on evidence and information from general meetings, documents, correspondence, international experience, professional knowledge and experience.	None usually	Typically advice given during meetings, usually by individual members. Not a CoRWM view.
2: Informal written	Based on evidence and information from general meetings, documents correspondence, international experience, professional knowledge and experience.	None usually	Views from task group or individual members, not a CoRWM view. Could involve members of CoRWM outside task group. Example: informal comment on draft Government proposals to promote invitation to communities.
3. Formal written: responses to consultations	Meetings and correspondence with specific stakeholders where appropriate. Evidence and information from general meetings, documents, correspondence, international experience, professional knowledge and experience.	Mainly with a limited range of stakeholders to check scope, collect evidence and check accuracy of facts.	Extent of PSE may depend on time frame. All formal responses to consultations are approved by CoRWM plenary and are a CoRWM view.

Type of advice	Evidence base	PSE	Comments
4. Formal written: position papers	Meetings and correspondence with specific stakeholders where appropriate. Evidence and information from general meetings, correspondence, documents, international experience, professional knowledge and experience.	Mainly with a limited range of stakeholders to collect evidence, check accuracy of facts and seek views on proposed conclusions.	Position papers have conclusions but not recommendations to Government. When approved by plenary position papers are a CoRWM view.
5. Formal written: reports to Government on specific topics, with recommendations	Meetings and correspondence with wide range of stakeholders and public. Review of published documents, international experience etc.	Wide range of PSE including website, e-bulletin, specific PSE events (workshops), bilateral meetings. PSE may take place at a number of stages during development of draft report and proposed conclusions and recommendations. It includes factual checking with selected stakeholders.	Most extensive staged process. Final version of report is approved by plenary and is a CoRWM view. Government responds to reports, if possible within 3 months of receipt.
6. Formal written: documents with recommendations to Government, other than reports	Any of those shown for items 1-5.	Wide range of PSE including website, e-bulletin, specific PSE events (workshops), bilateral meetings. PSE may take place at a number of stages during development of draft document and proposed conclusions and recommendations. It includes factual checking with selected stakeholders.	Most extensive staged process. Final version of document is approved by plenary and is a CoRWM view. Government expected to respond.
7. Formal written: urgent recommendations to Government	Evidence already available to Committee.	None.	Document containing recommendation published after submission to Government. Government expected to respond.

Type of advice	Evidence base	PSE	Comments
8. Annual Report	Evidence collected during year by any of the methods shown for items 1-5.	As 6 if report contains new recommendations. As 4 if report does not contain new recommendations.	As 6 if report contains new recommendations. As 4 if report does not contain new recommendations.
9. Work programme	Review of issues from previous programme, key organisations work programmes, meetings with selected stakeholders.	Draft proposals circulated by website and e-bulletin for public and stakeholder comment. PSE at draft and second draft stages.	Extensive staged process. Final version of proposed work programme is agreed at plenary before submission to Government for approval to proceed.

Note
Public and stakeholder engagement (PSE) is undertaken to gather the views of others and thus inform the Committee. The views expressed in CoRWM's documents are the Committee's own.

ANNEX B

Disclaimer for Draft CoRWM Documents

This document does not present the views of the Committee on Radioactive Waste Management nor can it be taken to present the views of its authors. It is a draft paper to inform Committee deliberations and both the authors and the whole Committee may adopt different views and draw entirely different conclusions after further consideration and debate.

Committee on Radioactive Waste Management

Professor Robert Pickard

Chairman of CoRWM

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CoRWM Document: 3053

8 June 2012

Dear Rhuari,

I am writing to confirm that no further evidence has been presented to cause CoRWM to change the view that was expressed in my letters to Councillor Elaine Woodburn and CALC [CoRWM doc 2902 (2011) and CoRWM doc 3023 (2012)].

There is evidence to show that the hydrogeology of West Cumbria is considerably more varied than suggested by Professors Smythe and Haszeldine, supporting the position that more investigations will be required during site identification and assessment, and consistent with the MRWS staged process.

With respect to geology, the area contains both crystalline rocks and mud rocks, both of which have been shown to be potentially suitable hosts for repositories abroad. We draw your attention to the letter of the 26th October 2011 sent by Dr Jeremy Dearlove to the Partnership in which he provided arguments that the geology and hydrogeochemistry of West Cumbria, as presently understood, does not warrant the conclusion that it is all unsuitable. In response to questions arising from their presentation to the MRWS Steering Group meeting of the 29th of March 2012, Chris McDonald (the Lead Inspector from the 1997 Nirex Inquiry) and Colin Knipe (the Technical Assessor and advisor on Geology and Hydrogeology for the 1997 Nirex Inquiry) confirmed (p.13) that they had never stated that “the whole of the geology of West Cumbria is unsuitable”, and indicated that it is not possible to rule out some areas at this stage.

It is clear that resolution of many of the issues raised by the respondents to PSE 3 require the levels of geological investigation that are planned for Stages 4-6 of the MRWS process. In our view it will not be possible to settle the arguments about the geology and hydrogeology of West Cumbria until further data have been obtained in the later Stages of the MRWS process.

Yours sincerely

Robert Pickard
Chair of CoRWM

Doc. No. 29.

CoRWM 3rd Meeting 14/15.1.04 Agenda 6.3

Stakeholder Engagement

Case Study: the BNFL national nuclear dialogue.

By Pete Wilkinson

December 2003

History

BNFL has been the target for unrelenting anti-nuclear campaigning for decades. It has responded by becoming defensive and inwards-looking, attitudes which have themselves reinforced the view that the company is secretive and devious. In short, BNFL has been under siege for more than 25 years, years which were characterised by direct actions, trial by media and litigation.

In 1995, discussions were held between the company and greens concerning the possibility of rapprochement and a period of dialogue in which attempts could be made to bridge the gulf between the two. By 1998, these initial discussions had matured into a decision to hold a meeting at which 'stakeholders' could discuss how, when and with what agenda such dialogue could be undertaken. The task of calling and facilitating this meeting was given to The Environment Council, an independent charity established specifically for the purposes of seeking resolution of environmental problems.

The resulting series of meetings which are still on-going at the time of writing developed into the most ambitious and longest-running example of unbounded stakeholder dialogue ever attempted in the UK.

Principles

The principles behind the BNFL national dialogue are those pertaining to only one kind of engagement process – unbounded dialogue – as distinct from the other means of engagement which begin with information provision. Unbounded dialogue is the most complex, lengthy and sustained type of engagement in which the stakeholders themselves establish the parameters on the engagement.

It is based on two fundamental principles which are depicted in Appendices 1 and 2.

Appendix 1 shows that beneath opposing 'positions' taken by two protagonists lie the deeper and more fundamental issues of 'interests' and 'needs', both of which underpin the positions and which will inevitably overlap. It is at this level that the dialogue seeks to work initially by examining these underlying and possibly common needs in both views and to increase the co-operation and trust by working on issues beneath those represented by 'positions'. This principle seeks to encourage 'collaborative bargaining' above 'positional campaigning'.

Appendix 2 shows the value of collaborative working over confrontational campaigning. The resolution of a dispute lies somewhere on the A-B axis but in the process of arriving at a resolution, confrontational activity such as litigation, undermining the opponent's position and the propounding of diametrically opposed views leads to an erosion of trust and a distancing which is unproductive and ultimately negative. A collaborative approach, on the other hand, enhances trust and leads to more positive and amicable relationship.

Structure

A representation of the structure of the BNFL dialogue is given in Appendix 3.

Being an 'unbounded dialogue', the BNFL engagement process asked the stakeholders themselves to set the programme. In September 1998, a group which was to become known as the 'Main Group' of the dialogue comprising of close to 100 stakeholders representing seven broad constituency sectors (green NGOs, trades unions, regulators, the company, customers, local authorities and individual experts) established a representative task group to design the programme of work.

The task group recommended a programme of work based on five key areas of contention relating to BNFL's work – solid radioactive waste, liquid radioactive wastes, reprocessing of spent nuclear fuel, the management of separated plutonium stocks and BNFL's business futures options.

What is interesting about the structure is that it establishes representative working groups to undertake the work itself on the understanding that the representatives of each sector brings its own constituency members upto date with developments as the discussions unfold. This is designed to achieve maximum 'buy-in' from constituencies and provide a 'no surprises'

methodology. The individual sectoral representatives are also required to act as conduits for issues raised in their broader constituencies to be taken to the working groups.

The outputs from the working groups are in the form of reports which seek consensus where possible but which are designed more as a vehicle for examining where divergences of opinion exist and why than as an attempt to reach an overall consensus or to present a majority view. The recipients of the reports – beside the company for whom the work is undertaken – is decided on by the working groups with approval from the Main Group which is also required to sign off the work periodically or to request redrafting. More often than not, the reports have been presented to Government as an important indicator of how a representative group of stakeholders view a particular issue.

Dealing with the issue of bias

Historically, a report emanating from one side of the debate or the other has been swiftly and roundly discredited by the other. This phenomenon is known as the 'tis, tisn't' syndrome in which no ground is gained at all and the only winners are the media who appear to be wedded to the reporting of controversy. In order to address this impasse, the dialogue has developed two important mechanisms which are based on the suspension of disbelief.

One is the technique known as joint-fact-finding (JFF) in which all representative stakeholders agree on what is required from a piece of work in order to reduce the level of uncertainty which may exist around a particular issue or even to seek consensus should that emerge as a possibility from the work.

Having agreed on the issue, stakeholders draw up and collectively agree on the terms of reference for the piece of work to be undertaken and then agree on the consultants to which the work will be offered on a tendering basis. Similarly, the appointment of the consultant is jointly agreed as is the methodology to be followed, as far as is possible, together with the monitoring programme, the report drafting and oversight. This process removes the doubt and suspicion about most of the elements of reporting and commits stakeholders to signing up to the findings, although in reality, the minority view must still be accommodated for.

The other process of equal value is that known as Strategic Action Planning (SAP) in which the consequences of a particular course of action are plotted on a matrix which looks at the issues which will need to be addressed, the actions which need to be taken as a consequence, the deferred actions and

contingencies which will need to be planned for. This process normally requires the examination of two extremes (close all reactors now or continue reprocessing indefinitely in the case of examining the reprocessing issue) and a median case (BNFL's existing business plan in the same example). The advantage of this process is to allow a logical examination of the consequences of particular courses of action across a wide range of issues from environmental impact to the need for Government legislation. It also throws up 'windows of opportunity' by which actions must be taken in order to deal with potentially unforeseen consequences.

Evaluation

The BNFL national nuclear stakeholder dialogue will draw to a close in the autumn of 2005 to be replaced by another process yet to be decided upon. The question remains, 'Was it all worth it and did it make any difference?' Each stakeholder will have their own view, but it is a fact that the impact on the company of the dialogue falls into the invisible and the visible impacts categories. The visible is what most stakeholders are interested in: the greens want to know if it resulted in the reprocessing of spent fuel to be terminated earlier than it otherwise would have been and if discharges are being reduced more quickly.

The dialogue has catalogued each and every recommendation arising from its work over the years and logged BNFL's responses. These, among a battery of other information, are being evaluated by an external team of consultants. The invisible impacts of the dialogue are more difficult to assess in that they relate to changing attitudes and changing culture within the company but there can be no doubt that the dialogue has fostered, encouraged and promoted an atmosphere of openness and transparency within the company which, while it is still far from perfect, is a significant advance on what it was five years ago.

The Greens

One of the most noticeable failings of the dialogue is that it does not enjoy the involvement of the two big national green NGOs – Friends of the Earth and Greenpeace. Both these organisation withdrew after a couple of years claiming that their resources did not allow them to participate and that the results from the dialogue were slow to arrive and difficult to quantify. There is also an undeniable multiplicity of consultation processes currently on-going which has given rise to a real and tangible claim among greens of 'consultation fatigue.'

While this situation is undoubtedly unsatisfactory, the dialogue does involve other greens and the green agenda is well represented by individuals. In addition, all greens in the green anti-nuclear network are kept appraised of dialogue developments and periodically, the absentees are consulted on major issues.

It is worth noting that 'dialogue' is not suited to campaigning organisations which rely on uncompromising policy stances as their political interface with their supporters. Dialogue requires precisely the opposite of positional campaigning for it to work: without the ability to shift ground or to contemplate compromise, unbounded dialogue which is long-winded, involved, complex and which requires the accommodation of views with which one may be uncomfortable, is not the ideal consultative vehicle for national green organisations while the remain wedded to confrontative campaigning.

Lessons for CoRWM

- Establish why you want to consult
- Determine precisely what you are consulting about and why
- Engage early
- Choose the method of consultation carefully – horses for course
- Choose the stakeholder groups you intend to use even more carefully but then….
- Allow for changes to that catchment on the advise of your stakeholders
- Establish expectations clearly and precisely
- Set groundrules early and reinforce often
- Make sure the groudrules cover all appropriate areas from issues of confidentiality to the start and finish times of meetings
- Address the issue of capacity building before the process even begins
- Establish conflict resolution processes early
- Consider an evaluation programme
- Let the consultation programme meet the needs of the work rather than the other way round
- Don't consult for consultation's sake

APPENDIX 1

1.3.1 The P-I-N 'Iceberg' model

People traditionally try to negotiate solutions to conflict by taking positions and then groping towards each other - successively taking and conceding new positions. This is known as a *positional* or *adversarial* approach. This can work well in simple situations but it encourages battles to 'win', complicated calculations about risk and probability, posturing and bluffing, and missed opportunities. All in all a generally negative approach to what is a common problem - the inability to agree.

Instead the consensus-building approach likens negotiating positions to the tips of icebergs. Negotiating positions tell you much about people's public ambitions, and what they say tells you only what they want you to know. The problem is that these are not enough - you need to know what underlies their positions: what do they *really* want to achieve; what are they concerned about; what values are important to them? So you need to look under the surface of the iceberg to see the *interests* and *needs* on which their positions rest. When one digs beneath the surface one discovers that there are always things common to both sides.

Public statements tend to be superficial, and we have to look below the surface to see what is really going on: what are the ***interests*** on which their positions are based and, below the interests, what are the ***needs*** that motivate them? When you start delving deeper like this, you begin to discover not only their interests and needs but also, more to the point, that there are always some that are common to both parties.

These shared needs and interests are the foundations of the common ground on which problems will be solved and consensus will be built. If you start from shared needs and interests, rather than incompatible positions, then you also set in motion a process that starts from the basis that there is already some measure of consensus.

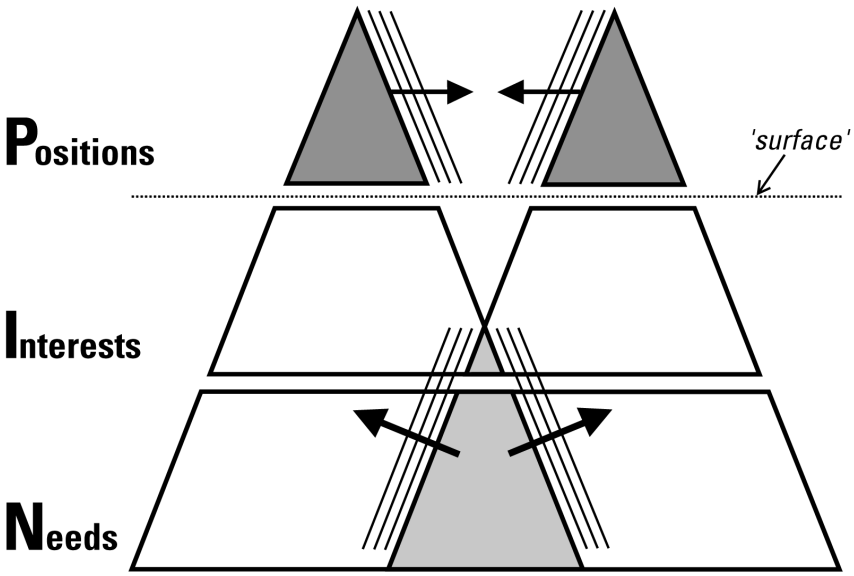


Figure 3: The P-I-N 'Iceberg' model

Simply finding areas of common ground does not solve the problem - there is still a large area where there is no overlap. The point is that starting from the common ground, and trying to build on it, is much easier than starting from conflicting positions and trying to bridge the gap.

APPENDIX 2

Consensus-building is all about people with different, and often opposing, views of a particular problem working together interactively towards agreement over a sensible way forward.

The trouble is that too many people think consensus-building is totally misdirected. They say the result will inevitably be a compromise - which, at least in our culture, is seen to be negative. Some even think that consensus and compromise are one and the same.

What makes it even more difficult is that they are right! At least they are right in that it ends in compromise - but then that is the only possible long-lasting resolution of conflict anyway.

Where they are totally wrong is in assuming that it has to be negative. This is simply not true. It all depends on how the compromise is reached - whether via conflict or via consensus.

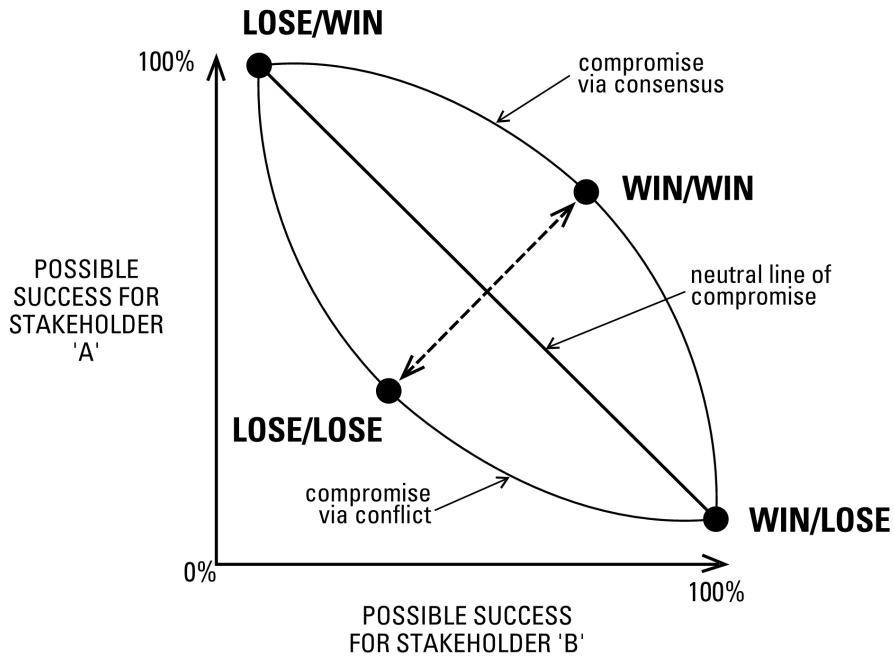
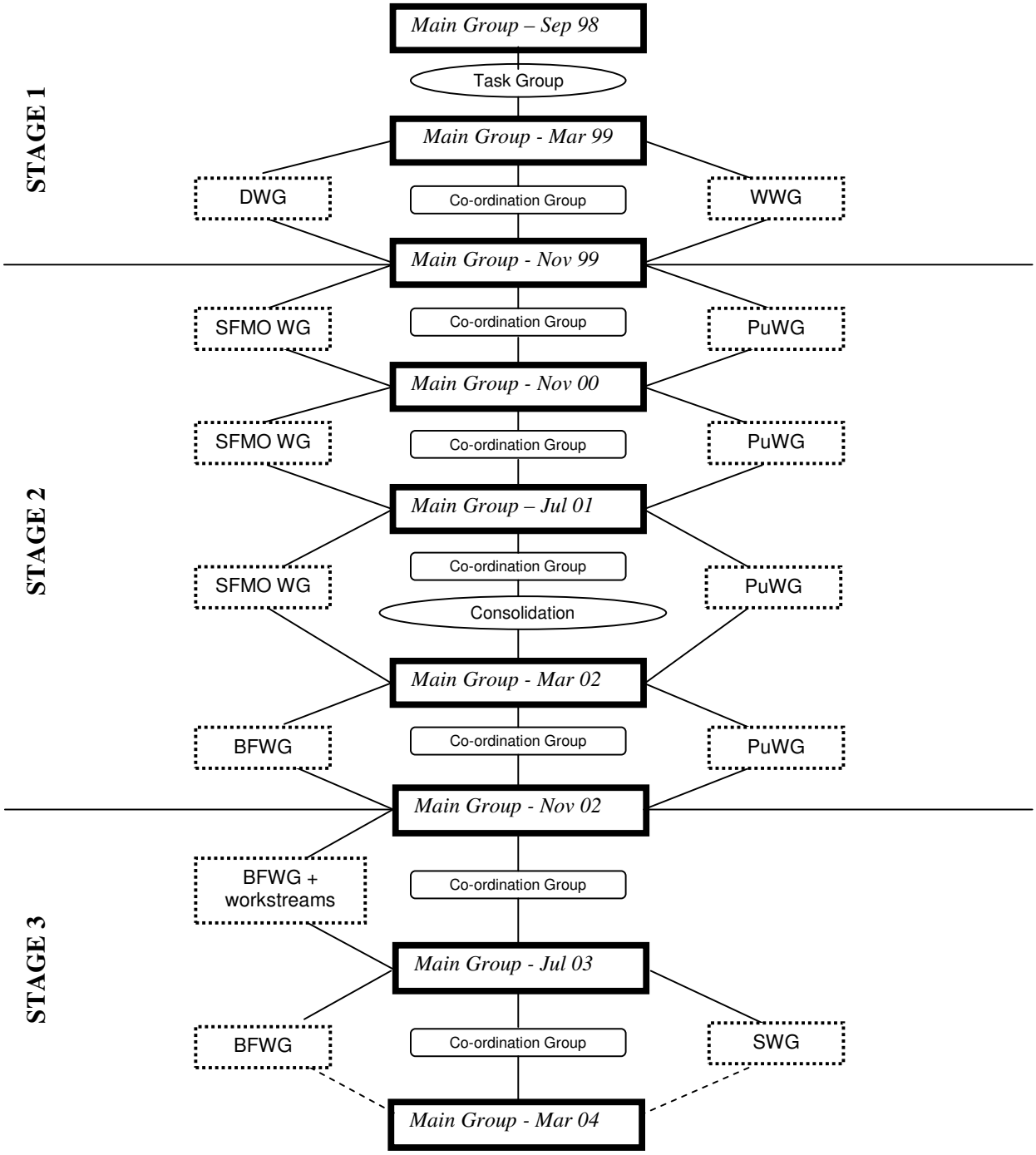


Figure 4: The different styles of compromise

Look at the two-dimensional model of compromise above. The vertical axis is the range of possible success for actor 'A' in a negotiation with actor 'B', expressed in terms of a percentage (0% to 100% of a fixed 'commodity'). The horizontal axis is the same for actor 'B'.

APPENDIX 3

Inception and Evolution of the BNFL National Stakeholder Dialogue



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16 February 2011

CoRWM Document Number: 2902

Dear Elaine,

CoRWM is tasked to scrutinise the implementation of Government policy on Managing Radioactive Waste Safely. It does this, independently, in the public interest and is accountable to the Governments of the UK, Scotland, Wales and Northern Ireland. To be successful, the MRWS process requires that all parties follow a disciplined engagement from stage to stage, one step at a time. This will ensure that adequate information will be available for each stage of deliberation. If individuals try to anticipate the debates of later stages in the process, prematurely, the deliberations will founder for lack of appropriate evidence that will only be forthcoming in later, stage-specific investigations.

Congratulations on your Winter 2010 Newsletter outlining progress on the MRWS process. CoRWM members have considered the two views presented on page three concerning the question: "Is West Cumbria's Geology Unsuitable?". We would like to take this opportunity to outline CoRWM's position on the views expressed. Our position is informed by our collective understanding of the requirements of the level of detail and quality of geological knowledge that is needed in order to move from the broader considerations of unsuitability, as used in the BGS screening study, to the more specific assessment of potential suitability in MRWS Stage 4. Our position is, therefore, offered in the context of the staged MRWS process and the proposed framework for site identification, which is currently being developed and will be subject to consultation later in 2011.

It is vital to the progress of the MRWS process, and engagement of the Partnership within it, that there is some confidence that potential subsurface sites may exist within West Cumbria. We recognise this and agree that it would be poor use of public resources, as well as community time, effort and capacity, to proceed towards a possible *Decision to Participate* if there was no prospect of potentially suitable sites being identified for subsequent, more detailed, assessment.

Our position is that there is presently no credible scientific case to support the contention that all of West Cumbria is geologically unsuitable.

It is important to recognise that the amount and level of geological information currently available across that part of West Cumbria not excluded by the BGS site-screening report is highly variable. For most of the region, insufficient geological information is available to make an informed decision on whether any sub-area is suitable or not. More work needs to be done on the assessment of existing geological and related information in order to assess potential suitability of different sub-areas prior to the identification of sites for further investigation. Even areas for which considerable geological information is already available will need to be evaluated further using consistent and robust methodologies.

Turning to the two articles on page three of the Newsletter, we consider that it is important to comment on their inaccuracies in order to assist you in assessing their relevance to your work.

Professor Smythe argues that 'scientifically ALL of West Cumbria is unsuitable' and cites this as a conclusion of the 1995-1996 Planning Inquiry. In our view, this was not the case. Reading of the report (Chapter 6: Scientific and Technical Benefits; Subsection 6A: Basic Repository Locational Criteria) and its conclusions (Chapter 8, paragraph 8.42 – Suitability of site) reveals that the Inspector, whilst noting the then current IAEA guidelines, did not at any stage reflect upon or draw conclusions on the suitability or otherwise of West Cumbria *as a whole*. His report, and that of the technical assessor, whilst drawing on evidence and views relating to other parts of West Cumbria, was focused correctly on that small area for which planning approval was sought for construction of an RCF.

Professor Smythe also states that 'the rocks and the underground flow of water are too complex and unpredictable' and claims that the UK is ignoring international guidelines that relate to this. The relevant international guidelines were at the time, and until very recently, contained in IAEA document 111-G-4.1, 1994 "Siting of Geological disposal Facilities" (*http://www.pub.iaea.org/MTCD/publications/PDF/Pub952e_web.pdf*). These guidelines on site selection (pages 10-11) are explicitly described as *general* guidelines and the IAEA acknowledges that there would be a need to adapt them to site-specific circumstances. These guidelines are, we understand, soon to be superseded by a new set of IAEA guidelines (Geological Disposal of Radioactive Waste [WS-R-4] - *http://www.ns.iaea.org/downloads/standards/drafts/xds334.pdf*), available in draft form.

Alun Ellis, in his statement supporting further geological investigations in West Cumbria, correctly outlines in general terms the process for moving from the BGS Report and non-excluded areas to identification of potential sites. However, we consider that his final statement that groundwater flows and flow paths determined at the Longlands Farm site were consistent with the safe disposal of intermediate-level waste goes too far. We agree, instead, with the more circumspect statement made in the revised and final NDA briefing note of 2nd February 2011. This states that the work that Nirex carried out in 1997 on the Longlands Farm site 'showed groundwater flows and flow paths which Nirex concluded *did not exclude the possibility* of safe disposal'

We trust that you will find these comments helpful in your continued deliberations within the MRWS process.

Yours sincerely,

Professor Robert Pickard
Chairman

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We trust that you will find these comments helpful in your continued deliberations within the MRWS process.

Yours sincerely,

Professor Robert Pickard
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1 June 2011

CoRWM document: 2932

Dear Professor Smythe,

Thank you for your paper, "Why a deep nuclear waste repository should not be sited in Cumbria: a geological review", which was received by CoRWM on 13 April 2011. We have read the paper with interest and in the recognition that it presents your views not only on the potential unsuitability of the sub-surface geology over the whole region but also on the specific issues, not all of them geological, that you consider to have pertained to the Longlands Farm site and the planning inquiry of 1995-1996.

The role of CoRWM is to scrutinise and advise on Government and NDA preparations and plans for the implementation of safe interim storage and subsequent deep geological disposal of higher activity radioactive waste. It is, therefore, not appropriate for us to comment on the specifics of the scientific case you build to support your views and conclusions. However, there are two points in your paper on which we need to comment in the interests of factual accuracy and to ensure that CoRWM's advice is not misconstrued by others or misrepresented to them.

In our letter of 14 February 2011 to the West Cumbria Partnership (CoRWM doc. 2902) we have stated our current position: "*there is presently no credible scientific case to support the contention that **all** of West Cumbria is geologically unsuitable".* We highlight the ***all*** in this statement to avoid any possible ambiguity. Your paper correctly quotes our position on page 1 but in your concluding remarks (Section 6, page 13) you re-phrase our position by asserting that CoRWM takes the view that "suitable geologies remain to be found within West Cumbria". This is not an accurate representation of our position. Our view is that, at this stage in the MRWS siting process, it is not known whether or not there are suitable geologies in West Cumbria.

The second point concerns the basis for our "*collective understanding of the requirements of the level of detail and quality of geological knowledge that is needed in order to move from the broader considerations of unsuitability, as used in the BGS screening study, to the more specific assessment of potential suitability in MRWS Stage 4".* You state on page 2 that the NDA

document, Geological Disposal: Steps towards implementation, "*is the document on which CoRWM's opinion rests*". This most definitely is ***not*** the case. Our collective understanding is based on the expertise and experience of CoRWM members in appropriate areas of geoscience, including but not limited to hydrogeology, engineering geology, structural geology and mapping, and geochemistry, as well as members' expertise in and understanding of radioactive waste issues. This collective understanding we refer to is informed both by members' scrutiny and review of an extensive range of published literature, reports, workshop papers and briefing documents relevant to geosphere characterisation, and also by their attendance at national and international meetings on the subject. Our collective understanding, therefore, is independent and based on international experience and practice. It is not reliant at all on the NDA document to which you refer.

Yours sincerely,

Professor Robert Pickard
Chairman

cc. West Cumbria MRWS Partnership, DECC, NDA/RWMD

CORWM PRESENTATION ON GEOLOGY AT WEST CUMBRIA MRWS PARTNERSHIP EVENT, WHITEHAVEN, 20 JUNE 2011

Simon Harley

1. At the invitation of the West Cumbria MRWS[1] Partnership, Professor Simon Harley, leader of CoRWM's task group on technical aspects of geological disposal, spoke on behalf of CoRWM at the seminar on geology held on 20 June 2011 in Whitehaven. This is a summary of his talk.

2. Professor Harley described himself as a geologist with extensive international experience in geological mapping, evaluation of the thermal and fluid-interaction records of rocks at depth, and experimental geology. He emphasised that he, and other geologists within CoRWM, are not experts on the geology of West Cumbria. He explained that this is important for the role of CoRWM, which is directed to issues at the national level rather than specific to any one region or area. He noted:

> "My experience, and that of others in CoRWM, informs our understanding of what is required in order to assess the sub-surface for geological disposal".

3. Professor Harley reiterated the overarching CoRWM remit, namely:

- "independent scrutiny and advice on the long-term management of higher activity radioactive wastes (HAW)
- scrutiny of Government and Nuclear Decommissioning Authority (NDA) plans, processes and actions for geological disposal of HAW
- provision of evidence-based advice to Government: CoRWM looks at the issues in a national context".

4. He then went on to outline CoRWM's tasks with respect to geological disposal, within the MRWS process for siting a geological disposal facility (GDF):

- "scrutiny and advice on the voluntarism and partnership approach to siting; under this task CoRWM attends Partnership meetings
- scrutiny and advice on site identification and selection processes (from screening to selection, MRWS Stages 2 to 4)
- scrutiny of NDA work in implementation of geological disposal and development of its Disposal System Safety Case (DSSC)".

5. In particular he noted, with respect to the role of CoRWM:

> "We are not part of any 'implementation team' – we exist to provide independent scrutiny".
>
> "Furthermore, CoRWM's role does not include in providing professional advice or answering questions on the geological suitability of West Cumbria; such questions should be addressed to experts commissioned by the Partnership and/or NDA".

6. With respect to the recent dialogue regarding geological suitability, he emphasised that the letter sent to the Partnership by CoRWM

> "presented comments provided within the context of the staged MRWS process, and from a national perspective. The CoRWM view is based on our understanding of the

[1] Managing Radioactive Waste Safely

principles of what would be expected in terms of geological information to allow for informed and evidence-based judgement".

7. In re-stating the CoRWM position regarding geological suitability he said

"*The key point is that it is premature to make broad statements or early decisions".*

8. To clarify and illuminate this point he noted:

"This is true for most areas of the UK – and certainly for those have are not exploited (or have been exploited for natural resources.

The level of knowledge required to assess suitability or otherwise at 500-1000m depths is not, in general, adequate for most areas in the UK.

For many areas, most of what appears in cross sections and the like is extrapolated from a small data set and involves considerable interpretation, with uncertainties that increase with depth.

In other circumstances, such as hydrocarbon exploration, even where detailed information has been collected for example from boreholes, the reality at depth has differed from what might have been expected or modelled. So we have to use the geological models (for example cross sections, 3D block diagrams and so on) with caution.

Detailed geoscientific information is needed for decision making at all stages and, eventually for modelling, performance assessments and safety cases. It has to be developed and assessed for the specific purpose of GDF hosting capacity".

9. Professor Harley then focussed on the example of hydrogeology, an important facet of any characterisation and assessment of the sub-surface. He explained:

"Groundwater flow depends not only on the hydraulic gradient or 'head' but also (and critically) on the hydraulic conductivity of the rock / rock packages. The latter may vary by several orders of magnitude.

Detailed geological information is required to assess the rock properties, the geometries of potential high-flow or bypass zones, and then the volume of low permeability, low-flow potential rock".

10. He then explained that in order to move forward further information would be required:

"Defining prospective rock volumes at depth relies on the above plus, where available, surface geophysics and deep borehole information.

All the necessary data may not be available, and extrapolations may leave wide margins of uncertainty. Where key information is missing, significant investment may be needed to develop the data to inform decision making".

11. In concluding his remarks, Professor Harley reiterated the main messages regarding the status of geological information and the role of CoRWM in the MRWS process:

"It is premature to make broad and seemingly definitive statements.

We will scrutinise the national process for moving from areas to sites, and will examine and advise on the rigour of its application and the content and quality of the geological information used to assess the subsurface.

We will maintain independence in doing this".

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Annex 1

Committee on Radioactive Waste Management

CoRWM DOCUMENT "NAMEPLATE"

1. Author **A T Blowers**
2. Date of paper: 15/3/04
Title / subject **AB note (march meeting)** **CoRWm 4th Meeting 2004. 1 & 2 April. Agenda item 8**
3. **Status** (e.g. 1st draft, final) Final. These papers were developed separately, although a brief discussion about them took place. The first proposes a "supporting programme" to provide a forum for a range of issues that require resolution. The second covers the nature of consensus, one of those issues and one that has been set down for discussion at the April plenary meeting.
4. Who is receiving a copy (delete as necessary:) All Members Others (list:) Adam Scott & Chris Harvey **(please also send a copy to Sam Bains in the Secretariat)**
5. Confidentiality Reasons (if any) why the document should not be published: ...
(Secretariat to complete:) **Document number** **296** ... **File** ... **Folder** ...

Document 296 - Note by Professor Blowers

Principles Working Group - issues to be considered further

Why a supporting programme?

1. A raft of concepts and issues, and the processes of discussion associated with them, has been exposed during the first three months or so of CoRWM's work. This note identifies some of the issues, and considers the mechanisms, by which CoRWM might best examine them further. It takes forward the idea of a "supporting programme" which was suggested at the Manchester (March 2004) plenary meeting. The purpose of such a programme would be to inform the Committee and enable it to explore and understand the context within which its recommendations are being developed.

2. The programme would not be set aside from CoRWM's main activities but be integral to them. Hence, the term "supporting programme" is used. No standing body is proposed though the programme could be facilitated by the Principles Group. It would take the form of sessions at plenary meetings and occasional commissioned events such as those described later in this paper.

What a supporting programme would do

3. Some of the matters that a CoRWM supporting programme might address were set out in paper 208 on *Deliberative Democracy* and in the earlier paper on *Ongoing Work of the Principles Group* (No. 204). These papers were discussed at the Manchester plenary meeting. Among the issues discussed are the nature of consensus, the definition of democracy, the problem of upholding the public interest in decision making, and the importance of ethics/values. They raise such questions as - how can we be sure our recommendations are robust, effective and legitimate?; how can we deal with irreconcilable conflict?; can deliberative approaches deliver democratic decisions?; and so on. Meanwhile, there has been a continuing dialogue among some members on such issues as Deliberative Mapping, ethics and complexity which indicate the need to identify and grapple with some important conceptual and practical problems that confront us.

4. The Manchester meeting welcomed the idea of a supporting programme and specifically approved a discussion on consensus at the next plenary and a workshop focusing on deliberative approaches and decision making. This note suggests what issues might be contemplated in such a programme and makes suggestions for developing the debate on consensus and the workshop on deliberative approaches.

The issues to be covered

5. A range of interconnected issues has surfaced through various papers and discussions. At each stage in our work, we should be able to

demonstrate that we have considered and understood the wider issues and their implications for our work. At the heart of this is the need to integrate concepts with process and outcomes to assist the Committee to present reasoned, robust and implementable recommendations. From discussions so far, I think the following themes have emerged.

The relationship of deliberative approaches to policy making

6. A range of points was made in paper 208 all of which need to be considered. In particular we need to understand -

- the purpose of deliberation;
- its role in relation to democratic processes;
- what constitutes consensus?;
- how to deal with conflicts;
- the rules of engagement and closure;
- the contribution of deliberation to achieving recommendations that are publicly acceptable and politically achievable.

These and related issues will be the focus of the workshop which is discussed further below.

Decision making in conditions of complexity and uncertainty

7. Issues relating to this theme were also raised in paper 208 and in contributions from Fred, David and Keith. In this area we might focus attention on:

- understanding how social and scientific uncertainty constrains decision making;
- understanding the relationship between timescales (social and geological) and their implications for choice of options;
- the problem of upholding the public interest in decision making.

These concerns will become important as we begin to interpret the nature of the problem and the options for management so we will need to start thinking around them fairly soon.

The role of values and ethical concerns.

8. Again, members have identified values and ethics as of primary importance. Among the key issues emerging here appear to be:

- the importance of equity – procedural, intra-generational, intergenerational;

- environmental ethics – the relationship of society and nature;

- instrumental and non-instrumental values – environment and economy;

- the relationship between science/expertise and social/lay perspectives.

A major aspect of the PSE process is to elicit values and we might wait until that process begins before we consider how values relate to the decision process.

Wider issues and outcomes

9. We have recognised that, during the course of our engagement, contingent issues will be raised. We also know that our eventual recommendations will need to indicate how the process moves forward to implementation. Among the contingent issues may be:

- energy policy and the role of nuclear power;

- climate change;

- societal stability and institutional continuity.

A way of approaching these may be through the concept of *sustainable development* in various dimensions.

10. Once a short list of options has emerged we shall need to consider issues of implementation. These may include retrievability, volunteerism, compensation and veto. But these issues should only be considered if they are relevant to options that are under serious consideration.

11. It may be noted that these themes all relate to our fundamental principles and must be seen to do so. The supporting programme may well elaborate our principles and introduce new ones of importance to the assessment stage in our work.

12. These are suggestions for a supporting programme. They are neither comprehensive nor is it suggested that all should be tackled. The meeting should consider:

- which issues should be included for consideration in a supporting programme?;

- at what stage they should be considered?

- how they should be considered?

Workshop on Deliberative Democracy

13. The issues to be covered are outlined above. I have had some preliminary discussions on the format this might take. The outline proposal is for a workshop taking one or two days. It would include the whole committee, the secretariat and a group of academics with expertise in the field. The suggestion is that it should be developed jointly by CoRWM and the Open University which has the relevant expertise. It could also be held in Milton Keynes providing the Committee with potential visibility in Britain's fastest growing city.

14. It is clearly understood that the workshop would apply the concept and ideas of deliberative democracy to the specific issue of managing radioactive waste. Among the issues for us to consider are,

- what do we want such a workshop to achieve?;
- what issues should it attempt to cover?;
- how should it be related to the PSE process?

Consensus

15. As suggested above, consensus is inevitably an issue which would be debated in the proposed workshop. It has also been identified as a subject for discussion at the plenary meeting in Bristol. Attached for reference is a relevant extract from a RWMAC paper which considered how scientific consensus might be achieved, together with a covering note by the CoRWM secretariat. The RWMAC report went much further suggesting societal consensus was also necessary to ensure publicly acceptable decisions. This might be a suitable starting point for the discussion. We might consider how the discussion should be framed and how it might relate to the proposed supporting programme.

Committee on Radioactive Waste Management

Robert Pickard

Chairman

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19 March 2012

CoRWM Document: 3024

Dear Mr Wales

Thank you for your email to CoRWM dated 19 February 2012 regarding the Managing Radioactive Waste Safely (MRWS) process in West Cumbria. CoRWM has discussed your email and the Committee's response to your points is below.

"I write as a resident of Cumbria who has real concerns over the volunteer process for selecting potential sites for a GDF. I had thought that after the failed NIREX planning appeal (1996) to site an RCF at Longlands farm near Sellafield that would be the end of the matter after serious concerns were raised about the unsuitable hydrogeology"

The Nirex study was based on detailed investigations of Longlands Farm but the Public Inquiry did not conclude that the whole of west Cumbria was unsuitable. The Inspector has recently reaffirmed that this is the case. So the areas of west Cumbria that were not excluded in the 2010 British Geological Survey (BGS) screening report MAY still be geologically suitable. The Longlands Farm site is within the non-excluded area but that does NOT indicate that the site is suitable. All that this indicates is that it has passed some very simple screening tests, based largely around the presence of mineral or water resources. Before any non-excluded location becomes a candidate site, it has to pass through a series of progressively more demanding investigations, initially desk based, but then moving on to field-based study, in Stages 4, 5 and 6 of the MRWS process.

"I remember the NIREX being chased off sites they were trying to investigate in the early to mid 1980s by local populations (mainly along the eastern seaboard of the UK, sometimes they were the main reports on the BBC National news at the time)"

CoRWM's view is that, regardless of the local geology, if there is not a supportive local community, there will be difficulties moving forward in the GDF siting process. Therefore, a supportive community is a requisite first step, and voluntarism is one way of ensuring this. The next step would be to consider the geology in more detail.

"*As a consequence of this the then Minister of State for the environment, Nicholas Ridley, said in the House of Commons " It would be better to look in those places which have a measure of support for the civil nuclear industry". Effectively, that statement gave the green light to NIREX to look in West Cumbria where there is a nuclear acquiescent population. So the process of site selection moved from one based on the best scientific principles as they relate to the inter generational storage of nuclear waste, to a political one".*

This is incorrect. The Minister's statement recognised that geological disposal cannot be a purely technical process but had to be one that incorporates both social and technical considerations. He acknowledged that even in areas chosen on the basis of "the best scientific principles", without the support of the local community the chances of success would not be high.

"Leaving aside for one moment the geological suitability or otherwise that any desk based study might pronounce on, as the way the consultation process is designed will only give a yes answer to move forward to phase 4, I wanted to raise four questions to which I would like a response".

1.1) Having looked at the MRWS Cumbria Web Site, in particular the page on International Experience" http://www.westcumbriamrws.org.uk/page/108/International-experience.htm I am very concerned the page makes no reference that in both countries there was firstly a process of screening out unsuitable geology ***before*** *communities were asked to volunteer. This to me seems a very logical and in these straightened financial times a very cost effective way to go about site selection. The Partnership makes no reference to this and takes its "educative" materials into local schools. For clarity I have copied here what the partnership web site does say:* ***"Finland and Sweden both applied voluntary processes to find suitable sites. In each case, development work and consultation has been carried out over a long period of time"***

'Volunteering' in the British process is not a single 'in or out' decision, but a gradual process, with the right to withdraw existing for a considerable time. Formally, the position is that Cumbria 'expressed interest' in volunteering, following which BGS undertook its initial screening, and now the process is moving towards a 'decision to participate' or not. Even if west Cumbria makes a decision to participate, it will still have the right to withdraw later in the process. It could be argued that the British process has also screened out unsuitable geology before asking communities to volunteer.

1.2) I'm uncertain as to if CoRWM's remit is to advise the partnership on such matters as ethics as they relate to educating schoolchildren or, if that is the responsibility of the Minister for Education? Nevertheless, it is obvious to me an ethically correct position would be to highlight the process of firstly screening out unsuitable geology. Then again I suppose the partnership has had to frame this the way it has for the only reason that most school children would probably see the nonsense of the existing situation and raise some fairly obvious questions.

Providing such advice would be outside CoRWM's terms of reference.

2) I was concerned to read Essex County Councils minutes on Radioactive Wastes. It would seem to me that most councils already think the National Repository will be in Cumbria. In the interests of just getting the facts right could CoRWM write to Essex County Council and point out that no decision has yet been made as to the siting of a "National Repository" for the simple reason that the question of suitable geology has not yet been answered.

Essex County Council has subsequently apologised through BBC Radio Essex for any confusion caused and has clarified its position with regard to the Essex Waste Development Document as follows:

"The Essex Waste Development Document consultation incorrectly makes reference to intermediate level waste (ILW) disposal to the existing repository in Cumbria. We understand that that facility is for low level waste only and not ILW. This is a factual correction which shall be addressed at the next stage of the waste plan, towards the end of the year.

To further clarify, the ILW arising from the decommissioning of Bradwell Nuclear Power Station in Essex is stored on that site in accordance with the terms of the planning permission.

We recognise that the programme for siting a Geological Disposal Facility (GDF) for ILW is at an early stage and that no formal decision about participation in that programme has been taken in Cumbria. The Essex Waste Development Document makes no assumptions about where a GDF will be sited."

3) Has anyone done a cost analysis on how much money will be wasted over time should the process go the whole way and then either a Judicial Review or as is more likely interest groups against geological disposal in Cumbria organise themselves and get international expert opinion as to unsuitability which causes the abandonment of the process though political opposing in other Nation States from within the EU? I'm thinking of Ireland in particular. The observation being we have been here before with a £400M+ failed investigation which the UK tax payer ponied up for.

This is outside of CoRWM's terms of reference. The Nuclear Decommissioning Authority's Radioactive Waste Management Directorate, which is the implementer of geological disposal, has done a good deal of work on costings and may be able to provide information. They can be contacted at *http://www.nda.gov.uk/contact/geo-disp-enquiries.cfm* .

4) Does CoRWM believe the abandonment of best geological principles for site selection in favour of a political process of acquiescent community volunteerism for a GDF is correct?

In making its recommendation to Government in 2006, CoRWM recognised that geological disposal is not purely a technical matter, but includes ethical, political and many other factors. It therefore advised Government that a process based on willingness to participate was essential. Government accepted that advice when it devised the MRWS process. The Committee was subsequently reconstituted with new membership and new terms of reference (in 2007) and the reconstituted committee continues to hold the view that the host community must be a willing one.

The MRWS process is not based on an "abandonment of best geological principles for site selection in favour of a political process of acquiescent community volunteerism". CoRWM supports the current approach for site selection, which is based on a combination of socio-

economic evaluations and the application of the best scientific principles. Such principles will be followed in identifying, assessing and investigating candidate sites in MRWS Stages 4-6. CoRWM does not take the view that a GDF needs to be located in the 'best' geological setting, however that may be defined. What is required is a site for which a satisfactory safety case can be made.

Your sincerely

Robert Pickard
Chair of CoRWM

CORWM PROGRAMME PROGRESS REPORT
MARCH - APRIL 2012

This paper summarises progress on CoRWM's work programme in March and April 2012. It is for information.

The paper covers the last month of 2011-12 and the first month of 2012-13. For continuity, progress is reported against the tasks in CoRWM's 2011-12 work programme (CoRWM doc. 2919). The next progress report will be for tasks in CoRWM's proposed work programme for 2012-13 (CoRWM doc. 3022).

TASK GROUP AND TASK	Progress March - April 2012 and Issues for Plenary Discussion/Decision	On track?
TG1 – Treatment, packaging, storage and transport **Task A**: scrutinise and advise on treatment, packaging, storage and transport of higher activity wastes (HAW). Carry out similar work for waste-related aspects of the management of spent fuels and nuclear materials. **Task G1**: scrutinise and advise on R&D for treatment, packaging, storage and transport of HAW, spent fuels and nuclear materials. **Task G3**: House of Lords Science and Technology Select Committee inquiry on UK nuclear R&D capabilities (preparing evidence, commenting on inquiry report). **Task G4**: scrutinise and advise on provision of R&D and other high end skills for the long-term management of HAW. **Task I**: scrutinise the PSE activities of Government and the Nuclear Decommissioning Authority (NDA) related to the management of HAW and advise as appropriate. **Task J**: scrutinise and advise on NDA and Government work on options for acceleration of the geological disposal programme.	**Progress** **Task A** • Meeting with NDA on spent fuels and nuclear materials (CoRWM doc. 3025). • Meeting with NDA on HAW, including upstream optioneering project (CoRWM doc. 3031). • Attendance at workshop on preparation of version 2 of the Nuclear Industry Interim Storage Guidance (contractors to NDA producing workshop outputs). • Meeting with RWMD on waste packaging (specification update and Letter of Compliance process) (note being drafted). **Task G1** • Attendance at meeting of Waste Packaging and Storage Working Group of Nuclear Waste Research Forum (NWRF). **Plenary Issues (all tasks)** • Verbal report on Industry Interim Storage Guidance workshop.	Yes

TASK GROUP AND TASK	Progress March - April 2012 and Issues for Plenary Discussion/Decision	On track?
TG2 – Scottish Government Policy **Task B**: Scrutinise and advise on the implementation of the Scottish Government's HAW policy.	**Progress** • A CoRWM TG2 member attended a TAG meeting held on 29 February 2012. Progress on finalising the Project Initiation Document and Scoping Report was not as substantial as had been hoped for. • A CoRWM TG2 member attended the PB on 14 March 2012. Scottish Government intends to review how the TAG, PB and the work to complete the HAWIS are taken forward. • An update meeting with SG (Claire Dodd and new Head of Radioactive Waste Team, Andy Warden) is being arranged for April 2012 to allow TG2 to understand better SG's plans. **Plenary Issues** • Brief report on SG progress on HAW Strategy Implementation. A section on the SG HAWIS progress will be written for the Annual Report. A review paper of the scrutiny and advice CoRWM has given to the HAWIS will be presented at the September (draft) and October (final) 2012 plenaries	Yes

TASK GROUP AND TASK	Progress March - April 2012 and Issues for Plenary Discussion/Decision	On track?
TG3 – Government and NDA Plans for Geological Disposal: Voluntarism. **Task C**: scrutinise and advise on the voluntarism and partnership approach to geological disposal facility siting. Sub-tasks are: **Task C1**: Scrutinise and advise on Government work to increase awareness of the invitation to communities and monitor responses. **Task C2**: Scrutinise and advise on Government and NDA engagement with, and support for, communities that have expressed an interest. **Task D**: scrutinise and advise on the governance and management arrangements of Government for implementation of geological disposal. **Task F2**: scrutinise the development of the Strategic Environmental Assessment (SEA) for geological disposal. **Task J**: scrutinise and advise on NDA and Government work on options for acceleration of the geological disposal programme.	**Progress (all tasks)** • A Member attended the meeting of the GDSG on 1st March • Members met officials from DECC on 27th March to discuss progress with raising awareness of the implementation programme nationally and progress in West Cumbria. **Plenary Issues (all tasks)** • Relevant sections of the Annual Report.	Yes
TG4 – NDA Plans for Implementing Geological Disposal	**Progress (all tasks)**	

TASK GROUP AND TASK	Progress March - April 2012 and Issues for Plenary Discussion/Decision	On track?
Task E: Scrutinise Government and NDA preparations for stage 4 of the MRWS Site Selection Process. **Task F**: Scrutinise and advise on NDA organisational preparedness and plans for implementation of geological disposal. Sub- tasks are: **F1** understand NDA's plans for the development of its Radioactive Waste Management Directorate (RWMD) to improve its capability to deliver geological disposal; advise if necessary. **F2** scrutinise the development of the Strategic Environmental Assessment (SEA) for geological disposal. **F3** gain an understanding of the Disposal System Safety Case (DSSC) suite of documents and advise Government as appropriate. **F4** scrutinise and advise on RWMD's issues management process. **Task G2**: scrutinise and advise on R&D for geological disposal.	**Task F3:** • Received GDSG comments on draft gDSSC Position Paper and revised specific paragraphs in the light of these comments. • Presented final revised gDSSC Position Paper to March 6th plenary meeting. Revisions agreed and Position Paper accepted for publication as CoRWM Doc. 2994 following minor editorial corrections. Doc. 2994 published on March 16th 2012. • Note of February meeting with regulators on the gDSSC produced (Closed doc. 3019) • Comments on CoRWM Doc. 2994 received from Dr T. McEwen, March 22nd, 2012. • Response prepared and submitted for Chair consideration and approval, April 4th. **Plenary Issues (all tasks)** • Discussion of comments and response re gDSSC Position Paper.	Yes

TASK GROUP AND TASK	Progress March - April 2012 and Issues for Plenary Discussion/Decision	On track?
Task G3: House of Lords Inquiry on nuclear R&D capabilities. **Task G4**: scrutinise and advise on provision of R&D and other high end skills. **Task J**: Scrutinise and advise on NDA and Government work on options for acceleration of the geological disposal programme.		
TG5 – Public and Stakeholder Engagement. **Task F4**: scrutinise and advise on RWMD's issues management process. **Task H**: summarise national and international nomenclature on reversibility, retrievability and recovery in the contexts of geological and near-surface disposal. **Task I**: scrutinise the general public and stakeholder engagement (PSE) activities of Government and NDA related to the management of higher activity wastes (HAW) and advise as appropriate. **Task K2**: organising CoRWM's own PSE.	**Progress (all tasks)** • RWMD Issues Management process will be considered again when the website version of the issues register is available (March or April 2012) • Paper on terminology for retrievability etc. prepared (CoRWM doc. 3003). • CoRWM members attended Seven consultation meetings organized by the WCMRWSP to allow the public to provide their views on the Partnerships Draft report and to consider the role of DECC and NDA in the process. • Meeting will be held with NDA to discuss their evolving PSE processes. **Plenary Issues (all tasks)** • Discussion of Members views on WCMRWSP, PSE3 events. • Consider if there are still reasons as to why CoRWM should hold a meeting with the NGOs and if so when and to discuss what • Discussion of paper on terminology for retrievability etc. (CoRWM doc. 3003). • Discussion of Annual Report PSE.	Yes

Committee on Radioactive Waste Management

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CoRWM Document: 3038

12 April 2012

Dear Professor Smythe

Thank you for your email dated 5 April 2012 regarding your response to the West Cumbria MRWS Partnership consultation on geological disposal.

I can confirm that the CoRWM Secretariat did circulate your document to all Committee Members.

Our Terms of Reference, with respect to geological disposal, require us to provide independent scrutiny of the implementation of the Government's published policy. We have agreed our work programme with Ministers for the remaining term of the present Committee and this is available in the public domain. Your document was submitted as part of the Public and Stakeholder Engagement (PSE 3) of the West Cumbria MRWS Partnership and will be assessed as part of that engagement by the Partnership and the results will be published. We have noted your document but would only consider discussing specific aspects of it if we were asked to do so by a body that has appropriate responsibilities within the ongoing process. I can confirm, however, that the Committee has not changed its views from those expressed in CoRWM docs 2902 and 3023.

I can also confirm that the short acknowledgement, dated 4th April, that was issued on receipt of your enquiry was entirely in order.

Yours sincerely

Robert Pickard
Chair of CoRWM

Annex 1

Committee on Radioactive Waste Management

CoRWM DOCUMENT "NAMEPLATE"

1. Author	**Pete Wilkinson et al**
2. Date of paper:	**2002**
Title / subject	**Extracts from INRP-Acronyms & Glossary**
3. **Status** (e.g. 1st draft, final) **Final**	
4. Who is receiving a copy (delete as necessary:) All Members **(please also send a copy to Sam Bains in the Secretariat)**	
5. Confidentiality Reasons (if any) why the document should not be published: ...	
(Secretariat to complete:) **Document number** .319.. **File** ... **Folder** ...	

13. List of Acronyms and Glossary

13.1 List of Acronyms

AGR: Advanced Gas Cooled Reactor
BGS: British Geological Survey
BNFL: British Nuclear Fuels plc
CDZ: Chemically Disturbed Zone
DEFRA: Department for Environment, Food and Rural Affairs
DETR: Department of Environment, Transport and the Regions (now DEFRA)
EBS: Engineered Barrier System
EA: Environment Agency
EDZ: Excavation Disturbed Zone
HLW: High Level Waste
ILW: Intermediate Level Waste
MOX: Mixed Oxide Fuel
NEA: Nuclear Energy Agency of the Organisation for Economic Co-operation and Development
OECD: Organisation for Economic Co-operation and Development
PA: Performance Assessment
PWR: Pressurised Water Reactor
RCF: Rock Characterisation Facility
RDP: Repository Development Programme
RWMAC: Radioactive Waste Management Advisory Committee
SKB: Swedish Nuclear Waste Management Company
TCHM: Thermo-Chemical-Hydro-Mechanical
UKAEA: United Kingdom Atomic Energy Authority
URL: Underground Research Laboratory
WVP: Waste Vitrification Plant

13.2 Glossary

Actinide: A heavy element, of the 'actinide series' of the Periodic Table, which includes uranium, plutonium and americium.
Activation product: An element which has become radioactive as a result of bombardment by neutrons. Activated elements are found in the components of nuclear reactors.
Alpha Radioactivity: Radioactivity arising from **radionuclide** decay involving the production of alpha particles, which consist of two protons and two neutrons.
Argillaceous Rocks: Rocks that are rich in clay minerals.
Backfill: Material placed in an excavation or between containers to provide mechanical stability by reducing voidage, and possibly to reduce groundwater flow and provide chemical conditioning.
Barriers: Components of the repository system that reduce the rate at which radionuclides from the waste can be mobilised and reach the human environment.
Becquerel (Bq): The unit of radioactivity, equivalent to the decay of one radioactive atom per second. A Terabecquerel is 10 to the power of 12 (a million million) Becquerels.
Beta Radioactivity: Radioactivity arising from **radionuclide** decay involving the production of beta particles, which are electrons (or positrons).

Biosphere: Regions of the Earth able to support life. This includes the land surface, the oceans (hydrosphere) and the atmosphere. In repository performance assessments the biosphere is generally taken to be those parts of the environment accessible to human beings.
Borosilicate Glass: The glass matrix that incorporates high level waste radionuclides in its chemical structure to form a solid waste material.
Buffer: A material placed in a repository around waste containers to protect them from mechanical damage and groundwater flow.
Canister: The outer containment of a waste package intended for emplacement in a repository: normally a metal, selected for its long-term corrosion properties. Sometimes termed **overpac**k. See also, **containe**r.
Colloid: A particle with dimensions between one nanometre (10^{-9}) and one micrometre (10^{-6}).
Conceptual model: A description of a system and the key processes that occur within it. This is used as the basis for establishing a **mathematical model** of the system.
Conditioning: The process of converting a waste material into a solid, stable **waste form** suitable for storage or disposal.
Container: The vessel (usually metallic) in which a waste is initially packaged for storage and transport to a repository. It may then be placed in a final disposal **canister**, chosen for its long-term corrosion properties.
Criticality: The state when an accumulation of spontaneously fissile radioelements reaches a concentration such that a self-sustaining nuclear fission reaction can take place. This can produce large quantities of energy.
Decommissioning: A generic term to cover all of the procedures undertaken once a nuclear installation has ceased to operate. It covers processes such as defuelling reactors, cleaning and making safe installations (which could include a long period of safe storage on site), dismantling, removal work and waste conditioning prior to storage or disposal.
Depleted Uranium: Uranium depleted in the fissile radionuclide, U235, and remaining after the process of **enrichment**.
Diffusion: The process by which a material spreads out in a fluid (gas or liquid) as a result of molecular motions.
Disturbed Zone (Excavation) - EDZ, Disturbed Zone (Chemically) - CDZ: A region of rock that has been altered as a result of underground construction or the emplacement of waste or engineered barriers. The changes may be physical and/or chemical and would usually be adjacent to the facility or the access route.
Drift: An inclined access tunnel to an underground facility.
Engineered Barrier System: A component of the repository or waste packaging or conditioning that delays or prevents radionuclide migration from the repository system.
Enrichment: The process by which the proportion of the fissile isotope U235 in uranium is increased to allow its use in modern reactor system.
Fission: Nuclear fission is the process by which a heavy atom (such as uranium) splits into two or more smaller fragments. This can occur spontaneously for some radionuclides, or may be induced by bombardment with neutrons.
Fission product: A nuclide produced either by **fission** or by the radioactive decay of a radionuclide formed by fission.
Gamma Radioactivity: Radioactivity arising from radionuclide decay involving the production of gamma rays: electromagnetic **radiation** of the same nature as X-rays, but with shorter wavelengths.

Geosphere: In general usage this is synonymous with the lithosphere; the outer layer of the earth. In repository performance assessments it is used to refer to the rocks between the repository and the **biosphere**.
Geochemistry: The study of the chemical composition of the Earth's crust and changes which take place within it.
Geotechnical: Relating to the engineering properties of a rock.
Grout: In radioactive waste management, a cement-based material used to immobilise radioactive waste in a container. In engineering, the use of a thin fluid mortar for filling fractures and reducing water flow through the fractures.
Half-life: The time taken for half the atoms of a particular radionuclide to undergo radioactive decay(s).
High-level waste (HLW): The highly radioactive waste which is separated during the first solvent extraction cycle of spent fuel reprocessing and, in the UK, subsequently converted to a solid glass waste form by the process of vitrification. It has a high thermal power. A high level of shielding and heat dissipation is required during storage and disposal.
Hydrogeology: The study of the geological factors relating to the Earth's water.
Intermediate-Level Waste (ILW): Radioactive waste of activity and heat output lower than **high-level waste** but higher than **low-level wast**e. Most UK ILW requires shielding. Heat production is usually less than HLW, but it may require provision for heat dissipation during storage or disposal.
Isotope: Atoms of the same element with different masses are referred to as isotopes of that element. As an example, one isotope of oxygen is O18, which has 18 protons and neutrons in the nucleus of the atom (10 neutrons and 8 protons). This isotope has 2 extra neutrons compared with the most common isotope of oxygen, O16 which has 16 neutrons and protons (8 of each). Similarly, Cl36 is an isotope of chlorine which has 36 neutrons and protons in its nucleus, one extra neutron compared with the more common Cl35.
Low-level waste (LLW): Radioactive waste containing less than 4 million **Bq** per kg of **alpha** radioactivity and 12 million **Bq** per kg of **beta** and **gamma** radioactivity. Does not require shielding during normal handling and transport.
Magnox: A magnesium alloy used for sheathing uranium fuel elements. This alloy gave its name to the first generation of UK gas-cooled nuclear reactors.
Mathematical model (or simply model): A description of the behaviour of a system using mathematical equations. Sometimes referred to as a numerical model.
Mixed Oxide Fuel (MOX): A nuclear fuel made up of a mixture of uranium and plutonium oxides.
Multibarrier Concept: Repository concept whereby a number of barriers (typically, solid waste form, container, buffer and surrounding rock) act in concert to contain the wastes and ensure that any radionuclides released from the waste return to the biosphere in concentrations which do not pose unacceptable risks.
Natural Analogue: An occurrence in nature of a material or process that is similar to those that are to be found in a waste repository. Natural analogues are studied principally because they offer the potential to evaluate processes which have been active over much longer times scales than it is possible to simulate in the laboratory.
Overpack: See **canister**.
Palaeohydrogeology: The study of the evolution of rock-groundwater systems through long periods in the past. This normally involves measurements of the

hydrochemistry and isotopic differences of groundwater bodies, as well as data on rock mineralogy.
Performance Assessment: The process in which the future evolution of all or part of a disposal system (a repository and its surrounding geosphere and biosphere) are analysed to evaluate behaviour or radiological safety.
Permeability: The capacity of a medium to transmit a fluid.
Policy Maker: Government Department responsible for setting radioactive waste management policy.
Porosity: The fraction of a medium that is pore space.
Radioelement: An element (such as plutonium) which is radioactive.
Radionuclide: A nucleus of an atom which is radioactive.
Reprocessing: The chemical treatment of **spent fue**l, initially by dissolution in nitric acid, to separate and remove uranium and plutonium. The residue of **fission products** and other **actinide** elements forms **high level wast**e.
Retrievability: Generally applied to the capability, at some future time, to remove waste from an underground storage or disposal facility, implying that disposal is not irreversible.
Rock Characterisation Facility (RCF): An underground excavation, comprising shafts, drifts and galleries, used to gain access to the rock at depth, at a potential repository site, so that it can be studied in more detail than by investigations from boreholes. Distinguished from **Underground Research Laboratories** by being at the site of an intended repository.
Regulator: An agency formally responsible for regulating and approving waste management and disposal practices.
Safeguards (Nuclear): The system of monitoring and security measures adopted nationally and internationally to ensure that material that has the potential to be made into nuclear weapons does not fall into unauthorised hands.
Shielding: In radioactive waste management, materials placed between a source of radiation and people in order to reduce the radiation dose received. Waste packages are referred to as shielded if they have their own shielding (such as concrete), or unshielded if not.
Site Characterisation: The investigation of the geological and environmental properties of a potential repository site by observations from the surface, from boreholes and from the underground.
Sorption: The process by which materials in a liquid phase are transferred to a solid phase (generally radionuclides being transferred from groundwater to rock or soil).
Spent Fuel: Uranium or uranium oxide fuel elements that have been removed from a nuclear reactor at the end of their useful lives. Spent fuel builds up a substantial content of fission products and actinide elements as it is 'burned' in the reactor. These progressively reduce the efficiency of the fuel, until it has to be replaced.
Spent Fuel Standard: Term used in the USA to describe the addition of 'extra' radioactivity to a plutonium waste form to make the waste as radioactive as the original spent fuel from which the plutonium was removed. This is done to make illicit diversion of plutonium more difficult, thus helping to ensure that **nuclear safeguards** are maintained.
Terabecquerel: See **becquerel.**
Thermo-Chemical-Hydro-Mechanical: the combined effects of heat, chemical, groundwater and mechanical aspects in and around a repository.

Transmutation: Process by which radionuclides are bombarded with neutrons (either in a nuclear reactor or a particle accelerator) and are converted into shorter-lived or stable nuclides.
Transuranic: An element in the Periodic Table which is heavier than uranium (includes elements such as plutonium, americium and curium).
Underground Research Laboratory (URL): An underground research facility in shafts and galleries in the rock, used to carry out tests and experiments to provide generic information on a typical geological environment. URLs are usually not located at specific repository sites and are to be distinguished from **Rock Characterisation Facilities**.
Vitrification: Process in which liquid HLW is calcined to dryness, mixed with inert chemicals, melted and cooled to form a stable, solid glassy waste product.
Waste Form: Solidified, conditioned waste material in a state considered suitable for packaging for long-term storage and disposal.
Waste Producer: Any organisation that produces, and has the responsibility for managing, radioactive waste.

Committee on Radioactive Waste Management

1. Author	Pete Wilkinson, Wynne Davies, Mark Dutton and Steve Mansfield
2. Date	30 April 2004
3. Title / subject	Meeting of the INRP group on 20 April 2004 CoRWM 7th Meeting, 6-7 May 2004. Agenda item 9
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5. Who is receiving a copy (delete as necessary:) All Members Others (list:) AS, KM, CH (please also send a copy to Sam Bains in the Secretariat)	
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All members of CoRWM

This paper will form part of Pete Wilkinson's report to the May 2004 plenary meeting in Glasgow and its purpose is to stimulate discussion.

The discussion of 20 April was used, in part, to attach properties (or attributes) to each of the options. Members should note that the properties are not meant to be comprehensive, consistent or definitive. Further work is being carried out in a number of areas, notably on the implications of international law, binding treaties and agreements, etc., and will need to be completed before this material can be using in PSE trialling.

INRP OPTIONS

DISCUSSION OF 20 APRIL 2004, WHITEHALL PLACE EAST

Present: Pete Wilkinson, Wynne Davies, Mark Dutton, Steve Mansfield (secretariat)

It was agreed that the INRP review of options would have a fundamental impact on the way in which the PSE programme was run and, potentially, on its outcome. Furthermore, by assessing the options themselves and ensuring that the accurate properties assumed by each are ascribed to those options, screening criteria would automatically emerge. With that in mind, it was decided that the purpose of the meeting was three-fold:

i. To examine the relationship between INRP follow-up work and the CoRWM technical working groups and other major work streams.

ii. To review the 14 INRP options with the possibility of identifying additional ones, and/or variants and interpretations of them.

iii. To attribute major "properties" to each option. This would initiate the process of identifying screening criteria to distinguish the potential core from the potential discretionary options, but would not identify "show-stoppers" at this stage.

1. Relationship of options work to CoRWM working groups and work streams

A schematic diagram, representing how the group felt interaction and inputs to the PSE programme should operate, is shown at **attachment A**. Essentially, there are three major workstreams stemming from the full committee – Inventory, Principles and INRP – which must feed into and combine their work outputs in the PSE programme which is assumed in the diagram to be an over-arching workstream central to and fed by the others.

The Principles Working Group has already determined the principles by which we will work and is now examining issues such as decision-making and consensus. The CoRWM Guiding Principles (a major output from these discussions) will not be fed into the PSE for consultation and are solely for internal guidance and steerage.

However, there is another important workstream which has immediate and important relevance to the PSE programme. Although beyond the strict remit of the group, the members present concluded that a range of ethical and environmental principles under discussion by Principles Working Group would be necessary not only to the PSE process, but also to defining the properties of each management option. Among other things, this would help to expose the values that the public and stakeholders associate with the various options.

Thus there are three workstreams which, after refinement, discussion and debate at plenary level and after inter-working group collaboration, feed their outputs into the PSE programme.

2. Additional options, variants and interpretations

The 14 options detailed in INRP were reviewed with a mind to determining if there were other options which had been omitted.

Three additional options were identified:

- Burning plutonium and uranium stocks in existing reactors (option 15).

- Re-categorising future ILW decommissioning arisings (i.e., non-legacy wastes) as short-lived and long-lived with a view to near surface disposal of the former (option 16).

- Underground storage followed by disposal (option 17). This option allows monitoring of both the waste packages and (if one or more vaults were backfilled) actual repository conditions. Waste retrieval would be possible if it became necessary. Option 3 (underground disposal) allows retrieval but subject to much greater engineering challenges.

Variants on options and interpretations include:

- "Underground" disposal by excavating the repository within a mountain accessed by a drift tunnel.

- "Dilute and disperse" is an option involving immediate treatment of waste to allow its dispersal into the marine or atmospheric environment. It does not take in landfilling where dilution and eventual escape to the environment is a gradual process.

- Substitution of overseas reprocessing wastes needed to be flagged as an issue of public and stakeholder concern, but it was not a true option since it affects only a relatively insignificant proportion of any waste category.

A "do-nothing" option (option 0) meant, in effect, that the policy is to have no policy. It was agreed that this was, in effect, above ground storage and it was decided not to include such an option.

3. Properties (or "attributes") of the 17 options

Note: An elaboration of the INRP ‘grid’ which indicates an ‘at-a-glance’ view of legal, environmental, technical, etc., hurdles faced by the options is being prepared and it is hoped to append that elaboration to this note for circulation before the Glasgow plenary.

In the absence of that final elaboration, the group examined all the options and arrived at the following 'properties' subject to the findings of that paper. All issues of questionable legality are being examined further.

All the options are thought to be technically feasible. The properties attributed to each represent the major advantages or disadvantages. The properties listed below are merely indicative: members are advised to read INRP, Chapter 3, to gain a clearer and fuller picture of the properties attributed to each option.

1. Above ground storage. Long-lived institutional control and need for refurbishment; worker dose, transport (if central store agreed); high vulnerability to terrorism; accommodates all wastes (a "comprehensive solution").

2. International above ground storage. All the above plus sea transport and questionable legality. In addition, there is also the issue of whether it is ethical to export UK wastes to countries that have no waste of their own or much less than the UK inventory.

3. Underground storage. Transport (if centralised); low vulnerability to terrorism; comprehensive solution.

4. International underground storage. As for option 3, plus sea transport and questionable legality. In addition, there is also the issue of whether it is ethical to export UK wastes to countries that have no waste of their own or much less than the UK inventory.

5. Underground disposal. No intention to retrieve although retrieval would be possible with difficulty; comprehensive solution on that release rates would comply with regulatory requirements and institutional control could be removed as could any perceived monitoring requirement.

6. International underground disposal. As for option 5, but with the addition of sea transport and questionable legality. In addition, there is also the issue of whether it is ethical to export UK wastes to countries that have no waste of their own or much less than the UK inventory. Added problems are the perceived competency of recipient nations and heightened terrorism aspects due to transport.

7. Direct injection. No UK facilities except offshore rigs; transport, questionable legality; new technology, high risk and worker dose (no safety case); contrary to the passive safe storage concept; high cost; not comprehensive. Requires conversion into liquid when UK is busily doing the opposite with HLW and when CoRWM's remit involves solid wastes.

8. Disposal at sea. Sea transport, questionable legality. Research would be required on the integrity of packaging and exposure pathways.

9. Sub seabed disposal. Sea transport, questionable legality; no safety case although sediments would probably offer additional barrier for 'thousands of years' .

10. Ice sheets. Three sub options – boreholes, anchored emplacement, surface disposal for eventual covering by snow and ice. May need heat generating source. No UK sites therefore automatic international option at present; sea transport; offers some monitoring and retrieval opportunities but ice-sheets are not static, questionable legality; climate change; no safety case; not a comprehensive solution.

11. Subduction zones. No UK sites hence automatically an international option with attendant problems; sea transport; questionable legality; no safety case although dilution rates would be large if achievable and return to the biosphere would be measured in millions of years.

12. P&T. New technology, high cost; long lead-time; not a comprehensive solution.

13. Space disposal. New technology; high cost; high risk. Not comprehensive – possible use only for transuranics.

14. Dilute and disperse. Questionable legality; not a comprehensive solution. BPEO and BATNEEC effectively rule this option out.

15. Burn in existing reactors. May require changes to UK law; practical, safety case requirements may make it uneconomic; redesign requirements small, not a comprehensive solution

16. Re-categorising ILW into short- and long-lived. Coupled with on-site long-term management, this would remove the need for waste movements. Possible licensing and planning issues; not a comprehensive solution. Change in policy required

17. Underground storage before disposal. Transport (if centralised); low vulnerability to terrorism; comprehensive solution.

There is also an international variant on option 17.

Committee on Radioactive Waste Management

1. Author	Pete Wilkinson
2. Date	May 2004
3. Title / subject	Technical inputs to the CoRWM process - needs and uncertainties
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(Secretariat to complete:) Document number 417 File ... Folder ...	

TECHNICAL INPUTS TO THE CORWM PROCESS – needs and uncertainties

A personal view by Pete Wilkinson

May 2004

Preamble

The nature of CoRWM's task has been characterised by some as an overwhelmingly technical one and that CoRWM's recommendations should be based on technical considerations. Others argue that all options are technically feasible and in that respect technical implementability is a given, making the issue largely driven by societal concern with the level of public acceptability becoming the primary determinant. In truth, the answer lies somewhere between these two views: CoRWM's recommendations will be based on a technically achievable option or options which offer the least environmental impact, the best safety profile and the greatest level of public acceptability. Without the combination, no option will gain confidence or acceptability. The question is how we achieve the optimum input across this range of considerations to a level which meet the concerns of all members and which can transparently reassure those we engage in the PSE programme and beyond.

INRP – a precursor to CoRWM's technical needs

As has been frequently pointed out, Defra foresaw the need for technical input to the CoRWM process and engaged Wilkinson Environmental Consulting to prepare the INRP (Information Needs Research Project) report. This lists 630 work packages which would be required to be undertaken if the need or desire to bring the level of knowledge to a common level across the range of waste management options was identified. These are overwhelmingly of a technical nature.

Technical input to the PSE - an incremental and appropriate process

Every stage of the programme will require some level of technical input as we are seeing with the strands of our work which require the preparation of data for the PSE trial. Both the inventory and options/criteria work streams are already generating their own level of required technical input which the output from these groups fundamentally demand. As was explained to us at the DM trial workshop, as stakeholders move through the programme, so there will be an iterative process requiring the inputting of appropriate technical information on an incremental basis. There are likely to be two distinct requirements in terms of technical input – that generated by their own questions and uncertainties and that required to further explain the technical background to various options and how the criteria impinge on those options. In that respect, the need for some technical input will be self-generating and other input will be discretionary.

In the larger PSE programme, whatever form it eventually takes, this process will likewise apply. In the intensive strand, many stakeholders will already be technically versed in the issues and therefore the level of technical input will be lower but still an important facet. In the extensive strand, the requirement will be greater in terms of the volume of input but the level of technical complexity required is likely to be much lower.

CoRWM's technical needs

CoRWM has the to ensure the implementability of its recommendations and clearly this will demand a significant input of technical data across the range of options. It is worth noting here that implementability applies not only to technical feasibility: an option may be perfectly acceptable from a technical point of view but unless it commands public confidence, it may not comply with the implementability criteria.

Technical data can be used either as a screen to reduce options or as a means by which options can be recommended. However, the use of technical information to either screen out or promote various options will clearly have to come as a step **after** the initial screening out of options on principles- or on criteria-driven bases to avoid the need to bother with the sourcing of technical input for options which are likely not to survive the initial screening. As the number of options decreases, so the level of technical scrutiny is likely to increase in order to demonstrate implementability and to boost public acceptability. INRP can be used as a guide to the sort of information likely to be required although its work package list may not be exhaustive nor as comprehensive as the committee find it is necessary to be.

Uncertainties

I trust this short paper has demonstrated that I am conscious and sensitive to the need for technical input – as I'm sure all members of the committee are - and that I do not see the process as being exclusively driven by the societal concerns issues. However, fundamental issues remain about how, where, when and through what media this expertise is introduced to the process. Moreover, issues remain about the different strands of technical information required – for the different stakeholder processes and for CoRWM itself. I suspect answers to these questions will become self-evident as the process evolves but perhaps that is too uncertain a view. It might be wise for us to debate this issue in plenary to narrow down the range of possibilities but essentially, I hope this paper is clear evidence that I see the need for technical input even if it doesn't answer the questions of how it should be provided.

Pete Wilkinson

1.	Author	• S J Mansfield
2.	Date	• June 2004
3.	Subject	• Visit to Cumbria - April 2004
4.	Status	• Draft
5.	Recipients	• All members; AS; KM; Ch; SB
6.	When commissioned by CoRWM	•
7.	Confidential	• No
8.	Additional notes	• Based on contributions from AB, JW and PW, the present draft incorporates the Chair's comments
9.	Document no.	• 545

CoRWM VISIT TO CUMBRIA: 13-16 APRIL 2004

Why we went to Cumbria

1. This was planned a part of a process of familiarising CoRWM members with the issues involved in radioactive waste management. Understanding the form of the wastes, the way in which they arise, and how they are managed on a large and complex nuclear site like Sellafield is important, but it is equally important to be able to grasp the concerns of the communities living close to these sites and the organisations interested in them.

2. The meetings we held with local people are not a substitute for public and stakeholder engagement – a process that will be a key aspect of CoRWM's future work. Rather, they were introductory in nature. This report is intended to convey that flavour and to reflect the frank, but friendly, discussions that took place. We have tried to quote the opinions of others accurately. These views are of great interest to us, but, particularly at the beginning of our work, we should not take them on board unquestioningly.

3. We are grateful to Members of Cumbria County Council's Nuclear Decommissioning Group, and of Copeland Borough Council's Nuclear Working Group, Cumbrians Against a Radioactive Environment (CORE), Friends of the Earth (FoE; Cumbria), and Members of the Six Parish Councils Committee for agreeing to meet us and for contributing to the discussions. We are also grateful to British Nuclear Fuels plc (BNFL) for permitting us access to wide parts of the Sellafield site and for answering our numerous questions with direct answers, and to staff from the Environment Agency and the Nuclear Installations Inspectorate who kindly joined us for part of the programme on the Sellafield site and at Drigg.

Some general observations

4. We were universally impressed by the commitment shown to the future of the region of West Cumbria, even though there are very different visions of it.

This includes that of the Cumbria and Copeland Councillors we met – evidenced by the vigorous arguments they put to us. We were careful to point out that our remit does not involve recommendations on the siting of facilities, but we also recognise that some of the issues that will certainly be raised at the stage (we hope) when our recommendations are implemented, such as different views on compensation and veto, need to start to be considered now.

5. We found all the meetings to be more valuable than we expected. We sensed that there was goodwill towards CoRWM, the hope that it would succeed and a wish to be involved.

6. Nobody from Cumbria sits on CoRWM, a fact regretted by the two Councils. The contrasts demonstrated by the area were new to many of us. A very large industrial complex occupies a chunk of some of Britain's loveliest landscape. At the same time, the benefits that Sellafield brings are inescapable. Its large workforce earns wages that are well above the local average. But, apart from tourism, there are few other sources of employment and wealth of similar scale. As site decommissioning proceeds, and jobs are lost, there are serious concerns that the area will offer little economic benefit to young people.

7. Alongside a genuine willingness to talk to us, we sensed, quite strongly, that many Cumbrian stakeholders had "seen it all before" and needed to be assured that our work was starting with a clean sheet of paper. Nor did they, initially at least, seem very impressed by our assurances that we want to involve them further in our work.

8. As far as whether West Cumbria has a "special position", we recognise the significance of the views of communities living close to where waste is stored, but we cannot promise to favour those views above others - CoRWM is committed to listen impartially to the whole spectrum of opinion and earn public trust. There are more than 30 UK nuclear sites where wastes are stored. Importantly, however, Sellafield has about 60% of all the wastes that exist at present. Getting the balance right will be a challenge for us.

The Sellafield plant

9. We visited a reasonably broad range of plants and facilities, from Calder Hall, Britain's first nuclear power station (now being decommissioned) to the very modern vitrification lines for high level waste from THORP (the reprocessing plant for oxide fuels), and the WAMAC plant (where low level waste bound for, or retrieved from, the Drigg disposal facility is compacted and packaged).

10. The site offers strong contrasts between the up-to-date and the outmoded. Drigg disposals are now facilitated by conditioning waste in grout and packaging in steel drums (carried out in WAMAC) followed by placement in steel containers in engineered vaults. Elsewhere on the Drigg site, magazines of World War 2

vintage still contain plutonium contaminated waste although these are gradually being decommissioned. At Sellafield, there is a range of facilities, known as the legacy ponds and silos, that fall well below modern standards of waste management and it was a pity that, on this occasion, time did not permit us to look at them in any detail.

11. There is a strong sense that Sellafield provides good quality skilled jobs, many of which are transferable to other sectors. We were impressed by the commitment of the staff we met. There are bonds built on mutual interests and respect between the company, its workforce, and the local communities in which employees live.

12. Another important dimension that we sensed both on and off the site was that of safety and risk. BNFL is highly safety conscious. Management, employees and local people are all aware of the very hazardous materials and wastes held on the site (notably, of course, the high active liquid wastes from THORP and the Magnox Reprocessing Plant) and the problems this poses in a post 9/11 world.

Our meetings

13. Several major themes emerged and, in many ways, it is surprising to what extent some views are held in common between different groups.

A legacy of mistrust

14. While relations with BNFL generally appeared good, some critical views were still expressed about UK Nirex Ltd, the nuclear-owned company that had, until its proposals were rejected at a public inquiry in 1997, been investigating the prospects for an underground repository in the Sellafield area. For the greater part, this is the consequence of a past failure of openness on the part of the company, particularly criticised in 1997.

15. Our impression was that recent consultative exercises have not always been completely successful. There have been some difficulties with the ISOLUS initiative to identify a long-term storage solution for the UK's redundant submarine reactors. A public meeting held locally as part of ISOLUS does not seem to have achieved its purpose. There was wider strength of feeling that the ISOLUS process should be halted for the course of CoRWM's own work. There was also some criticism, albeit more muted, of local consultative meetings held by the Nuclear Decommissioning Authority.

Well being

16. A natural concern for present and future well being – of individuals and of the wider community - was recurrent although expressed in different ways. We

were slightly surprised that health concerns (Sellafield, although subject to rigorous regulation, pollutes the environment with radiation and other chemical contaminants) did not emerge particularly strongly, although there are clearly many who are worried about radiation dose effects even at low levels.

17. Well-being had an important economic dimension. Three generations of West Cumbrians have experienced a strong job market with consequent spin-off benefits for the local economy. People are worried about structural change and the effect that the collapse of the British coal and steel industries had on the regional economies, particularly of Wales, the East Midlands and South Yorkshire.

18. Another perception, not always well understood by outsiders, relates to respect for the natural environment and a wish to protect it. Little was said about the long-term prospects for recycling the Sellafield site for future brownfield use or (if possible) returning it to greenfield status. Rather, the NGO representatives we met from CORE and FoE, were strongly opposed to activities that create more waste and could result in wider environmental contamination. The older Magnox power plants and the Magnox reprocessing plants were seen as prime culprits in this regard and there is strong support among the NGOs for their early closure.

"Our waste but not theirs"

19. There was ready recognition among a number of groups we met that West Cumbria has benefited economically from hosting a major part of the UK nuclear industry. Views were expressed that the area should not now shirk what are regarded as its fair share of responsibilities - many people in Cumbria believe that the waste at Sellafield, however it is actually managed in the future is not, in practice, going to go anywhere else. There was also acceptance that, at least in its present form, the industry is in decline and that the prosperity it has provided is threatened. There is a strong feeling that the regional economy should be protected, and this might include keeping the waste at Sellafield.

20. There was adverse reaction to the possibility of hosting more waste from other parts of the UK. This includes the transfer of stored intermediate level waste and spent nuclear fuel at other sites and also the Scottish Environment Protection Agency's proposal to transfer current arisings of low level waste at Dounreay for disposal at Drigg.

21. The views of many we met could be summed up by – *we are prepared to continue to look after 60% of the waste as long as we do not lose the benefits that come with it, but enough is enough, and we expect other communities to do the same*. Some stakeholders mentioned the possibility of regional waste management facilities near where the waste arises and is currently stored.

Participation not bribery

22. Some arrangements are already in place to try to offset the effects of nuclear industry restructuring, one being the activities of West Lakes Renaissance, a regeneration company set up by the North West Development Agency. Mechanisms still exist for the award of regional grants and subsidies. At the same time, the view was expressed that *we (West Cumbria) cannot be bought*. This does not, we sensed, mean that compensation was off the agenda, only that it should be accompanied the right of veto over proposals. This would give the region a real stake in, and legitimate power over, the process.

23. At both meetings with the Councils, the view was expressed that local communities needed to be more involved in decision-making concerned with the economic effects of nuclear industry restructuring. Cumbria and Copeland both belong to the UK Special Interest Group (SIG) of local authorities set up to address these issues and interface with government. We were told by Cumbria Councillors about the Office of Worker and Community Transition and Federal Government funding, two mechanisms that are used in the USA to enhance the credibility of stakeholder groups. This is seen as an important issue for the UK Government. Cumbria and Copeland are keen to attract support for central government funding to enable them to work within SIG to greater effect.

The future – what CoRWM should do

24. We went away with a strong feeling that we had made a decent start to establishing meaningful relationships. And we do not want to put that in jeopardy by failing to meet expectations and letting people down. At the same time, we realise the problems that appearing to favour the region could cause. There is the possibility that regular dialogue with Cumbrian stakeholders could give the impression that decisions on where to manage the waste have already been made.

25. We need to decide how we will maintain our contact with the area. We are considering the value of regular, if not frequent, meetings of this kind. Another possible mechanism is occasional presentations, coupled with more regular, reports on our activities. It should also be possible for small groups of our members to meet with local stakeholders more often than full scale visits would permit. We have not ruled out the possibility of further meetings in West Cumbria in the future or that we will hold a Committee meeting there sometime in 2005. And our Chair has now met representatives of the Sellafield and Chapelcross site Trade Unions, a meeting that did not prove possible when we were in Cumbria in April.

CoRWM secretariat
July 2004

CORWM

Committee on Radioactive Waste Management

Managing our Radioactive Waste Safely

CoRWM's recommendations to Government

CoRWM Doc 700

July 2006

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ANNEXES

Introduction by the Chair

The Committee on Radioactive Waste Management was asked by Government in 2003 to make recommendations for the long-term management of the UK's higher activity wastes that would both protect the public and the environment, and inspire public confidence. To do this, we have combined a technical assessment of options with ethical considerations, examination of overseas experience and a wide-ranging programme of engagement both with the public and with interested parties (stakeholders). I am happy to present our recommendations in the pages that follow. Chapter 14 contains our main recommendations and brief rationales for each.

This integrated package of recommendations deals centrally with specific management options for radioactive wastes but they are also framed more broadly. Government, in setting the Committee's terms of reference, also suggested that we might also want to offer advice on implementation issues and we have placed our recommendations on options within a proposed implementation process. Reports on implementation and on the inventory of wastes are also attached to this report.

It is impossible to acknowledge all the many individuals and organisations that have helped CoRWM to reach its conclusions. But I do especially want to thank both our secretariat and our programme managers (AMEC NNC for most of the two and a half years) without whom our very large task would have proved impossible in the time we had to complete our work.

The Committee believes that our recommendations form a sound basis for the further development of radioactive waste management policy in the UK, and urges Government to build on the momentum we have helped establish.

Gordon MacKerron
31 July 2006

Overview: Radioactive waste - a new approach

For over three decades, efforts to find solutions to the problem of long-term radioactive waste management in the UK have failed. Government initiated a fundamental review of policy and appointed the Committee on Radioactive Waste Management (CoRWM) to take this forward. CoRWM has adopted an innovative approach, based on engagement with the public and stakeholders, expert knowledge and reflection on ethical issues. Consideration of these inputs has led to a set of interdependent proposals which recommend: (1) geological disposal as the end state; (2) the vital role of interim storage; and (3) a new approach to implementation, based on the willingness of local communities to participate, partnership and enhanced well-being. The proposals form a basis for Government to act upon without delay.

2. Ever since the Flowers Report three decades ago drew attention to the problem, the UK has sought but failed to find a long-term solution to the problem of managing its higher activity radioactive wastes. In part, the problem has been a technical one, the need to identify solutions which, in the words of the Flowers Report, could demonstrate 'beyond reasonable doubt that a method exists to ensure the safe containment of long-lived highly radioactive waste for the indefinite future'.[1] But radioactive waste is also a social problem. Its association with nuclear energy and weapons and the risks to health from radioactivity make the management of radioactive waste an issue of controversy and conflict. A solution to the problem must not only be technically achievable but also publicly acceptable. CoRWM's terms of reference (see Annex 1) recognise this in specifying the need for management options that both protect people and the environment and inspire public confidence. This Report brings together both technical and social considerations, in setting out the best way forward for the management of radioactive wastes in decades to come.

3. The problem of radioactive waste must be understood in terms of a changing social and political context. From the later 1940s until the early 1970s radioactive waste did not constitute a political problem. The focus was on the development of the nuclear industry and the weapons programme; wastes were either dumped at sea (first near the Channel Islands, later in the north Atlantic) or accumulated in stores at nuclear sites, notably Sellafield and Dounreay. From the mid 1970s until the early 1990s, the international nuclear industry experienced a series of setbacks in terms of high costs and technological problems. These included accidents at Three Mile Island and later at Chernobyl, growing concerns about radioactive emissions and, in the UK, conflicts over proposals for reprocessing and proposed locations for radioactive waste facilities. The links to weapons, and the dangers of proliferation, further added to a decline in confidence and a lack of trust in the nuclear industry. During this period, every initiative to find a way forward to manage radioactive waste foundered in the wake of opposition and protest. First, the drilling programme to assess the geological suitability of sites for high level waste disposal faced local protests and was abandoned. Then, sea dumping of wastes was suspended in the face of combined action by trades unions, Greenpeace and international protests. Next came attempts to find suitable sites in eastern England for the disposal on land of intermediate and low level wastes which were effectively countered by coalitions of local government and citizen protest movements.

4. These initiatives tried to impose technical solutions but failed to respond to the need for public acceptability. In an effort to find a solution that would be technically suitable, but also achieve local public support, the Nuclear Industry Radioactive Waste Management Executive (Nirex) identified Sellafield and

Dounreay (later withdrawn) as potential sites for the deep disposal of intermediate and low level wastes. After an extensive borehole drilling programme and a lengthy Public Inquiry, the proposal for an underground laboratory (Rock Characterisation Facility, RCF) at Sellafield was rejected in 1997. The series of reversals culminating at Sellafield had left the UK without any options for the long-term management of its solid intermediate and high level radioactive wastes.

5. The rejection of the Sellafield RCF, though a setback at the time, proved also to be an opportunity. It offered a fresh start. Moreover, the social and political context was becoming more favourable to finding an acceptable solution. By the late 1990s conflicts over reprocessing and radioactive waste were receding, memories of major accidents were fading and nuclear energy was in retreat. In such circumstances, it seemed possible that both pro- and anti-nuclear interests might work together to find the best solution to deal with the hitherto intractable problem of radioactive waste. Given the nature of the problem in the UK, and the history of conflict over earlier proposals, this was a moment to undertake a complete review of the issue. In the absence of any ongoing initiatives, it was possible, and necessary, to go back to the beginning, to undertake a fundamental policy review for the management of radioactive wastes.

6. The House of Lords Select Committee on Science and Technology addressed the issue of radioactive waste in its report in 1999.[2] It recognised that 'openness and transparency in decision making are necessary in order to gain public trust' and that mechanisms to include the public in decision making would be necessary. The report proposed setting up a Nuclear Waste Commission with the initial task of consulting on a comprehensive policy. The Radioactive Waste Management Advisory Committee (RWMAC) in a series of reports [3] set out the key guiding principles for the process of developing policy. These included early involvement of the public, adequate time to take decisions, openness and transparency, and a deliberative, accessible approach to decision making. RWMAC also advocated a staged process managed by an 'oversight body'.

7. These and other similar proposals were embraced in the Government's Managing Radioactive Waste Safely consultation paper published in 2001.[4] The aim was to develop and implement a policy which 'inspires public support and confidence'. The paper went on, 'to do that, we have to demonstrate that all options are considered; that choices between them are made in a clear and logical way; that people's values and concerns are fully reflected in this process; and that information we provide is clear, accurate, unbiased and complete'. On the basis of the consultation, the Government proposed that an 'independent and authoritative' committee be set up with terms of reference 'to oversee a review of options for managing solid radioactive wastes in the UK and to recommend the option, or combination of options, that can provide a long-term solution providing protection for people and the environment'. Its task was to 'inspire public confidence' by engaging with the public, and applying ethical principles as well as the best science and technology to decision making. CoRWM was appointed to undertake this task and began its work in November 2003.

8. CoRWM is an advisory body with members appointed with a range of expertise able to offer scientific, social, economic, environmental and public perspectives on the issue of radioactive wastes. It is a Committee that has brought a diversity of viewpoints, experience and knowledge to its work. CoRWM was presented with a unique opportunity to develop a process for selecting options and to consider ways forward for implementing its proposals. Most countries have programmes for identifying sites for radioactive waste disposal that include forms of public participation. These programmes have experienced various degrees of success, with Finland and Sweden at the present time furthest ahead in terms of siting repositories for the geological disposal of civil wastes. The UK is the only country which has used an extensive programme of public and stakeholder engagement in

going back to the beginning and has undertaken a thorough analysis of all options for waste management. After the Sellafield RCF decision, the UK was lagging behind other countries in its policy for radioactive waste management. If the Government accepts these recommendations, the UK can point to an innovative and radical policy process that, in certain respects, is well in advance of those being pursued elsewhere. In CoRWM's view, it provides a way forward that is both achievable and acceptable.

9. At the technical level, the UK's radioactive waste problem has distinctive characteristics. It has substantial volumes of so-called 'legacy' wastes arising from the weapons programme, from its various experimental reactor programmes, from nuclear power plants and from the reprocessing of their spent fuel. The waste streams are complex and some of the earlier wastes were managed to lower standards than today's, thereby necessitating a major clean-up effort currently being undertaken by the Nuclear Decommissioning Authority (NDA). The lower level wastes are disposed of, for example at the shallow low level waste repository near Drigg in Cumbria. It is the higher level wastes that are the subject of this Report. They comprise wastes already in store and those which will arise from existing nuclear activities in the future. These committed wastes constitute a total of approximately 478,000 cubic metres (a volume five times that of London's Royal Albert Hall) and an activity of 78 million terabequerels.* The volume and complexity of the UK's radioactive waste inventory presents a considerable technical challenge that must be met to ensure safe management over the long-term. CoRWM has, following its terms of reference, also examined the way in which plutonium, uranium and spent fuel should be managed if in future they are treated as wastes.

10. CoRWM's approach embodied the following elements:

    i. **Ethics**. At the start of its work CoRWM developed a number of key Guiding Principles. They have been actively pursued in all aspects of the Committee's work. The Principles reflect the values which the Committee believes are integral to the development of a successful waste management policy. In particular the values of equity (fairness) and sustainability have played a vital role in the assessment of options. CoRWM also paid explicit attention to the way in which ethics play an integral part in deciding on what to do with radioactive waste. It paid particular attention to the issue of fairness between generations and to the different ways in which the principle of intergenerational equity can be interpreted as well as to the practical applications of any given interpretation. Ethical perspectives may be in conflict. In reaching its recommendations, CoRWM had to achieve a consensus which could incorporate the different ethical positions held by its members. One of the strengths of CoRWM's recommendations is that they are founded on ethical principles.

    ii. **Participation**. CoRWM placed a very high value on the need to engage with stakeholders and citizens. There were four main phases of public and stakeholder engagement (PSE) designed to involve participants in continuing contribution to key decisions. Various techniques were used including stakeholder round-table discussions, Citizens' Panels, a National Stakeholder Forum and open meetings. Wider audiences were reached, including young people through an in-depth Schools Project involving 15 schools and 1305 students in Bedfordshire, through a widely circulated Discussion Guide and through some 700 website and written responses. All contributions were recorded and comprised a significant input to CoRWM's decisions. Members of the public were also able to participate through attendance at CoRWM's

* Radioactivity is measured as the rate at which atoms disintegrate. One Becquerel (Bq) is equal to one disintegration per second. One terabecquerel is a million million becquerel.

plenary meetings, which included public question and answer sessions, and through written and web-based correspondence. CoRWM's PSE programme is probably the most wide-ranging, informative and influential effort so far undertaken in the UK in public decision making. It has proved an integral element in the CoRWM process and provides the basis on which the Committee can claim it has laid the foundation for inspiring public confidence in its recommendations, especially as the response to the Committee's draft recommendations was supportive from nearly all respondents.

iii. **Use of expert knowledge**. If the Committee's recommendations are to offer protection to people and the environment, they need to be based on the best available scientific and technical knowledge. CoRWM engaged with the scientific community in a variety of ways. For example, it used expert knowledge in a specific context in short-listing options; it deployed much more intensive application of scientific knowledge to the detailed assessment of short-listed options in assessing option performance within the framework of formal Multi-Criteria Decision Analysis (MCDA); and it used broader scientific assessments to examine the critical question of confidence in the long-term safety of geological disposal.

iv. **Deliberation.** In line with its terms of reference, the Committee adopted a deliberative approach to its work from the outset. Deliberation enables knowledge, values and ideas to be explored and discussed openly among participants. Starting from multiple and sometimes conflicting perspectives, it helps enable a rational weighing of evidence. A deliberative process should be inclusive and facilitate consensus building through expressing and integrating divergent viewpoints. Deliberation was an integral part of CoRWM's decision making process. The Committee deliberated in public in deciding the shortlist of options, in assessing the options both in formal and holistic ways and in coming to its overall conclusions on the best options for managing wastes. Deliberation was a major feature of CoRWM's engagement with the public and stakeholders in decision making. The report on Deliberative Democracy and Decision Making for Radioactive Waste explains what deliberative approaches are and how they can be translated into decision making.[5] CoRWM's deliberative approach has helped to ensure that its conclusions are as balanced, fair and comprehensive as possible.

v. **Democratic.** Taken together, deliberation and participation have enhanced the democratic nature of CoRWM's decision making. The process was democratic in several respects. First, it encouraged equality of exchange among participants. Second, it tried to reflect all the relevant viewpoints and values. Third, it enabled decisions to be reached based on a shared understanding. Deliberative approaches to participation provided a basis for informed judgements and decisions. Thus, the PSE process informed CoRWM's recommendations which, in turn, are presented to Government for its decision. While democratic deliberation informs, representative democracy ultimately decides. But, CoRWM's process offers a far more informed basis for political decisions on the management of radioactive waste than has existed previously.

vi. **Integration**. CoRWM's decision making has been informed by different forms of knowledge. Scientific knowledge was used at several different points in the process, for example in the MCDA where panels of experts discussed criteria and scoring for option assessment. There was extensive consultation with the nuclear industry, regulators and advisory bodies. Overseas experience was drawn on to identify potential approaches both to option assessment and implementation. Stakeholders and the public provided various forms of knowledge. An holistic assessment enabled a more discursive and intuitive approach where ethical, scientific and public forms of knowledge could be

brought together in reaching conclusions. Overall, it was CoRWM's task to integrate the variety of knowledge streams in making its final recommendations. The recommendations, then, are not simply an expression of expert knowledge and judgement. They reflect the combined knowledge developed by the Committee. It was gratifying to discover that different forms of knowledge were, on the whole, not in conflict but complementary, providing mutually reinforcing contributions to the decisions that were reached.

vii. **Implementable**. CoRWM's main task was to identify the best option or combination of options for managing higher activity radioactive waste in the long-term. But the Committee was also invited to consider siting issues. This does not mean identifying potential sites, rather, as the terms of reference put it, generic issues including, 'whether local communities should have a veto or be encouraged to volunteer, and whether they should be offered incentives'. CoRWM has not adopted the approach of incentives to volunteer and compensation for taking on burdens on behalf of society. The approach is based on the enhancement of the well-being of communities who are willing to participate in the management of radioactive waste. This may be achieved in various ways. One is through the development of Involvement Packages to enable communities to participate and Community Packages that provide the resources to support both the short and long term well-being of the community. Another way to ensure well-being is through a partnership approach whereby communities hosting radioactive waste facilities enjoy an open and equal relationship with the Implementing Body. In these ways, communities would have more control over decisions that affect their well-being, including whether to participate, how to make use of resources and the ability to influence the development of the project together with the right to withdraw from the partnership up to a pre-defined stage. Previous attempts at finding sites for radioactive waste facilities relied on the imposition of solutions from above. CoRWM's approach is quite different and rejects such imposition. The Committee considers its approach, supported by its PSE process, offers a radical but realistic way forward to successful implementation of its recommendations.

viii. **Interdependence**. CoRWM's proposals for the long-term management of radioactive waste form a carefully articulated and integrated set of recommendations which are interdependent and which the Committee believes can only be successful if adopted as a package. In this sense CoRWM has gone beyond the narrow confines of its remit. It is not simply offering the best option or combination of options in a narrow and technical sense. Rather, the proposals set out the constraints and uncertainties, technical and social, that will influence the achievement of the recommendations. In reaching its proposals, CoRWM has analysed and taken account of PSE, scientific and other inputs to show a future pathway. It presents a well-researched political and social analysis of the possibilities. The recommendations recognise that geological disposal is the right end-point for all, or almost all, the wastes in the CoRWM inventory but also recognise the significant role that must be played by storage both as an interim solution on the route to disposal as well as a contingency in the event of any interruption in the progress towards the end-point. In carrying forward the recommendations, a staged process supervised by an independent Overseeing Body is recommended. Overall, CoRWM's proposals offer Government a way of getting from the present to the future that, if followed, is most likely to prove successful.

11. The results of these processes are a set of recommendations. These are presented, with their main rationales, in Chapter 14 and reproduced here at paragraph 21.

12. The management of radioactive wastes is a problem that extends into the far future. Over such long time-scales, dealing with uncertainties becomes a central issue. The problem that faced CoRWM may be conceived as one of managing the waste in the face of uncertainties. In reaching its recommendations, CoRWM, in conjunction with experts and stakeholders, has had to assess the importance of different forms of uncertainty at different times in the future. This assessment has focussed on the fundamental choice that has to be made between options relating to continuing storage of wastes and options which favour geological disposal.

13. One way of understanding the issues is to consider the contrast between the time-scales appropriate to what may be called geoscientific time and those relating to cultural time. Geoscientific time-scales are relevant to geological disposal options and are concerned with the safety of repositories over periods of hundreds of thousands of years. The focus of attention here is on the uncertainties associated with engineered and geological barriers and hence on the stability and integrity of engineered and geological containment systems. The question for CoRWM was, 'is scientific knowledge about the safety of containment systems in the far future sufficiently credible to enable commitment to geological disposal now?' This is both a scientific and an ethical question. The scientific aspect concerns what we can do in the knowledge that the level of uncertainty, and hence the predictability of change, increases with time. 'At some time, uncertainty will be so great that precise, quantitative predictions will become meaningless'. [6] However it is also the case that over hundreds of thousands of years radioactive decay reduces potential hazards, eventually to insignificant levels. The ethical question concerns the way in which society now should discharge its responsibilities to the far future. Members generally accepted the ethical case for treating all future generations equally, but disagreed on the implications of this in terms of action. One view is that responsibility for the future should not diminish over time, therefore we should avoid actions that might impose risks on generations in the far future. The other view is that since we cannot exercise control over the far future we should pay more attention to the impacts of our actions in the near future.

14. The dilemma of whether to take action now (start the process of disposal, recognising that flexibility will gradually decline) or avoid making a final decision (by continuing interim storage allowing flexibility and later choices but also imposing burdens) is also present in the context of cultural time, the time-scale of human perception and concern. By comparison with geoscientific time-scales, cultural time-scales are very short. Indeed, it is often asserted [7] that the period of human concern about the future extends no further than one or two generations, perhaps no more than a hundred years or so. Human perception tends to be conditioned by historical time-scales, in other words we tend to look as far forward as we can look back, a time-scale measured in hundreds of years. Over such relatively short time-scales (in terms of radioactive waste) it is the uncertainty surrounding the stability and survival of institutions that is of greatest concern. Few institutions have survived for more than a few hundred years and most have life-spans measured in decades rather than centuries. The issue of institutional control has a bearing on the time-scale for storage options and how long retrievable options (storage or phased disposal) might be continued to allow future generations to have a say in decision making. Again there are scientific (including social scientific) as well as ethical aspects to the question. The scientific aspect concerns the survival of stores and institutions that can maintain them. Ethically, the problem is whether, in the interests of providing flexibility for future generations to make their own decisions on how to manage wastes, it is right to pass on burdens of cost and risk.

15. The trade-offs between flexibility and burden are at the heart of the choice among options. They emerged as one of the major discriminating issues in the MCDA, were the focus of the ethical debates over intergenerational equity and were a constant theme throughout the PSE process. In reaching its own conclusions

CoRWM concluded that, within the context of present knowledge, it had sufficient confidence in geological disposal as the best method for long-term management, and the relevant regulators believe that they could, in principle, accept a long-term safety case. But CoRWM's recommendations needed to take account of the uncertainties surrounding disposal. Therefore, the recommendations indicate the need for continuing research on geological disposal and storage to reduce uncertainties and a commitment to leaving open - until repository closure - the possibility of alternative management options becoming available. These and other caveats resulted in a set of interconnected proposals leading to geological disposal as the end-point.

16. Having opted for geological disposal as the recommended end-point, the Committee was then faced with the issue of how soon the option could be implemented, and when a repository should be closed. This gave rise to considerable debate among experts, stakeholders and within CoRWM itself. In the first place, the Committee recognised that the disposal option could not be implemented for several decades. It concluded that there were social and ethical concerns within UK society about the disposal option that would need to be resolved as part of the implementation process. This is quite aside from the fact that the process of implementation, requiring willing communities, the setting up of partnerships, as well as the development and engineering of the repository itself, would take a considerable time. All this would have a bearing on the form of disposal ultimately chosen. For CoRWM, the critical issue was whether it believed that the repository should start to be closed as soon as practicable (the 'early closure' option) or whether it should be left open for future generations to decide when to close it (the 'phased disposal' option). The key issues are summarised here.

17. Among the arguments in favour of 'early' closure (in practice at least a century from now), assuming sufficient confidence in the long-term safety of the concept, are:

    - It minimises the burdens of cost effort and worker dose transferred to future generations.
    - It recognises that future generations may lack the skills or motivation to deal with the wastes.
    - It places less reliance on maintaining institutional controls.
    - It provides greater safety in the near term, which is what concerns people most.
    - It provides greater security from terrorist attacks and the problem of nuclear proliferation.
    - Keeping a repository open even for a few centuries will not add materially to existing knowledge of its probable long-term behaviour.

    The arguments that support early closure also support early backfilling vault by vault as the waste is emplaced.

18. The case for leaving the repository open after it is filled with waste (for up to 300 years or possibly more) rests on the following arguments:

    - It provides flexibility for future generations to take decisions.

- It allows for the lack of trust and confidence in the long-term safety case for disposal.
- It enables future generations to have access to a potential resource.
- It leaves open the possibility of alternative or improved methods for management of wastes.
- It seeks to maintain flexibility whilst making progress in reducing the burden.

19. After considerable debate, CoRWM has reached the unanimous conclusion that early closure is a preferable course of action. Its reasoning includes the points made above but also reflects the fact that early closure will not be achieved until at least a century from now. This, in the Committee's view, provides sufficient flexibility for further research to be undertaken to achieve public confidence and approval and to provide for key decisions to be taken in future.

20. Nonetheless, CoRWM recognises that many stakeholders and citizens have expressed strong support for phased geological disposal, and did not want the Committee to make a prescriptive recommendation about forms of geological disposal. Some members therefore consider that potential host communities should be given the opportunity to scrutinise the pros and cons of different forms of geological disposal, taking into account the views of CoRWM and those with regulatory responsibility. While recognising that Government and regulators will need to be involved, these CoRWM members think that potential host communities should have a considerable influence on final decisions about whether to design a repository for early or delayed closure. Other members consider the case against phased geological disposal to be sufficiently strong that CoRWM should recommend an early closure repository design. While these members support the idea that potential host communities should be able to influence repository design, they do not think that this influence should extend to the possibility of designing a repository to stay open for up to 300 years or more. As a result the Committee has not reached agreement in this area and accepts that this issue will continue to be a matter for public debate.

21. The role of storage as an integral element in the recommendations is extremely important. Storage is the only available option in the short and even medium term and the NDA is responsible for the safe and secure management of the majority of existing stores. It has recently published its Strategy and is actively considering storage options, including the balance of advantage between local and more centralised versions of storage. The NDA is consulting widely on this and other issues. CoRWM's concern is with the development and location of stores that will form part of the interim management on the way to geological disposal. The Committee has explored a number of storage options and combinations including those with and without enhanced protection against terrorist attack, surface and underground, local and central. It has also looked at storage in relation to different waste streams. Among the factors affecting the location of new stores will be the desire to minimise transportation and double handling of wastes, the public acceptability of maintaining stores at existing locations or finding new locations and the vulnerability of sites to sea level rise and other factors. In principle, CoRWM's proposals for implementation, including willingness to participate and the development of partnerships supported by Community Packages, should apply to new central or major regional stores at new locations. The extent to which they should be applied to other new stores and changes to existing stores is a matter for further consideration.

22. The following are CoRWM's final recommendations

In the light of the views of consultees, CoRWM believes that its recommendations provide the basis for inspiring public and stakeholder confidence. We commend them to Government as an integrated package and urge progress without delay so that the momentum established by the CoRWM process is not lost. CoRWM considers that an open and transparent process is essential for successful implementation of these recommendations.

Recommendation 1: *Within the present state of knowledge, CoRWM considers geological disposal[*] to be the best available approach for the long-term management of all the material categorised as waste in the CoRWM inventory when compared with the risks associated with other methods of management. The aim should be to progress to disposal as soon as practicable, consistent with developing and maintaining public and stakeholder confidence.*

Recommendation 2: *A robust programme of interim storage must play an integral part in the long-term management strategy. The uncertainties surrounding the implementation of geological disposal, including social and ethical concerns, lead CoRWM to recommend a continued commitment to the safe and secure management of wastes that is robust against the risk of delay or failure in the repository programme. Due regard should be paid to:*

i. reviewing and ensuring security, particularly against terrorist attacks;

ii. ensuring the longevity of the stores themselves;

iii. prompt immobilisation of waste leading to passively safe waste forms;

iv. minimising the need for re-packaging of the wastes;

v. the implications for transport of wastes.

Recommendation 3: *CoRWM recommends a flexible and staged decision-making process to implement the overall strategy, which includes a set of decision points providing for a review of progress, with an opportunity for re-evaluation before proceeding to the next stage.*

Recommendation 4: *There should be a commitment to an intensified programme of research and development into the long-term safety of geological disposal aimed at reducing uncertainties at generic and site-specific levels, as well as into improved means for storing wastes in the longer term.*

Recommendation 5: *The commitment to ensuring flexibility in decision making should leave open the possibility that other long-term management options (for example, borehole disposal) could emerge as practical alternatives. Developments in alternative management options should be actively pursued through monitoring of and/or participation in national or international R&D programmes.*

Recommendation 6: *At the time of inviting host communities to participate in the implementation process, the inventory of material destined for disposal must be clearly defined. Any substantive increase to this inventory (for example creation of waste from a new programme of nuclear power stations, or receipt of waste from overseas) would require an additional step in the negotiation process with host communities to allow them to take a decision to accept or reject any additional waste.*

Recommendation 7: *If a decision is taken to manage any uranium, spent nuclear fuel and plutonium as wastes, they should be immobilised for secure storage followed by geological disposal.*

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[*] "Disposal" in the context of CoRWM's recommendations on geological disposal means the burial underground (200 – 1000m) of radioactive waste in a purpose built facility with no intention to retrieve the waste once the facility is closed.

Recommendation 8: *In determining what reactor decommissioning wastes should be consigned for geological disposal, due regard should be paid to considering other available and publicly acceptable management options, including those that may arise from the low level waste review.*

Recommendation 9: *There should be continuing public and stakeholder engagement, which will be essential to build trust and confidence in the proposed long-term management approach, including siting of facilities.*

Recommendation 10: *Community involvement in any proposals for the siting of long-term radioactive waste facilities should be based on the principle of volunteerism, that is, an expressed willingness to participate.*

Recommendation 11: *Willingness to participate should be supported by the provision of community packages that are designed both to facilitate participation in the short term and to ensure that a radioactive waste facility is acceptable to the host community in the long term. Participation should be based on the expectation that the well-being of the community will be enhanced.*

Recommendation 12: *Community involvement should be achieved through the development of a partnership approach, based on an open and equal relationship between potential host communities and those responsible for implementation.*

Recommendation 13: *Communities should have the right to withdraw from this process up to a pre-defined point.*

Recommendation 14: *In order to ensure the legitimacy of the process, key decisions should be ratified by the appropriate democratically elected body/bodies.*

Recommendation 15: *An independent body should be appointed to oversee the implementation process without delay.*

CoRWM takes no position on the desirability or otherwise of nuclear new build. We believe that future decisions on new build should be subject to their own assessment process, including consideration of waste. The public assessment process that should apply to any future new build proposals should build on the CoRWM process, and will need to consider a range of issues including the social, political and ethical issues of a deliberate decision to create new nuclear wastes.

23. Chapter 14 describes these recommendations in detail and the preceding chapters explain how CoRWM reached these conclusions.

24. CoRWM's work is part of a staged process initiated by Government in its 'Managing Radioactive Waste Safely' programme (MRWS). In its discussions with ministers, departments and the devolved administrations, CoRWM has been impressed by the sense of commitment within Government to finding a solution to the problem of radioactive waste. The Committee believes its recommendations are securely founded on scientific research, on broad public and stakeholder acceptance, on considerations of ethical and social issues and that they form a practicable, realistic and implementable set of proposals.

25. CoRWM's recommendations now need to be taken forward by Government. Given the past history of conflict and failure to achieve solutions, some expect hesitancy on the part of Government. Throughout the PSE programme there was scepticism as to whether Government would act on CoRWM's recommendations. At the same time, there was a very large measure of support for both CoRWM's approach and its recommendations and a strong expression that Government should capitalise

on the momentum that had been generated by taking action to implement the proposals.

26. Much will depend on being able to sustain the favourable political environment in which these recommendations have been developed. It must be emphasised that CoRWM's recommendations are directed to existing and committed waste arisings. CoRWM believes that its recommendations should not be seen as either a red or green light for nuclear new build. The main concern in the present context is that the proposals might be seized upon as providing a green light for new build. That is far from the case. New build wastes would extend the time-scales for implementation, possibly for very long but essentially unknowable future periods. Further, the political and ethical issues raised by the creation of more wastes are quite different from those relating to committed - and therefore, unavoidable - wastes. Should a new build programme be introduced, in CoRWM's view it would require a quite separate process to test and validate proposals for the management of the wastes arising. To that end, CoRWM has issued a statement on new build which is included after the recommendations in paragraph 21.

27. CoRWM's recommendations reflect a consensus achieved among its members which it believes lays the basis for wide-ranging public confidence. It considers that the Government can act with confidence in the knowledge that the proposals should be both politically feasible and publicly acceptable.

References

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3 Radioactive Waste Management Advisory Committee, (1999) "Advice to Ministers on the Establishment of Scientific Consensus on the Interpretation and Significance of the Results of Science Programmes into Radioactive Waste Disposal"; (2001) Advice to Ministers on the Process for Formulation of Future Policy for the Long Term Management of UK Solid Radioactive Waste, September; (2002) Response to the Government's Consultation Document: "Managing Radioactive Waste Safely"

4 Department for Environment, Food and Rural Affairs and the devolved administrations "Managing Radioactive Waste Safely: Proposals for Developing a Policy for Managing Solid Radioactive Waste in the UK", Defra, 2001.

5 Committee on Radioactive Waste Management, "Deliberative democracy and decision making for radioactive waste", document 1346, 2005.

6 Radioactive Waste Management Advisory Committee/ Advisory Committee on Safety of Nuclear Installations "Site Selection for Radioactive Waste Disposal Facilities and the Protection of Human Health", Report of a Study Group drawn from members of RWMAC and ACSNI, 1995.

7 Duncan, I, Radioactive Waste: Risk, Reward, Space and Time Dynamics, Ph.D thesis, Oxford University; (2002) "Disposal of Radioactive Waste: a Puzzle in Four Dimensions", Nuclear Energy, 41.

Chapter 1 Introduction – the radioactive waste problem

The problem is two-fold – technical and social. A large quantity of higher activity radioactive wastes exists now and significantly more will arise over the next 100 years or so. There is no currently agreed long-term management method for these wastes. There is also a high degree of historical distrust of the nuclear industry and those charged with developing waste management facilities, which has led to a breakdown of previous attempts to implement a policy. The key lesson from UK and international experience is that radioactive waste policies cannot be imposed as past 'decide–announce–defend' strategies. There has to be early public and stakeholder involvement in determining a policy that can inspire sufficient confidence for it to be implemented.

Why is radioactive waste management a problem?

1. The production of radioactive waste in the UK began in the 1920s with the early uses of radioactivity in medicine and industry. The quantities increased after the Second World War with the development of nuclear power generation, nuclear weapons and nuclear-powered submarine programmes. Radioactive waste continues to arise today as these applications are ongoing and it will arise in the future as existing nuclear facilities are decommissioned (dismantled and demolished).

2. The range of waste materials that need to be managed in the UK is more complex than in most other countries because of the range of uses (including military), the number of different reactor types and the ways in which the radioactive materials have been treated. For example, the mechanical and chemical separation (reprocessing) of by-products from the nuclear fuel which has been used in a nuclear reactor ('spent fuel') produces separated uranium and plutonium as well as residues of very long-lived, highly radioactive, waste materials.

3. The social and political context of nuclear matters, and radioactive waste in particular, has changed over the past 50 years. There was little or no public concern over waste during the early development of the nuclear industry and the nuclear weapons programme. However, increasingly over time, a number of anti-nuclear organisations (such as the Campaign for Nuclear Disarmament and Greenpeace) have voiced concerns and these concerns have been reflected in a reduction in confidence and trust in the nuclear industry.

4. Radioactive materials and wastes are potentially harmful because they emit ionising radiation, which can damage cells in the body. Very high doses to the whole body can cause death in a short time; high doses to limited areas of the body can cause other immediate local effects; and low doses over extended periods of time can give rise to effects that may not be seen for decades (e.g. induction of cancer). Some materials or wastes are also potentially harmful because of their chemical toxicity, while others, such as plutonium, would additionally have the potential to start a nuclear chain reaction if not properly managed. For these reasons, the management of radioactive wastes and materials is subject to strict regulatory control, in terms of safety, environmental impact and security.

5. There is no internationally agreed method of classifying radioactive wastes. Historically, in the UK they have been categorised in terms of their nature and activity and this has generally been used to determine the approach to waste management. The classification has taken account of the quantity of radioactivity the wastes contain and their heat generating capacity and has resulted in four

basic categories: high level waste (HLW), intermediate level waste (ILW), low level waste (LLW) and very low level waste (VLLW) (see Chapter 2 for detailed descriptions). Unlike several overseas countries, there is no differentiation in the UK between short-lived and long-lived wastes, despite several reports recommending such differentiation[1].

6. Past Government policy has been 'to dispose of radioactive wastes safely at appropriate times and in appropriate ways'[2]. The main current management arrangement for most LLW involves disposal at the national low level waste repository (LLWR) near Drigg in Cumbria. Some low and very low level solid waste is incinerated and some VLLW is disposed of in small concentrations in conventional landfill sites. Both these low and very low level categories are the subject of a separate Government review.[3]

In the context of solid waste, disposal is the emplacement of waste in a disposal facility without intent to retrieve it at a later time.

7. Because there is no disposal of the higher activity wastes (HLW and ILW, and some LLW which cannot be disposed of at the LLWR near Drigg because of its composition), there are already over 80,000 cubic metres (over 100,000 tonnes) of these wastes stored at nuclear sites around the UK, awaiting a Government decision on how to manage them in the long term. The wastes contain a mixture of radionuclides. Some of these will take several hundreds of thousands of years to decay to the level at which the radioactivity poses no measurable hazard to people or the environment.

Box 1.1

Radioactivity is the spontaneous disintegration of unstable atomic nuclei, with loss of energy through emission of charged particles and/or gamma radiation.

Almost all materials are, strictly speaking, radioactive because they contain traces of naturally occurring radionuclides. Radionuclides can also be man-made, most being produced in nuclear reactors.

All radioactivity reduces naturally over time. This is called radioactive decay. The rate of decay is measured by reference to the **half-life**: the time for the radiation emitted to fall by a half. Half-lives of radionuclides vary considerably and can be as short as a few seconds or as long as many thousands or millions of years. Radioactive waste can contain very long-lived material. After 10 half-lives one-thousandth of the activity remains. After 20 half-lives one-millionth remains.

The uses of radioactivity are varied:

- in electricity production from nuclear reactors
- in defence in nuclear submarines and nuclear weapons
- in medicine for diagnosis and for use in the treatment of cancer
- in industry in measurement gauges and process control

The history of disposal

8. The early methods of management of radioactive waste evolved from the 1950s along two main routes – land disposal and sea disposal (in coastal as well as international waters) – with the remainder being stored on the sites where it was generated. In the early 1970s, the UK began to use a deep-sea site 600 miles south-west of Land's End and an annual operation managed by the UK Atomic Energy Authority (UKAEA) took place in which approximately 2000 tonnes of packaged LLW and ILW was disposed of from a chartered vessel.

9. Since the 1976 report of the Royal Commission on Environmental Pollution ***Nuclear power and the environment***[4] and up to 1997, Government long-term policy aim for the management of solid radioactive waste was deep underground disposal. The history has already been recorded elsewhere[5 6] but is summarised here for completeness.

10. As part of the research on HLW disposal, the drilling of boreholes began at a site in Scotland in 1979 and later in Oxfordshire. The drilling programme was discontinued in 1981 as a result of public opposition.

11. In 1982 the Government set up the Nuclear Industry Radioactive Waste Management Executive (Nirex), initially as a co-ordinating committee of the four major organisations in the UK nuclear industry (Central Electricity Generating Board (CEGB), South of Scotland Electricity Board (SSEB), UKAEA, and British Nuclear Fuels (BNFL). This later became UK Nirex Ltd, with the main task of locating, building and running disposal facilities for LLW and ILW. The Government proposed to store HLW for 50 years, mainly to allow it to cool to the point where it could be safely placed underground.

12. Nirex had taken on responsibility for both land and sea disposal but in 1983, following increasing opposition internationally and in the UK, including a vote of contracting parties at the London Dumping Convention, it suspended the practice of sea disposal. It was eventually totally abandoned by the Government in 1993 and is now prohibited under the OSPAR Convention.

13. Nirex then focussed on developing new facilities to dispose of ILW and LLW, proposing a disused anhydrite mine at Billingham, Cleveland, for the long-lived ILW, and a CEGB storage depot from the Second World War at Elstow, Bedfordshire, for short-lived ILW and LLW. Following significant local opposition, the Billingham proposal was withdrawn in 1985 and Nirex was asked to identify a number of sites for co-disposal of LLW and ILW.

14. In 1986, therefore, Nirex put forward proposals for four shallow disposal sites for LLW and short-lived ILW waste in Elstow, Bedfordshire; South Killingholme, Humberside; Fulbeck, Lincolnshire; and Bradwell, Essex. Widespread public opposition in the areas concerned followed, and at about the same time, a House of Commons Committee report, which included a review of operations at the LLWR near Drigg, recommended that future shallow sites should be engineered facilities restricted to LLW[7]. In 1987, the Government and Nirex abandoned shallow sites because of co-ordinated coalitions of protest from the four sites and decided to establish a deep underground site for the co-disposal of ILW and LLW.

15. It was now very clear that radioactive waste management was a social issue. Recognising the public acceptability issues, Nirex undertook a consultation to ascertain the suitability of sites ('The Way Forward'). The sites identified through the process were not revealed – a key example of the secrecy and 'decide–announce–defend' approach of the era. In the event, there was no general support and only Caithness (Dounreay) and Copeland (Sellafield) showed interest in the proposals.

16. In 1989, following this site selection process, Nirex proposed to research only Dounreay and Sellafield as potential sites, and from 1991 concentrated on Sellafield. In 1992 it proposed a rock characterisation facility (RCF) at Sellafield to test the geology and other scientific and engineering issues.

17. Nirex submitted a planning application for the RCF in 1994, but this was refused by Cumbria County Council. Nirex appealed against the decision and after a Public Inquiry, the Inspector recommended against the appeal. As a result, the planning application for the RCF was rejected by the Secretary of State for Environment in 1997. Besides concerns about environmental impacts and local plans, reasons for rejection included scientific uncertainties, technical deficiencies and the way in which the site was chosen.

Time to change the approach

18. The House of Lords[6] carried out a substantial review of where this left the UK. In 1999, it recommended that underground, geological disposal remained the best policy, using a phased approach to develop technical and public confidence; it also recommended that to develop that confidence the Government should draw up a comprehensive radioactive waste management strategy for all wastes and consult the public on its proposed policy as well as the alternative solutions. This should also include a proposed site selection process. The Radioactive Waste Management Advisory Committee (RWMAC) also contributed to the debate with key guiding principles for the process of developing policy, including early involvement of the public (see Overview).

19. The Government recognised that the old approach of 'decide–announce–defend' was no longer appropriate and there was a need to involve stakeholders and citizens at an early stage, address their concerns, and learn from their knowledge and opinions. It decided on a revised approach in 1999: to undertake a more fundamental review of options for managing radioactive wastes in the long term, and to set up an independent body to advise it. The Government's 2001 consultation paper '**Managing radioactive waste safely'**[8] did not present a decision, but a process for reaching one, including a review of long-term management options, a period for decision making and further consultation, to be followed by an implementation programme.

20. The first step, therefore, was to identify the best way of managing the waste, ensuring that this was scientifically and technically sound and could inspire public confidence. The Government – UK environment Ministers, including those from the devolved administrations for Scotland, Wales and Northern Ireland – appointed the Committee on Radioactive Waste Management (CoRWM) in November 2003. Ministers asked CoRWM to undertake a thorough review of all the options for managing the higher activity wastes and recommend an option, or combination of options, that could provide long-term protection to people and the environment, and that could inspire public confidence.

21. Some of the plutonium, uranium and spent nuclear fuel, arising from the nuclear fuel cycle is currently regarded by their owners as having potential future use. CoRWM has also been asked to advise the Government on the implications of treating some or all of these as wastes.

22. The next step, having identified the best approach, will be to establish a clear plan for implementing it, including deciding who will do it, how they will identify any waste management site or sites, and how they will ensure public and stakeholder confidence. This is partly where the previous processes failed, because there was no clear, transparent, logical and trusted site selection process before the search for sites began. This step is for the Government to take following CoRWM's

report. CoRWM's advice on implementation issues (including a process for identifying potential 'host' communities) is covered in Chapter 17 of this report.

References

1 Radioactive Waste Management Advisory Committee, "Categorisation of Solid Radioactive Waste", Department of the Environment, 1997.

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5 Parliamentary Office of Science and Technology, "Radioactive Waste - Where next", November 1997.

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Chapter 2 Identifying the radioactive wastes and materials that the UK has to manage

The projected volume of higher activity wastes that will arise up to approximately 2120, following decommissioning of existing nuclear facilities, is 478,000 cubic metres (a volume five times that of London's Royal Albert Hall), with a total activity of 78 million terabequerels. Although 92% of the activity is contained in the high level waste and spent fuel, these two categories represent less than 2% of the total volume. The greatest impact on the baseline inventory would be from a programme of new build nuclear power stations. Only a small proportion of the intermediate level waste (1% by volume) can be categorised as short-lived.

1. One of CoRWM's first priorities was to identify how much material might eventually need to be treated as waste, in order to ensure that any option or combination of options recommended can accommodate such wastes. The Committee started from the Government-sponsored UK Radioactive Waste Inventory[1]. Although that document, and the way in which radioactive materials are accounted for, are subject to rigorous control by UK safety and security regulators, it was important for CoRWM to scrutinise it and challenge some of the underlying assumptions. CoRWM consulted stakeholders – including nuclear waste producers and management, central and local government, regulators and environmental groups – before producing a preliminary Inventory Report in 2004[2].

2. CoRWM sought comments on the preliminary report in the first round of Public and Stakeholder Engagement (PSE 1) from November 2004 to January 2005. The comments[3] and the latest national inventory information[4] were taken into account in the preparation of the final version of the report, which was published in July 2005. These data formed the basis for the subsequent assessments of waste management options. Details are given in Annex 3 and in the CoRWM Inventory Report[5], which accompanies this Report.

3. The Inventory Report considers:

   i. the materials that currently exist as waste or could arise over the next century or so as a result of decommissioning of existing nuclear facilities, both in terms of volume and radioactivity

   ii. the characteristics of the materials including any likely technical difficulties that could apply to their management

   iii. the current locations

   iv. any special considerations that apply, such as security.

Box 2.1

Radioactive wastes – the legacy that the UK must manage
(UK material only, eventual projected volume at approximately 2120)

Material	Packaged Volume (m3)	% Volume	Activity (TBq)	% Activity
HLW	1290	<0.3	39 million	50
ILW	353,000	73.9	2.4 million	3
LLW (Non-Drigg [1])	37,200	7.8	<100	<0.001
Plutonium (Separated)	3,270	0.7	4 million	5
Uranium	74,950	15.7	3,000	<0.01
Spent Fuel	8,150	1.7	33 million	42
		Total		**477,860**

[1] Low level waste that cannot be disposed of in the LLWR near Drigg because the radioactive content or physical/chemical properties do not meet the site acceptance criteria.

The main components of the inventory

4. **High level waste** is very radioactive, mainly fission products, and generates a great deal of heat. This heat generation has to be taken into account when storing HLW and designing facilities for its management in the long term. HLW arises at Sellafield as a highly radioactive nitric acid liquid waste solution following the separation of uranium and plutonium from spent nuclear fuel during reprocessing. These liquid wastes are being converted into a passively safe solid form, as borosilicate glass within 150-litre stainless steel containers, using a process called vitrification. Once vitrified, the wastes are currently to be stored for at least 50 years to let the heat-emitting radionuclides decay to levels that facilitate long-term management. In a programme agreed by the site operators and the nuclear regulators, by 2015 the majority of the backlog of high level liquid waste stockpile will have been vitrified. A smaller volume of liquid waste (currently required by the regulators to be a maximum of 200 cubic metres) will then be maintained to facilitate ongoing site operations and decommissioning, before eventually being vitrified. When in liquid form, the wastes require active management and control, including the provision of continuous engineered cooling because of the heat generated, and substantial shielding because of the very high radiation levels. Once vitrified, the solid waste is passively stored in naturally cooled, shielded concrete stores.

5. **Intermediate level waste** is less radioactive than HLW, and does not generate sufficient heat for this to be taken into account in the design of the facilities for management, but can require significant shielding. Some of the waste can have very long half-life. The form of the waste is much more varied than HLW. Major components include metal items, such as nuclear fuel cladding and reactor components, graphite from reactor cores and sludges from treating radioactive liquid effluents, as well as some wastes from medical and industrial users. It is stored in tanks, vaults and drums, usually with some shielding to protect operators from radiation. Waste is progressively being immobilised in cement-based materials within 500-litre stainless steel drums or, for larger items, within high capacity steel or concrete boxes.

6. **Reactor decommissioning waste (RDW).** Some of the ILW that will arise in the future from reactor decommissioning is relatively short lived (<30 year half-life). This material would decay to LLW in around 300 years and could be considered for co-disposal with LLW in any future shallow disposal facilities that may follow the LLW review[6]. Some of this RDW may contain waste, which is longer lived (i.e. would be present well after 300 years). If this was present in relatively small concentrations, it might be possible to make a case that this would not pose a significant hazard after 300 years.

7. **Low level wastes** are less radioactive than ILW, and consist largely of redundant equipment, protective clothing and packaging. In future, as nuclear plants are decommissioned, the main components will include soil, concrete and steel items such as ducting, piping and reinforcement. Most of the existing LLW is disposed of at the national LLWR near Drigg in Cumbria. It is compacted, packaged in large metal containers and put in an engineered vault a few metres below the surface. Some LLW that does not meet the LLWR site acceptance criteria because of its radioactivity or physical/chemical properties, is included in the inventory that CoRWM is considering.

8. **Naturally occurring radioactive materials (NORM)** contain radioactive elements such as uranium and thorium (which came into existence when the earth was formed) and their radioactive decay products. The majority of NORM arises from non-nuclear industrial processes in very large quantities but low specific activity. The main area of particular interest is the solid radioactive waste, containing low activity radium scales, that arises from the oil and gas industry. The waste may not meet the conditions for disposal at the LLWR near Drigg, but there is currently one shore-based facility that is authorised to discharge these low activity radium scales to the marine environment. The generation of NORM from a variety of non-nuclear industries could potentially have important consequences for LLW disposal capacity.

9. **Plutonium** is created as a by-product of the use of uranium fuel in nuclear reactors and is used in nuclear weapons. It can represent a significant health hazard if inhaled or ingested. It is contained within spent fuel when it is removed from a reactor, but can be extracted by reprocessing the spent fuel. It could, in this extracted form, be used to make some reactor fuels. The UK's stockpile of plutonium is stored at Sellafield and future arisings from reprocessing will be stored at the same place. The Nuclear Decommissioning Authority (NDA) is evaluating the options for managing this stockpile, which include consideration of use in reactor fuel and various methods of encapsulating it as a waste[7].

10. **Uranium** is found naturally, and can be processed to give highly enriched, low enriched and depleted uranium (these forms having different concentrations of uranium-235). It is also a product of the reprocessing of spent fuel and can have similar uses to plutonium. Less radioactive ('depleted') uranium has a wider range of uses, including artillery shells and aircraft counterweights. Uranium is stored at a limited number of British Nuclear Group (BNG) and UKAEA sites (see Figure 2.3) and future arisings from reprocessing will occur at Sellafield. As with plutonium, the NDA is evaluating options for managing this stockpile. The vast majority of the uranium inventory is depleted and the potential risks associated with this material are considerably less than most other materials in the CoRWM inventory.

11. **Spent nuclear fuel** is a mixture of plutonium, uranium and waste materials. It can be reprocessed to extract the plutonium and uranium; or it can be managed in another way, such as packaging it and placing it in a waste repository, as is planned in a number of countries that have nuclear power stations. The UK stocks of non-reprocessed spent fuel consist of arisings from Magnox and Advanced Gas-cooled Reactors and from the Sizewell B Pressurised Water Reactor, along

with submarine reactor spent fuel and smaller quantities of specialist fuel from research and prototype reactors.

Scenarios that could affect the inventory

12. The Inventory Report also looks at the impact on the inventory of possible future scenarios and uncertainties, including the following:

- **New build.** This is the amount and type of waste that could arise if further nuclear power stations were built. The scenario chosen was of ten new AP1000 nuclear reactors which could use up the UK's separated plutonium stockpile in the form of mixed-oxide (MOX) fuel and create a MOX spent fuel waste stream. Chapter 18 sets out the Committee's view on how new nuclear build could negatively affect the successful implementation of any radioactive waste strategy.

- **Waste substitution.** High, intermediate and low level waste is produced when spent fuel from abroad is reprocessed in the UK. Contracts require that these wastes be returned to the country of origin. The waste substitution policy allows the addition of some UK HLW to the overseas HLW that is to be sent back to the country of origin, to compensate for a radiologically equivalent amount of the overseas ILW and LLW that is retained in the UK. This leaves each party with the same amount of waste in radiological terms but significantly reduces the number of waste transport shipments required.

- **Decontamination, storage for decay, and segregation of intermediate level waste**. This involves waste producers decontaminating or decay-storing suitable ILW streams (or segregating some components of these streams) so that they can eventually be disposed of at the LLWR.

- **Life extensions** of five years for existing Advanced Gas-cooled Reactor stations and ten years for Sizewell B.

- **Early closure** of fuel reprocessing plants and early decommissioning of nuclear reactors. This could involve early closure of Magnox plants but continued reprocessing of their spent fuel.

- **Naturally occurring radioactive materials (NORM).** Although this category of waste is not within the CoRWM remit because there is one current disposal route to sea, there are uncertainties of whether this route will continue to be used. The waste is LLW, but the radium content may make it unsuitable for disposal at the LLWR. Alternative routes of disposal could be sought following the LLW review.

The volume and activity of wastes

13. CoRWM's Inventory Report estimates that the amount of wastes which will eventually have to be managed will total approximately 478,000 cubic metres (a volume five times that of London's Royal Albert Hall) and an activity of 78 million terabequerels once they are conditioned and packaged. Approximately 80,000 cubic metres of the inventory have arisen already; the remainder will arise at various times over the next 100 years or earlier, as the decommissioning of existing nuclear facilities progresses.

14. ILW makes up approximately 74% of the volume of the CoRWM inventory, uranium approximately 16% and the other categories in total approximately 10%. While the combined volume of HLW and spent fuel is less than 2% of total volume, they comprise 92% of the total radioactivity (HLW 50%, spent fuel 42%). HLW is

now only located at Sellafield, and spent fuel will principally be located at Sellafield and Sizewell. ILW arises at all the 36 major waste producing sites in the UK. In terms of the total volume of ILW projected, Sellafield accounts for approximately 43%, the eleven Magnox stations account for 28%, the seven AGR power stations 16% and Dounreay 4%.

15. The total volume is unlikely to vary by more than 10% for any of the scenarios considered. The greatest impact on total activity would come from a programme of new nuclear power stations – it could rise by a factor of nearly three as a result of construction of ten reactors because of the spent fuel. If spent fuel was not reprocessed, but declared a waste, then the spent fuel element of the total waste inventory would be approximately five times greater in volume and radioactivity than the present anticipated quantity. If plutonium were used as MOX fuel this would also affect the amount and chemical form of the plutonium within the total inventory.

16. If plutonium and uranium were declared wastes, this would have little impact on the overall size or radioactivity of the inventory. But their management would need to reflect the composition of the materials including criticality and security risks.

17. Only a small proportion of the ILW inventory volume (about 1%) can be categorised as short-lived and so would potentially be suitable for near surface disposal. Furthermore, the impact of attempting to segregate more waste for near surface disposal would be likely to be very modest.

18. Submarine spent fuel is presently stored at Sellafield in ponds and is not designated as waste. The Ministry of Defence, its owner, has no plans to dispose of the spent fuel. The Ministry, however, has said that it does not envisage that there would be insurmountable problems associated with long-term dry storage of the fuel. If it was decided that submarine spent fuel was to be emplaced in a long-term store with civil fuel, it would need to be in a separate vault from civil fuel in order to ensure security and separation for safeguard accounting. To place this management issue in context, the total quantity of submarine spent fuel that could be managed in 2040 is equivalent to only a small fraction of the stockpile of pressurised water reactor spent fuel from Sizewell B[8].

Chart showing volume contributions to the baseline inventory

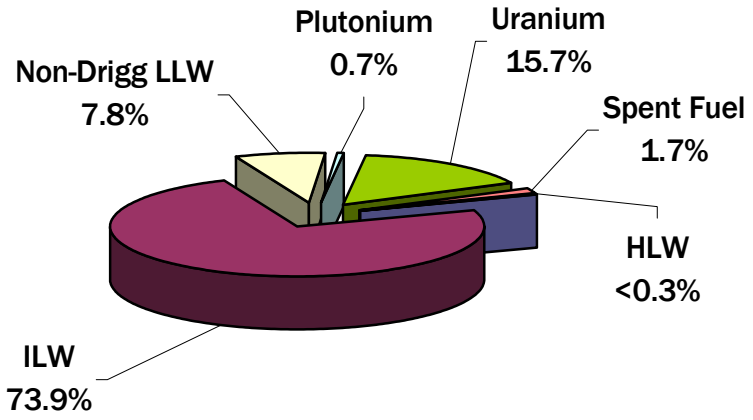
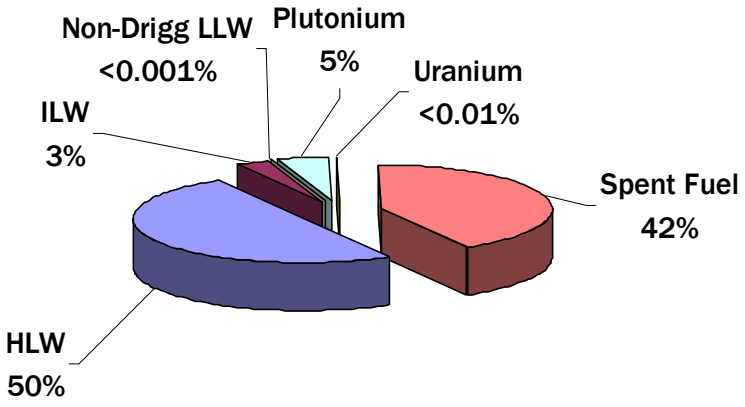


Chart showing radioactivity contributions to the baseline inventory



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5 Committee on Radioactive Waste Management, “Radioactive Wastes and Materials Inventory”, document 1279, July 2005.

6 Department for Environment, Food and Rural Affairs et al., "A Public Consultation on Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom", February 2006.

7 The Environment Council, Management of Nuclear Materials Information Group, Draft Report, Nuclear Materials Disposition Study, Document 0024, April 2006.

8 Communication to CoRWM from the Ministry of Defence, March 2006.

Chapter 3 Other current initiatives in the development of policy

There are a number of concurrent Government and other initiatives which potentially impact on CoRWM's work. The Committee has maintained contact with those involved and taken relevant information into account in developing the CoRWM recommendations.

1. CoRWM has been working to recommend long-term management options for all solid radioactive wastes except those at low levels of radioactivity. Deciding on these options is a major part of the radioactive waste policy agenda, but there are other issues in radioactive waste management, especially in the shorter term, including decommissioning. This in turn means that there are many other initiatives which affect CoRWM's work and which have been taken into account.

2. The Government set up the NDA in 2005 to take strategic responsibility for the UK's nuclear legacy (principally owned previously by BNFL and UKAEA). The NDA's main task is to ensure that the civil public sector nuclear sites of BNFL and UKAEA are decommissioned and cleaned up safely, securely, cost effectively and in ways that protect the environment now and in the future. The NDA is overseeing the management, in the short term, of much of the waste on which CoRWM is making long-term recommendations. The NDA has to make judgements, for example, about investing in storage facilities with a lifespan of many decades, and its decisions will be substantially affected by CoRWM's recommendations and the Government's reaction to them. CoRWM and NDA have met regularly to exchange information on technical and stakeholder issues, and to ensure that CoRWM's review of options is not constrained by any of the NDA's proposals. The NDA is also responsible for the long term management of LLW at the LLWR near Drigg.

3. In 2005, the Government also initiated a review of LLW management policy.[1] Many nuclear and other facilities need to be decommissioned over the next few years, yielding a large volume of wastes. These are currently managed in different ways and places, including the LLWR. The review is considering such issues as the limited capacity of the LLWR, the nature of the various wastes and how different types of waste could be best managed – including removing the potential need for transporting large volumes of relatively low activity waste over long distances. While CoRWM is considering only higher activity waste, the LLW review has implications for reactor decommissioning wastes and the consideration that the NDA is giving to the local management of LLW at its sites.

4. The Government published its latest energy policy review in July 2006 at a time when CoRWM was finalising its recommendations.[2] In the review, the Government conclude that "new nuclear power stations would make a significant contribution to meeting our energy policy goals" and that the Government will take steps to improve the planning process for all energy infrastructure. Should more nuclear reactors be built, this would add to the waste inventory, extend the period during which waste management facilities have to operate for an indeterminate period and could affect public confidence in the waste management programme being proposed by CoRWM for current waste. Any proposed changes to the planning process would also need to be considered as to whether they have any implications for CoRWM's implementation recommendations. CoRWM considers that the social, political and ethical challenges relating to any new nuclear build, and waste generated, could be greater than the technical challenges (see Chapter 18).

5. The Government has examined options for managing non-military plutonium and will be guided by the advice of the NDA. The result could affect the amount of plutonium that has to be managed as a waste – though even if plutonium were to be used in nuclear fuel, there would eventually be more waste to be managed.

6. Nuclear submarines, which have been removed from service with the Royal Navy and defuelled, contain ILW within their reactor compartments. Arrangements for the interim storage of this waste prior to its eventual disposal are being developed by the Ministry of Defence through Project ISOLUS (Interim Storage of Laid-Up Submarines) set up in 2000. In response to public consultation3 and in order to ensure a cross-Government approach to radioactive waste management, the Ministry aligned the ISOLUS process closely with CoRWM's deliberations. Future decisions on the project will be made in the light of CoRWM's recommendations to Government.

7. The SAFEGROUNDS project (1998)[4] has involved civil and nuclear site operators, Government, stakeholders and others in developing and disseminating good practice and guidance for managing radioactively and chemically contaminated land. As with ISOLUS, CoRWM has kept in touch with the organisers to share experience about PSE activities and avoid duplication.

8. The Government reviewed its waste substitution policy and announced its decision in 2004.[5] Substitution is considered to be a controversial issue. Contracts for reprocessing overseas spent fuel at Sellafield specify that all reprocessing products, including ILW and HLW, are to be sent back to their owners. No such returns of wastes have yet taken place. Under substitution arrangements, now approved in principle by Government, the UK would be able to retain overseas LLW and ILW from reprocessing and return, on top of the HLW already in overseas ownership, an additional amount of HLW equivalent in radioactivity to the ILW retained in the UK. Thus, the overseas owners will receive back, in a concentrated form in HLW, the same amount of radioactivity as that contained within the original spent fuel. The major motivations for substitution are cost savings and reduced international transport. This new policy would change, by a small margin, the amount of waste needing to be managed in the UK; there will be a slightly smaller volume of HLW but a larger amount of ILW – the Government estimates about 1.4% more by volume. So the overall volume managed in the UK would increase slightly, but the total radioactivity would not (see the CoRWM Inventory Report [6]).

9. In 2005, the Government took ownership of UK Nirex Ltd, which since 1997 has been providing advice on the conditioning and packaging of waste, compiling the UK Radioactive Waste Inventory jointly with Defra, and maintaining the UK's stock of knowledge on geological disposal of radioactive waste. It has been an important information source for CoRWM, especially in relation to the geological disposal options. In 2005, Nirex also published the list of potential repository sites it had considered during the 1980s and early 1990s.[7]

10. An independent body, the Radioactive Waste Management Advisory Committee (RWMAC) was set up in 1978 and advised on radioactive waste policy issues generally. It was put into abeyance in 2004 after CoRWM was set up to recommend a long-term policy for solid wastes. There is currently no independent committee advising Government on all types of radioactive wastes including their current management.

11. Many of these developments are interrelated. The Government has set up an interdepartmental Radioactive Waste Policy Group and an Implementation Planning Group to consider these and other issues including CoRWM's recommendations and what policy or organisational changes should follow.[8]

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1 Department for Environment, Food and Rural Affairs & others, "A Public Consultation on Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom", February 2006. See also Defra website http://www.defra.gov.uk/environment/radioactivity/waste/index.htm

2 Department of Trade and Industry, "The Energy Challenge: Energy Review Report 2006". See also DTI website http://www.dti.gov.uk/files/file31890.pdf.

3 Ministry of Defence, "Interim Storage of Laid Up Submarines: Consultation on ISOLUS Outline Proposals: Ministry of Defence Response to Lancaster University's Final Report", February 2005. See also ISOLUS website http://www.lancs.ac.uk/users/csec/isolus2/isolus%20history

4 CIRIA, "The Safegrounds Learning Network", 2006. See Safegrounds website http://www.safegrounds.com.

5 Department of Trade and Industry, "Intermediate Level Radioactive Waste Substitution", December 2004. See also DTI website http://www.dti.gov.uk/files/file30058.pdf.

6 Committee on Radioactive Waste Management, "CoRWM's Radioactive Waste and Materials Inventory", July 2005, CoRWM Document No. 1279.

7 UK Nirex, "Nirex publishes historic site list", 10 June 2005. See also Nirex website http://www.nirex.com/index/iold_list.htm.

8 Department for Environment, Food and Rural Affairs: see website at http://www.defra.gov.uk/environment/radioactivity/waste/rwpg/index.htm.

Chapter 4 CoRWM's principles and practice

At the start of its work, CoRWM drew up a set of five principles to guide every aspect of its work. These principles have been applied both to the way the Committee itself worked, and in the approach to the process of engagement with the public and stakeholders.

1. Principles may be described as statements of fundamental core values. CoRWM's five principles have underpinned everything that the Committee has done. They are:

   i. **To be open and transparent**. Our aim is to earn public trust by securing confidence in our actions. Openness requires that we operate in public and are accessible both in person and through our publications. Transparency means that we aim to make as clear as possible how, and why, we have formulated our recommendations. This principle is reflected in our publication scheme and transparency policy.

   ii. **To uphold the public interest by taking full account of public and stakeholder views in our decision making.** Our objective is to identify and evaluate the options and decide on the recommendations for the future management of radioactive waste. We shall achieve this through encouraging discussion and deliberation with the public, local political representatives and a wide range of stakeholders. Through this process, we aim to make recommendations that are both practicable and acceptable.

   iii. **To achieve fairness with respect to procedures, communities and future generations**. We consider fairness (equity) to be fundamental in order to inspire public confidence. We shall try to ensure that anyone who wants to participate in the process has the opportunity to do so. We shall strive to avoid favouring particular groups, stakeholders, communities or regions. But we also recognise that some may have a greater interest in the process and its outcomes than others, for example, people living close to sites where waste is currently managed. Fairness also involves recognising the rights of future generations.

   iv. **To aim for a safe and sustainable environment both now and in the future.** This principle applies to present and future generations and embraces the natural, as well as the human, environment. In seeking to fulfil this principle, we recognise the need to apply the best available sound science and other specialist input and acknowledge that achieving a safe and sustainable environment requires its integration with social science through an interdisciplinary approach. We accept that proposals for the long-term management of radioactive wastes should seek to avoid placing undue burdens on the environment, both now and for future generations.

   v. **To ensure an efficient, cost-effective and conclusive process**. We recognise we must operate within resource and time constraints. We must maintain the direction and objectives of the programme, keeping within budget and reaching conclusions within an appropriate timescale. We will ensure that other matters that are raised are considered in appropriate ways. But, above all, we will endeavour to present recommendations which have broad support and which we believe will provide a solution to the problem.

Practices that have evolved from these principles include:

2. Taking a deliberative approach, both in Committee discussions and in working with citizens, specialists and stakeholders. Deliberation can be defined as a process of 'arriving at common judgements on common interests founded on reasons and argument'.[1] It can contribute significantly to decision making by uncovering and examining the reasons why people hold certain views. The outputs from a deliberative

process can be integrated with the results of other approaches to help formulate policy recommendations. CoRWM held a deliberative democracy and decision-making workshop [2] which was led by academics specialising in politics. A key aspect of deliberation is that it encourages the free expression of ideas, views and beliefs, and is a vehicle for identifying and understanding what people think and what is important to them. While there is an obvious need for robust scientific knowledge when dealing with the issue of radioactive waste, there are inherent uncertainties in such a complex topic. Other forms of knowledge based on experience and values are an important input into decision making. One of the outputs of the workshop was an acknowledgement that deliberative processes are a way of establishing mutual respect and trust between expert and lay knowledge and opinion.

3. **Recognising that there is a very strong ethical dimension to the issue of radioactive waste**. Why radioactive waste is an ethical issue and what that might mean for the Committee's work was explored at another workshop with a panel of national and international ethicists.[3] Among the key ethical principles identified as relevant to CoRWM's work were: respect for life, concern for well-being, ensuring justice, and respect for dignity and liberty. These principles require consideration of such issues as intergenerational equity (the distribution of burden over time), intra-generational equity (fairness between communities), and the environment. As the Committee's work progressed, these difficult moral and ethical issues increasingly influenced our discussions and conclusions (see Chapter 6).

4. **Using all appropriate sources of information.** Constituting a Committee made up of people with very diverse backgrounds and experience, the members themselves possessed a wide range of knowledge and expertise on which to draw. CoRWM recognised that it would use the large amount of research that had been carried out in the field of radioactive waste management in the UK and internationally. CoRWM aimed to act as an intelligent customer in commissioning and evaluating work which drew on this experience. In addition, Committee members visited the two principal nuclear sites in the UK – Sellafield and Dounreay – as well as sites in Sweden and Finland, where the management of radioactive waste is more advanced (see Chapter 9).

5. **Making CoRWM's process open and transparent**:

   - One of the Committee's first actions was to draw up a transparency policy which can be viewed on the CoRWM website.[4] The policy explains CoRWM's aim of making as clear as possible how and why it came to its recommendations.

   - The transparency policy was complemented by a publication scheme[5] which explains how the various types of information used or generated by the Committee could be accessed by the public. Only a very small number of documents covering commercial contracts are not accessible.

   - CoRWM held its plenary meetings in public, as far as practicable moving the location of meetings around the country in order that people interested in listening to members speak were able to do so. Option assessment was carried out in public – possibly for the first time in the UK. Opportunities for people to ask questions were provided at all meetings.

   - CoRWM set up a website (www.corwm.org), which advertised forthcoming events, provided opportunities to comment on work, gave updates and bulletins on process, and included a search engine for finding and downloading documents.

6. **Being Efficient.** While recognising that it was set up as an overseeing committee, CoRWM discovered that in order to get the work done, members had to do a

considerable amount of work themselves. The Committee sought to make best use of its time and members' expertise by forming working groups to work on specific issues as delegated by the full Committee. The structure, role, and membership of these working groups changed as the Committee's work progressed. When necessary, appropriate specialists were co-opted onto working groups for specific tasks. The working groups took on specific areas of work, operating in parallel with one another and reporting to plenary meetings on the results. The areas of work carried out in this way were:

- establishing guiding principles
- scoping and describing the CoRWM inventory
- design and management of PSE
- gathering information enabling options to be compared
- designing option appraisal methodologies
- providing advice on implementation
- quality assurance of CoRWM's work
- content and management of the CoRWM website.

Reports from working groups to plenary can be found on the CoRWM website.

7. **Ensuring Quality.** CoRWM established a Quality Assurance working group to oversee quality assurance and to ensure that the work was of good quality and would lead to robust recommendations to Government. As well as some CoRWM members, the group included independent academics proposed by the Royal Society and the Royal Academy of Engineering. CoRWM's quality assurance arrangements were formalised to ensure that the key parts of the programme were delivered in an efficient and timely way. They include four basic elements: delivering outputs on time; ensuring the quality of specialist or technical reports; ensuring the quality of CoRWM's processes; and ensuring learning from experience.

8. **Evaluating and learning**. CoRWM's work has been independently evaluated by Faulkland Associates, who produced regular evaluation reports on specific aspects of CoRWM's programme.[6] Strengths and particularly weaknesses pointed out in these reports have been used when planning subsequent activities. CoRWM evaluated the events it held, both by asking those involved to provide feedback, and by holding debriefing sessions. The resulting lessons were used when planning future events.

References

1 O'Neill, J., "Representing people, representing nature, representing the world", Environment and Planning, Volume 19, 2001, pages 483-50

2 Committee on Radioactive Waste Management, "Deliberative democracy and decision making for radioactive waste", 2005, document 1346.

3 Committee on Radioactive Waste Management, "Ethics and Decision Making for Radioactive Waste - A Report for CoRWM", 2006, document 1692

4 Committee on Radioactive Waste Management, "Transparency Policy". See CoRWM website at http://www.corwm.org.uk/content-264.

5 Committee on Radioactive Waste Management, "Publication Scheme". See CoRWM website at http://www.corwm.org.uk/content-265.

6 Faulkland Associates, "CoRWM Phase 2 Evaluation", October 2005, as an example. See CoRWM website at http://www.corwm.org.uk/content-595.

Chapter 5 Key steps in the programme

CoRWM developed a wide-ranging programme of activities to enable it to assess the options for managing radioactive waste in the long term and formulate its recommendations to government. This chapter gives a broad overview of the key steps in the programme to set subsequent chapters in context.

Overview of the programme

1. CoRWM's terms of reference (see Annex 1) required the Committee to supply recommendations by no later than the end of 2005. As the process of setting up the Committee took longer than anticipated, the original programme of work submitted to Government proposed a reporting date of November 2006. Government asked whether this could be brought forward to July 2006, which CoRWM agreed to do. This compressed timescale has necessitated an intense programme of work, and significant parallel working. A revised programme of work evolved over time, the key steps of which are shown in Figure 5.1. This illustrates the critical and continuous input from the scientific community, specialists, stakeholders and the public.

2. CoRWM divided its programme into three phases. The first phase ran until September 2004 and was primarily focussed on information gathering, testing methods, drawing up the long list of potential options for managing radioactive waste and deciding how to undertake a shortlisting process. The second phase from September 2004 until July 2005 included the shortlisting process and deciding how to assess that shortlist. The third and final phase lasted a year from August 2005 until July 2006 and included the assessment of the shortlisted options, the formulation of recommendations, and drafting the report to Government. The various activities that took place within these phases, sometimes spreading across all three phases (e.g. identifying the inventory of waste) are briefly described below.

Information gathering and pilot testing

3. CoRWM began by gathering information and learning about the issues. In terms of public and stakeholder engagement, the Committee learned lessons from the events surrounding the oil platform Brent Spar, and from the 'GM Nation?' debate about genetically engineered crops.[1]

4. CoRWM studied material, visited establishments and organisations in the UK and abroad, and paid particular attention to meeting the requirement in its terms of reference to 'engage members of the UK public, and provide them with opportunity to participate'.[2] With this in mind, the Committee trialled a technique called Deliberative Mapping (DM), which is a participative, multi-criteria, option appraisal process developed by researchers at University College London and the University of Sussex.[3] Although the Committee decided not to adopt the DM process in total, many lessons were learned about how to interface with specialists, stakeholders and the public, and several techniques used in the DM trial were adopted later in CoRWM's process. The Committee also commissioned a comprehensive review of methods for engaging with the public and stakeholders.[4]

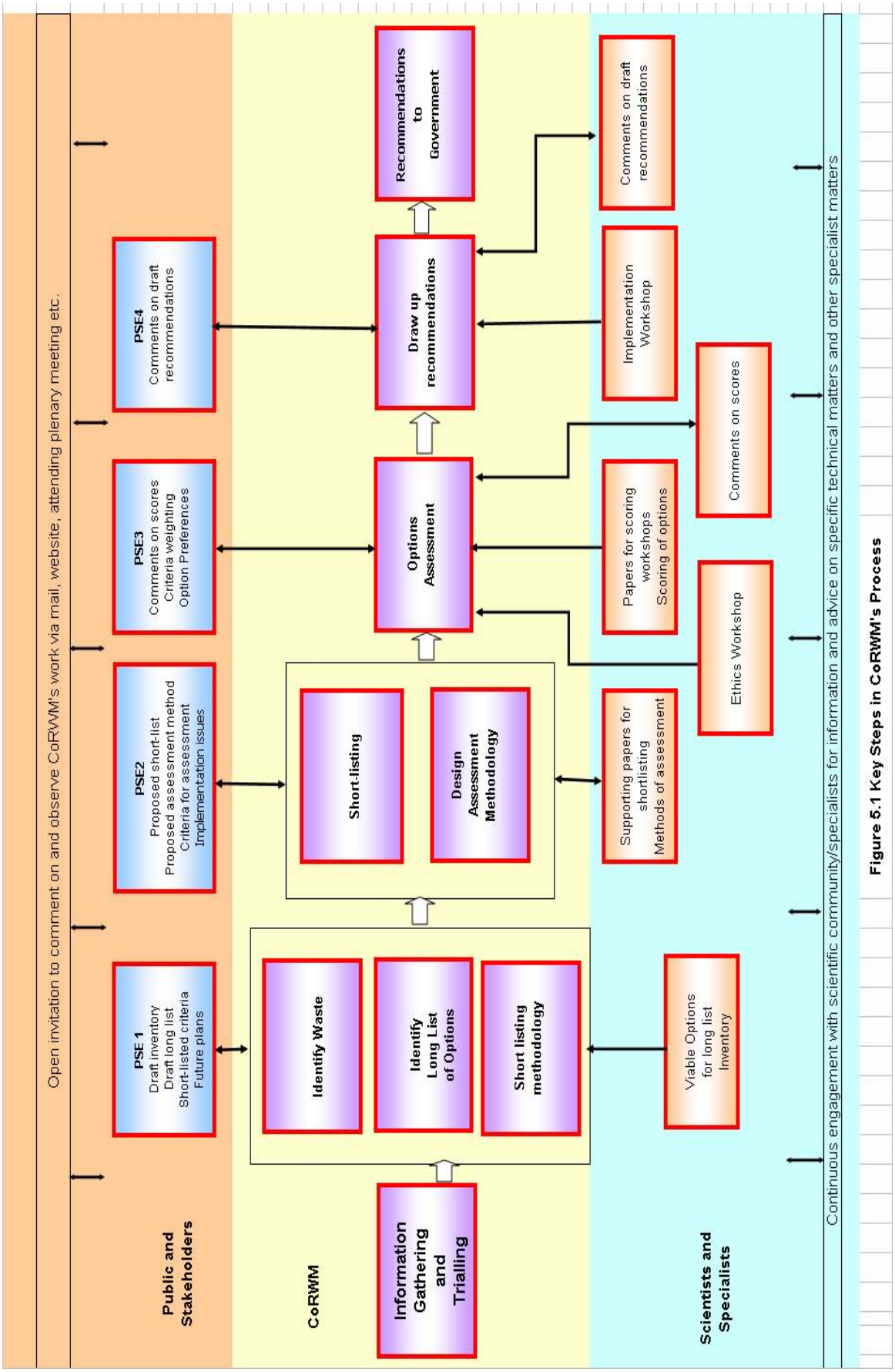

Figure 5.1 Key Steps in CoRWM's Process

Identifying the waste to be managed

5. An early task was to identify the quantity and location of radioactive waste and materials that came within CoRWM's remit. Appropriate specialist organisations were consulted and a draft inventory of waste was drawn up.[5] Comments on this draft inventory were then invited.[6] Chapter 2 describes the identification of the inventory of waste, and addresses some of the issues that were raised by stakeholders and the public, including the impact of potential nuclear new build, substitution and reprocessing.

Identifying a long list of options

6. Government asked CoRWM to identify the options for the longer term management of the various waste materials based on public and stakeholder views. A long list of options had already been drawn up by a team of consultants working on a previous project,[7] and this had been widely reviewed. These options had therefore been considered viable by the international scientific community and were put out for further public and stakeholder comment and specialist review to ensure that there were no significant omissions.

Integrating ethical issues

7. Radioactive waste management decisions have fundamental ethical dimensions. CoRWM recognised early on the importance of making the relevant ethical issues explicit. It organised a two-day workshop for members on ethics and radioactive waste, and deliberated on the issue with four internationally recognised ethical experts on the subject. CoRWM ensured that ethical issues remained prominent throughout its process, and Chapter 6 describes the substantive questions involved.

Shortlisting

8. At the same time, people's views were sought on how the long list should be assessed to create a shortlist. In particular, the public and stakeholders were asked to comment on CoRWM's proposed shortlisting criteria.

9. CoRWM commissioned a number of short technical briefing papers to draw on existing scientific knowledge to provide information to assist in shortlisting the options, and asked the public and stakeholders for their views on the emerging shortlist.[8] Feedback from this consultation informed discussions that led to an agreed shortlist. Chapter 10 describes the shortlisting process.

Assessing the shortlisted options

10. CoRWM commissioned work to identify different methods that might be used to assess the shortlisted options, and co-opted specialists onto the working group that designed a bespoke methodology. To ensure that this proposed methodology had wide agreement, comments were invited, and feedback was used to optimise the process. Annex 4 provides more detail on how the assessment methodology was designed.

11. Using an innovative approach based on the Co-operative Discourse Model developed by Ortwin Renn[9], CoRWM undertook two separate processes to enable it to assess the shortlisted options: a Multi-Criteria Decision Analysis (MCDA) process and an holistic assessment process. The outputs from both of these processes were used to inform CoRWM's own option assessment deliberations as part of formulating its recommendations. For the MCDA process, CoRWM involved approximately 70 specialists in scoring the options against the criteria that had

been drawn up after consultation with the public and stakeholders. This included commissioning papers designed to give the specialists additional information they requested to assist them in their task. Members of the public and stakeholders were also involved in the assessment processes. For MCDA, they provided input into the weighting of the criteria and for the holistic assessment they gave their option preferences and supporting reasoning[10]. An opportunity to comment on the specialist scores was offered on the CoRWM website. Chapter 11 describes the assessment process in detail.

Implementation issues

12. In parallel with its options assessment process, CoRWM conducted substantial work on implementation issues, commissioning external expert analysis as well as using Committee expertise. This included a two-day implementation workshop for members. The detailed results of the implementation work are contained in the accompanying report[11] and the main conclusions are in Chapter 17.

Integration and drawing up recommendations

13. CoRWM needed to integrate all the inputs it had received from its many activities and deliberations in deciding on its recommendations. In this integration process CoRWM considered the outputs from the two methods of assessment, and took into account scientific, ethical and PSE opinions. Integration was itself a deliberative process and it led to the formulation of the recommendations. These draft recommendations were then put out for public and stakeholder comment (PSE4).

14. CoRWM reviewed all the comments received on its draft recommendations and submitted its final recommendations to Government on 31 July 2006.

References

1 Committee on Radioactive Waste Management, Minutes of 2nd Meeting, 8-9 December 2003 (CoRWM document 27). See CoRWM website http://www.corwm.org.uk/content-120

2 see, for example: Committee on Radioactive Waste Management, reports on meetings with Greenpeace, 5 March 2004 (CoRWM document 653), Ministry of Defence, 12 March 2004 (doc. 654), nuclear regulators, 26 March 2004 (doc. 655), and visit to UKAEA Dounreay, 30 June-2 July 2004 (doc. 666)

3 Faulkland Associates, "Evaluation of the Deliberative Mapping Pilot - A Report for CoRWM", document 586, August 2004

4 Hunt, J. "Review of Intensive Public and Stakeholder Engagement Methods", document 660, August 2004

5 Committee on Radioactive Waste Management, "Preliminary report on the Inventory", document 542, 2004

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9 Renn, O., "Analytic-deliberative Processes of Decision Making: Linking Expertise, Stakeholder Experience and Public Values" , document 847, 2004

10 See CoRWM website www.corwm.org.uk/content-986 for details of reports from citizens' and stakeholders' events

11 Committee on Radioactive Waste Management, "Moving forward: CoRWM's proposals for implementation", document 1703, July 2006.

Chapter 6 An ethical problem

Radioactive waste is an ethical issue and CoRWM placed ethics at the heart of its deliberations. Ethical concerns about responsibility for future generations influenced CoRWM's thinking on the choice between dealing with radioactive wastes now or leaving it for future decision. Ethical arguments were also important in defining ideas of participation, partnership and compensation that are the basis for the Committee's proposals for implementation. On the question of new build, a clear ethical distinction can be made between dealing with existing and unavoidable wastes and the creation of new wastes.

1. Ethics are sets of principles or standards concerned with behaviour and well-being. They act as a guide to what is acceptable or unacceptable, what we should do, what is right or wrong, good or bad. Ethics are about how we ought to act in contexts that have significant implications for human and non-human lives and well-being.

2. Radioactive waste is an ethical issue for several reasons. It is associated with nuclear energy, nuclear weapons, the dangers of proliferation and terrorism, all of which raise ethical concerns. Radioactivity impacts unevenly between places and across generations and raises ethical issues of fairness. It is also an ethical issue because its longevity and complexity place it in the realm of both science and values. In making option assessments it is necessary to combine both empirical and ethical knowledge, facts and values.

3. Ethical positions are informed by values and may be stated as principles. The ethical principles of primary concern to CoRWM are those embraced in two of its guiding principles (see Chapter 4). One is the principle of equity. Equity is a core value embedded in Guiding Principle 3, to achieve fairness with respect to procedures, communities and future generations. In choosing options, it is necessary to consider the implications and impacts of decisions for present and future generations. The other key principle is that of sustainability identified in Guiding Principle 4, to aim for a safe and sustainable environment both now and in the future. Concerns about equity, sustainability and safety are at the heart of deliberations about options.

4. CoRWM has therefore put considerable emphasis on the importance of ethics throughout its programme of work. Ethical concerns informed the criteria used in the shortlisting process. During the options assessment phase of the programme, stakeholders and citizens were invited to apply a set of ethical questions as part of their holistic assessment. The Multi Criteria Decision Analysis (MCDA) was a systematic assessment involving a specialist input in which value judgements also played a major part. It was recognised that ethical issues play a role in evaluating the importance of criteria such as safety, security, flexibility and burden on future generations (see Chapter 11).

5. As part of its preparatory work, the Committee held a two day workshop where members were able to engage in ethical deliberations with a panel of ethicists. The contributions of the panel and the discussions at the workshop are reported simultaneously with this Report.[1] The workshop was a significant input to the overall assessment performed by members which led to the strategy for long-term management of wastes that is proposed in this report. Ethical considerations have played a significant role in CoRWM's decision making, both on the best option for the management of radioactive waste, and also on how the option can be successfully implemented.

6. During the discussions at the workshop, some fundamental ethical principles were identified. These included the principles of well-being, of justice and of dignity. Well-being represents a utilitarian approach and emphasises the need to maximise good impacts and to minimise harmful ones. Justice is a distributional principle focussing on the norm of fairness in the distribution of burden. The principle of dignity relates to ideas of autonomy and acceptability to those affected by decisions. In this sense, it is related to the general principle of liberty which emphasises the freedom for people to pursue their lives as they choose. When applied to the problem of radioactive wastes, these principles sometimes reveal conflicting perspectives.

7. The way in which a given ethical principle is applied in practice will often depend on judgements from other branches of knowledge, including science. If, for example, the ethical principle of fairness between generations is prominent, what this means for option recommendations will depend heavily on scientific judgements about the degree of confidence in the long-term safety of geological disposal.

8. While ethics are important they do not provide a simple answer to the question, 'What is the best option?'. Rather, ethical considerations enable us to apply our values to the options and help us to justify our choice by appealing to our value position. It must be said that ethical judgement requires careful analysis and reasoning, not simple assertion or subjective impression.[1]

9. Ethics, then, are an integral aspect of decision making. Ethical considerations were prominent in developing CoRWM's thinking in three broad areas: environmental sustainability; intergenerational equity; and intra-generational equity.

Environmental sustainability

10. On the issue of environmental sustainability there are contrasting views. The most commonly articulated is the *anthropocentric* view which focusses on the environment as necessary for human well-being. The *ecocentric* viewpoint emphasises the intrinsic value of Nature in which humans are one species among many. It may be preferable to see these views in terms of a continuum rather than a dichotomy. However, they express different conceptions of sustainable development. Anthropocentric perspectives imply a version of sustainability stressing the efficient use of resources to support human needs and aspirations. Ecocentric views provide an interpretation which stresses the protection of environments and minimising impacts. There is a tendency to adopt an anthropocentric view when considering the impact of radioactive waste.

11. CoRWM's Guiding Principle 4 explicitly embraces 'the natural, as well as the human, environment' in its aim for sustainable development. The MCDA process identified impact on the environment as a separate criterion of assessment. During the public and stakeholder engagement process, environment was rated as one of the most important issues by Citizens' Panels, young people in the Schools Project and by the general public through the Discussion Guide (Chapter 7).

Intergenerational equity

12. Ethical concerns were a central matter in choosing the best option or options. Here the focus was on the broad area of intergenerational equity, more specifically on the question, 'How far should the present generation take responsibility for the impacts of its actions on the future?'. Two contrasting perspectives may be identified. One, expressed by a member of the ethics panel, is that 'responsibility has to extend to the reach of the impact of our actions'[1].

There is no justification for an arbitrary cut off point. An alternative view, which mixes the ethical and the pragmatic, is that we should exercise what responsibility we can whilst recognising that our capacity to do so necessarily will diminish over time. This perspective may also reflect a view that society has greater concern for the immediately following generations, in which it has both influence and interest, than for those in the far future over which it has much less control or concern. There is, thus, a contrast between the view of a continuing responsibility and that of a diminishing responsibility.

13. There are two broad alternatives for the long-term management of radioactive waste. They are, simply expressed, Deal with it Now, or Leave it until Later. These formed the basis of the Committee's ethical deliberations on its preferred options.

14. *Deal with it Now*. This position broadly reflects ethical considerations of justice arising from the belief that those who benefit should bear the burden. It emphasises the responsibility of the present generation to do what it can as soon as it can so that the transfer of burdens to following generations can be minimised. This position tends to favour geological disposal placing no reliance on the ability or willingness of future generations to deal with a problem created by the present.

15. *Leave it until Later*. By contrast, this approach emphasises the principle of liberty, providing the future with the freedom to make its own choices. This comes from a position which recognises both the rights of future generations as well as the responsibilities of the present. It is incumbent on the present to provide information and compensation to enable the future to take responsibility. This view tends to favour continuing storage options with the possibility of retrievability.

16. These contrasting ethical positions, where justice appears to conflict with liberty, were reflected in the conflict between minimising burden and increasing flexibility that became one of the most significant issues discriminating between options in the MCDA.

17. The choice between ethical perspectives and their related preference for storage or disposal is not necessarily straightforward. It must also be recognised that choices may contain elements of different ethical positions. For instance, the principle of liberty may impose burdens on succeeding generations while being concerned with ensuring justice to generations in the far future. By keeping wastes retrievable, the burden persists, but it leaves open the possibility of achieving greater confidence in the safety of disposal. The concept of phased disposal (delaying closure of the repository, see Chapter 15) represents, in effect, a way of trying to meet concerns about flexibility while also minimising burden.

18. Not surprisingly, the ethical panel argued from different ethical perspectives. There were those who favoured continuing storage on the grounds that radioactive waste should not be 'out of sight and out of mind'. It was important to maintain knowledge about potential dangers, to be able to develop new knowledge that would increase safety, to have access to potential resources and to protect future generations.

19. Phased disposal received strong support from the public and stakeholders with whom CoRWM engaged. This reflected the dilemma posed by conflicting ethical principles and the desire to keep options open for a few hundred years while providing a long term solution that reduces the burden on the present and near future generations.

20. By contrast, there is the view that we should dispose of the wastes as soon as practicable on the grounds that we cannot know what technological needs or powers may be available to our successors. The present generation should

remove the burden imposed by its actions from the future. This view ultimately prevailed among the Committee and the arguments are presented in the Overview and in Chapter 13.

Intra-generational equity

21. Ethical concerns were also an important element in the Committee's development of its proposals for implementation. The key principle here is intra-generational equity. In terms of radioactive waste, the problem is how to apply the principle to such issues as siting facilities, compensating communities and ensuring participation in decision making.

22. In terms of siting, radioactive waste facilities are necessarily unevenly distributed geographically. Intra-generational equity requires that actions should not impose an unfair or undue burden on individuals or groups within the current generation. There are different ethical considerations that are relevant in applying the broad principle to siting. Applied as a principle of justice, intra-generational equity might be interpreted in terms of: parity (sharing of the burden among places); proportionality (those who benefit take the burdens); responsibility (putting waste in places which already have it); and vulnerability (avoiding burdening such communities).

23. Viewed in terms of well-being, intra-generational equity suggests a utilitarian perspective, providing the greatest benefit to the largest number through, for example, siting facilities in areas of low population or through avoiding transportation of waste by leaving it where it is. Another approach might be to consider siting in terms of the principle of dignity, interpreted as locating facilities in those places where public acceptability can be achieved.

24. It is clearly not possible to satisfy all the possible ethical criteria that can be applied to siting. But, through its public and stakeholder engagement and in its own deliberations, CoRWM concluded that fairness in siting facilities could only be achieved by the enhancement of well-being and public acceptability based on a willingness to participate and a right to withdraw from a siting process. These principles are embodied in CoRWM's recommendations on implementation in Chapter 17 and in its report on Implementation.[2]

25. Once a community has expressed a willingness to participate, ethical issues of compensation arise. To an extent, compensation may be a condition of participation but it may be regarded as unethical to use it as an inducement. Such an approach may be seen as targeting the vulnerable. Rather, compensation should be a matter for negotiation and provided as recognition of a responsibility undertaken on behalf of society as a whole. Furthermore, compensation should not be seen in terms of financial reward, but in the broader context of regional development both now and in the future. These considerations led CoRWM to propose the establishment of partnerships between host communities and the implementing body and the provision of packages to ensure the social and economic well-being of the community.

26. Intra-generational equity also bears on the issue of participation in decision making. Here the ethical issues concern how communities are represented and who has the power to take decisions. Ethical concerns focus attention on the rights of communities to participate, on the need for broad participation and on the need for participation to be endorsed by the community. This raises the issue of how participation is made effective and how it relates to democratic decision making by elected representatives. These ethical and political considerations gave rise to much debate within CoRWM. The Committee affirmed the principle that key decisions must be ratified by appropriate democratically elected bodies. There

remained the issue of how host communities, as well as neighbouring and other communities affected by transport of radioactive waste, could secure effective representation. It is fair to say that this and other issues such as how communities are defined, how rights to withdraw are exercised and so on, have to be resolved. These issues of the relationship between participative and representative democracy are matters for further discussion during the implementation process.

New build

27. CoRWM's ethical concerns focussed on legacy wastes and those wastes within the inventory as defined in Chapter 2. During CoRWM's discussions the possibility of new build arose and led the Committee to consider the ethical concerns in relation to wastes arising from a programme of new nuclear power stations. It was suggested that an ethically sound solution for wastes arising from new build might be different from the option that might be ethically acceptable for the unavoidable wastes that were within CoRWM's remit. CoRWM subsequently issued a statement on new build (see Overview) which stressed the need for new build wastes to be separately considered. The ethical issues surrounding new build are discussed in the report of the Ethics Workshop.

Conclusion

28. Throughout its deliberations, including public and stakeholder engagement and the MCDA, ethics played a significant role in CoRWM's decision making. Ethics enable us to deepen awareness and understanding of issues and to explore what should be done and why. They form part of an overall assessment which seeks to integrate different forms of knowledge to reach conclusions that are founded in science, in values and in public trust and confidence.

References

1 Committee on Radioactive Waste Management, "Ethics and Decision-Making for Radioactive Waste", Workshop Report, document 1692, March 2006.

2 Committee on Radioactive Waste Management, "Moving forward: CoRWM's proposals for implementation", document 1703, July 2006.

Chapter 7 Involvement of citizens and stakeholders

The requirement to engage widely throughout its work was highlighted in CoRWM's terms of reference, and it was quickly identified as a critical strand of CoRWM's programme. The Committee used a suite of methods to engage with a wide range of members of the public and stakeholders (interested parties) to test and inform its thinking and decision-making at each stage of its programme, including its recommendations. As a result of this substantial engagement, CoRWM believes that its recommendations can inspire public confidence.

1. CoRWM's terms of reference clearly showed that public and stakeholder engagement, and the need to inspire public confidence, should be key elements of the Committee's work. While this would in no way eclipse the need for robust technical solutions, the way in which the terms of reference were couched showed that the Government recognises that radioactive waste is a social as well as a technical problem. This chapter shows how CoRWM involved the public and stakeholders throughout its programme to ensure the robustness of programme outcomes, as well as to lay the basis for inspiring public confidence in the final recommendations and how they were reached.

Terms of reference

2. CoRWM was required by its terms of reference to:

   - Engage members of the UK public, and provide them with opportunities to express their views
   - Provide opportunities for participation by key stakeholder groups with interests in radioactive waste management
   - Inspire public confidence in the way in which it works, in order to secure confidence in its eventual recommendations.

Approach

3. The Committee felt that a participative, inclusive, deliberative approach to public and stakeholder engagement was necessary. It believed that to develop its work in private for subsequent peer review by a limited number of consultees was not acceptable. CoRWM therefore opted for a substantial programme of engagement involving as wide a range of different views as possible, including intensive engagement with invited participants. Recognising the ubiquity of ethics and the need to inspire public confidence, the Committee believed that those with limited prior knowledge of radioactive waste issues would have an important role to play. It was also committed to adopting a deliberative approach whenever possible, to enable values and ideas to be explored openly and through wide-ranging dialogue between participants. Every effort was made not simply to consult, but to encourage debate and exchange of views, and to enable the public and stakeholders to participate in key stages of CoRWM's assessment and decision-making processes.

The role and nature of PSE

4. CoRWM needed to ensure that its PSE programme stimulated informed debate and feedback in order to inform decision-making at key stages within the programme. The aim was not to seek to persuade participants to reach a

particular point of view nor, at the other extreme, simply to adopt what people said. Where possible, participants were encouraged to be open-minded and to weigh evidence and arguments, as the process of engagement proceeded and at key points within the programme.

5. As this was such an important strand of its work, CoRWM allocated time and resources to investigating methods of public and stakeholder engagement that might fit its purpose. In particular, the Committee placed emphasis on types of PSE activity that would provide opportunity for deliberation.[1] The trialling of 'Deliberative Mapping' early in its work has been mentioned in Chapter 5, and is described in more detail in section 1 of Annex 4. Lessons from this trial enabled the Committee to feel confident that the types of activity undertaken in the Deliberative Mapping exercise would generate useful and informative feedback.[2] A comprehensive review of methods for engaging with the public and stakeholders was undertaken,[3] and examples of previous use of some of these methods were studied such as the radioactive waste management citizens' panel organised by UK CEED.[4]

6. The time and effort put into studying what methods were available allowed CoRWM to design a PSE programme that used a variety of different methods, and involved a wide range of people. Each phase of PSE was planned to meet the aims of that phase, and the resulting mix of activities was chosen to maintain a balance between engaging with members of the public and engaging with stakeholders who have a known interest in the issue. Balance was also required between national stakeholders and local nuclear site stakeholders from different parts of the UK, and between open access events and those which were by invitation only (see Table 7.1 for further details).

PSE engagement methods

7. CoRWM wished to engage at both national and local levels, and with those who held a wide range of expertise, knowledge and views. This included those with a technical knowledge of radioactive waste, such as the regulators and industry; those with no detailed technical knowledge but a remit to uphold the well-being of society such as local councillors; those with no public appointment but with an interest in the issue, either through living in the vicinity of a nuclear facility, or through membership of an environmental pressure group; and members of the public with no prior knowledge of, or 'stake' in, radioactive waste issues. The last category could be divided into two: a small number of citizens who would be engaged with more intensively by being given time to learn about the issue and deliberate on its various aspects, and a much larger number of citizens who would be asked for their views after a basic introduction to the issues. The former category will be referred to as the intensive strand, and the latter as the extensive strand.

8. Each PSE event was tailored to the level of knowledge and expertise of the participants as well as to the information that CoRWM needed for the particular phase of the programme. Much time and effort was then put into process design to enable participants to play to their strengths. While some groups were formed at the beginning of the programme and continued with the same method of engagement throughout, for example the National Stakeholder Forum, others such as the discussion groups, were used at different stages in the programme. This approach made it possible for significant improvements to be made in successive stages of PSE by building on the experience of earlier stages. To help design and run its PSE activities, CoRWM involved a range of specialists, including The Environment Council, The Centre for the Study of Environmental Change at Lancaster University, Dialogue by Design, Public Space Ltd and Wayne Talbot Associates.

Table 7.1

Activity	Participants	Main Aims
Discussion Groups	Eight groups of 8 recruited citizens at different locations across the UK.	To elicit basic views and concerns about radioactive waste management (PSE1).
Citizens' Panels	Four panels of 12-16 citizens met three times. The panels covered Scotland, Wales, North and South England. Citizens were recruited to ensure a mix of gender, age and social class, but to avoid people who work for the nuclear industry or belong to an anti-nuclear group.	To participate in shortlisting, options assessment and review of draft recommendations (PSE2, 3 and 4).
Discussion Guide	568 self-selecting groups from across the UK, including community groups, environmental groups, older people and schools	To discuss issues relevant to the assessment of shortlisted options and provide feedback (PSE3).
Schools Project	1305 students (aged 11-18) from 15 schools in Bedfordshire.	To identify and discuss the issues considered important to the assessment of options and provide feedback (PSE3).
National Stakeholder Forum	20-25 participants from national bodies, including Government Departments, Non-Departmental Public Bodies, the nuclear industry, the regulators, local government and campaigning groups. The NSF met four times.	To participate in shortlisting, options assessment and review of draft recommendations (PSE1, 2, 3 and 4).
Nuclear Site Stakeholder Round Tables	Meetings in eight locations for stakeholders from local organisations around a total of 14 nuclear sites (covering civil and military, public and private sector and different types of facilities). The RTs met three times, with a fourth round of events for nominees from each area.	To participate in shortlisting, options assessment and review of draft recommendations (PSE1, 2, 3 and 4).
Open Meetings	Two rounds of open meetings were held in eight areas close to nuclear sites.	To identify views and concerns about radioactive waste management, including shortlisting (PSE1 and 2).
'Bilateral' Meetings	A series of meetings between CoRWM members and representatives from stakeholder organisations.	To obtain information and discuss issues as appropriate to the aims of each period of PSE.
Consultation Documents	Various stakeholders and members of the public	To seek views on a formal consultation document over a three month period (PSE1 and 2).
Web-based	Various stakeholders and members of the public.	To provide opportunity for comment on consultation papers, specialist judgements of option performance, and draft recommendations (PSE1, 2, 3 and 4).

9. Thought was given to the number of events of each type, the representation of different viewpoints, and the numbers attending each event. Table 7.1 provides an overview of each type of event and the main aims of engagement.

The PSE programme

10. While few of the methods used by CoRWM were particularly innovative when considered alone, the combination of such a wide range of activities, involving both stakeholders and members of the public, across four periods of time, was distinctive and novel. The PSE periods were timed to provide the necessary input to allow the Committee to proceed with its programme.

11. Time pressures meant that it was not always possible to await the full results from engagement activities before starting to plan subsequent phases, but no decisions that were dependent on PSE feedback were ratified until full consideration had been given to the views expressed. The four phases of engagement were:

    - PSE 1 (November 2004 – January 2005)

      To seek views on the inventory of radioactive wastes and materials, a long list of long-term radioactive waste management options and the criteria that should be used to screen out options.

    - PSE 2 (April 2005 – June 2005)

      To seek views on the proposed shortlist of management options, the criteria that should be used to assess them, participatory processes for options assessment, and implementation issues.

    - PSE 3 (October 2005 – February 2006)

      To enable participation in the assessment of shortlisted options, including the expression of views on the importance of different criteria, on specialist judgements of option performance ('scores'), and preferences for long-term management options.

    - PSE4 (May 2006)

      To seek comments on CoRWM's draft recommendations, including proposals on how they should be implemented, and ways of increasing public confidence.

12. Dividing the PSE programme into successive stages had many advantages. It provided an opportunity to deliberate on feedback so that decisions on substantive issues, and on programme design, were informed by public and stakeholder views. It also enabled the Committee to apply learning about processes of engagement to subsequent PSE activities. Participants were able to weigh evidence and arguments through a sustained programme of engagement, and there was no doubt that it helped to build confidence and trust among participants.

13. These activities produced significant feedback to inform CoRWM's programme at critical stages. CoRWM members did not just rely on the reports of the events, but placed great importance on attending PSE events so that they could hear for themselves the views and arguments that were being expressed.

Involvement of stakeholders

14. CoRWM used tried and tested methods of engaging with stakeholders, and put a great deal of thought into the breadth and depth of participation required. It saw the National Stakeholder Forum as a sounding board consisting of all the major sectors with an interest in the issue at a national level. These sectors were UK Government and the devolved administrations, non-departmental public bodies, regulators, the nuclear industry, and non-governmental organisations. The Committee recognised that representatives from many of those sectors at a local level would bring a different perspective, and that there were also other sectors that should be included at that level. These additional sectors were community representatives and local Government.

15. Time and resources did not allow stakeholders from all nuclear sites to be included, so the programme of local nuclear site round tables was based on events held at eight locations which were judged to maximise the number of sites represented (14) and covered civil and military, public and private, and different types of facility. Many of the earlier discussions at these events utilised mixed stakeholder groups (mixing the sectors) giving the benefit of cross-fertilisation of views and ideas. When specific sector views were required, break-out groups were formed by sector. By giving careful consideration to the input that CoRWM needed at each stage, stakeholder events were designed to maximise the value of bringing together a good cross section of stakeholders from a range of sites.

Involvement of citizens

16. During the first period of PSE (PSE1), CoRWM was interested in the general values that people with limited prior knowledge of radioactive waste applied to the problem. It therefore organised a series of discussion groups. A recruitment firm was contracted to recruit 64 citizens, from various parts of the UK, with a good mix of age, gender and social class. Eight groups of eight citizens were asked to discuss, in two meetings each of two hours, their general views and thoughts about what was important when considering radioactive waste, having been sent a leaflet about the issue, and been given some basic facts during the discussion. A particular aim was to assess how citizens might be involved in later stages of the programme.

17. Many of the discussion group participants had barely heard of radioactive waste before. Yet by the end of the second session they were commenting on CoRWM's long list of options, and the criteria by which they should be assessed. Most said that they would have liked more information, particularly technical information, and that they would be happy to remain involved in the CoRWM process. While this did not prove possible, the major lesson that had been learned in the Deliberative Mapping trial, that citizens are well able to engage in radioactive waste issues, was reinforced. A theme that was to continue throughout the CoRWM PSE process was that the discussions had been stimulating and informative, and that CoRWM should recommend more education on the issue in schools as well as measures to increase public awareness.

18. During PSE1, a series of Open Meetings was also held near existing nuclear sites around the country. These were aimed at citizens living close to nuclear sites who were not invited to stakeholder events, but who, CoRWM believed, would wish to have an input into the Committee's deliberations. A second round of Open Meetings at the same locations was held in PSE2. While much of the time in these meetings was spent answering questions, CoRWM members obtained useful information on the views of people living with the reality of nuclear activity close to their homes.

19. Largely as a result of what was learned in both the Deliberative Mapping trial, and in PSE1, CoRWM put in place plans to involve citizens in the substantive options assessment phase of its work. There was a desire to elicit two main types of view: what citizens feel once they have developed a reasonable level of understanding of the issues and had time to deliberate on them, and how citizens respond when just provided with basic information and a relatively short time to discuss the issues. There was also recognition of the very long term nature of radioactive waste, and its potential impact on future generations. The Committee was therefore interested in the views of the younger generation, in particular whether their values and ethical stance differed from those of their parents and grandparents.

20. The main method of intensive engagement with citizens was through Citizens' Panels. Four panels each of between 12 and 16 citizens of mixed age, gender and social class were recruited, one each in Scotland and Wales, and one each in the north and south of England. The Committee was advised that although this could not be claimed to be representative in the statistical sense, the numbers and geographical spread were sufficient to provide a good understanding of the range of views that would exist among the general public. While much of the first round of panels necessarily involved briefing and initial discussions about radioactive waste, CoRWM was also seeking views on what people felt was important when considering a difficult socio-technical issue. This included the elicitation of criteria that the citizens felt that CoRWM should use when assessing its options. The second round of panels included an opportunity for the participants to question specialists about technical and ethical aspects. For each panel CoRWM recruited four or five specialists representing a range of views on the issues being put to the panels, and citizens heard short presentations and questioned the specialists intensively over the course of a day. Several of the specialists commented on the high quality of the debate. The citizens then participated in elements of the assessment process itself. They engaged in substantive deliberation, and the quality of the discussions and output was high. This was particularly noticeable in the third round of panels when participants were asked to discuss some of the more difficult ethical issues in the context of technical solutions.

21. The intensive form of engagement with young people was in the form of a project run in 15 schools in Bedfordshire during PSE3. Participants were initially taught the basics of the issue, and were asked to research the answer to some questions. Having fed back what they learned, they then devised a method of consulting their peers on the relative importance of CoRWM's criteria for assessing waste management options. This involved a much wider group of students, allowing over 1300 young people to provide their views. The penultimate stage was an assessment by the original participants of the relative importance of the criteria. Members from all 15 schools then had the opportunity to report their findings at a combined conference during which CoRWM members led discussions on particular issues. Again, the quality of the discussion was high, and the ability of the young people to provide a top level view on which waste management option they favoured, and to justify that view, was impressive.

22. The extensive engagement with citizens and young people was primarily based on use of a Discussion Guide in PSE3.[5] The aim was to enable many more people to discuss the issue, and provide their views to CoRWM. The discussion guide consisted of basic information about the radioactive waste issue in a readily usable form along with some simple questions to prompt and guide the discussion. The main topics for discussion were the relative importance of CoRWM's assessment criteria, views on ethical issues, and an opportunity to provide a view on their preferred long term management option. The guide was given as much publicity as possible, inviting already formed groups of people such as local environmental groups, church groups, and women's institutes, to spend an hour or so discussing the issues and answering the questions. The feedback from the 568

groups who provided a response was analysed, and a website was set up for participants to see the results. A significant number of those who participated were school groups, the results of which were analysed separately to give the views of young people.

23. In addition to these activities, in both PSE1 and PSE2, CoRWM put together a formal consultation document[6] supported by information leaflets laying out the background and asking specific questions. These were available on the CoRWM website, with the facility in PSE2 for an electronic response. They were also sent to between 4000 and 5000 people who had previously expressed an interest in radioactive waste to Defra. Responses were received from a wide range of stakeholders and members of the public, and were analysed in 'written and website' response reports.

24. CoRWM has been asked how people with little or no knowledge about radioactive waste issues can provide input into such a complex technical issue. It is worth reiterating that great care was taken to involve each group of participants in ways that were appropriate. The level of question, and the topics, were carefully chosen so that meaningful and useful responses were received. People were asked specific questions that involved them using their existing experience, knowledge and values to make judgements within their competence, and the resulting data were used in appropriate ways.

How the PSE process influenced CoRWM's decisions and recommendations

25. CoRWM members are clear that the public and stakeholders have had a very significant influence on their work from the time of the first consultation (PSE1) to the formulation of the recommendations (PSE4). A vast amount of feedback has been analysed, and each period of PSE has been formally reported, with all reports published on CoRWM's website.[7] It is impossible to reflect all the ways in which CoRWM took people's views into account, but the following gives a brief outline of the main ways in which CoRWM's decisions and recommendations have been influenced by PSE.

The Inventory

26. The feedback from PSE1 on CoRWM's draft inventory report[8] was used to inform the development of a revised report[9] In response to comments, the new version contained, for example, more information on the suitability of some ILW waste streams for near surface disposal and a wider range of scenarios exploring the impact of different energy futures. Even at this early stage, and continuing throughout CoRWM's engagement process, some participants encouraged CoRWM to address the issue of new nuclear power, and also whether plutonium, uranium and spent fuel should be declared as waste, both issues that strictly lie outside CoRWM's remit. Later chapters show how the Committee has responded to these requests.

The long list of options

27. The main messages from PSE1 were that CoRWM's proposed long-list included all the main categories of options and that they were sufficiently characterised.[10] CoRWM concluded that suggestions for specific examples and variants could be accommodated within its future assessment of short-listed options.[11] It also clarified the meaning of 'indefinite storage', which it renamed 'storage forever'. PSE1 participants also pointed out that some options on the list – for example incineration, melting, and use in reactors – should be seen as processes rather than end points. As a result, these sorts of options were not carried forward on to CoRWM's shortlist of options. While there were a few respondents who felt that

CoRWM had included too many 'unlikely' options on its long list, the majority supported the need for a thorough, root and branch, review.

Screening criteria

28. During PSE1 CoRWM's proposed screening criteria were broadly supported, but some were criticised for lack of precision.[12] A small number of additional criteria were proposed. CoRWM's response was to provide improved definitions of the criteria and to add a tenth criterion about whether an option should be implemented abroad if it were feasible to implement it in the UK.[13] It also decided to take comments about other potential criteria into account in developing criteria for use in assessment of short-listed options.

The shortlist

29. The feedback from PSE2 showed that there was widespread support among participants for the proposed shortlist, in the sense that it contained those options that should be carried forward for detailed assessment.[14] A range of comments and suggestions was also made on potential additions and deletions from the list, on potential 'watching brief' options, and on the options themselves. CoRWM reviewed these comments when finalising its short-list.[15] As a result of PSE2, the Committee was able to take decisions on the shortlist, confident that it had not excluded any options that had widespread support. It also indicated that it would return to the issue of 'watching brief' options in its final recommendations (see recommendation 5 on research and development in Chapter 14). Further details on the shortlisting process can be found in Chapter 10.

Assessment criteria

30. In PSE2 CoRWM asked for comments on the criteria that it proposed to use to assess the shortlisted options.[16] The feedback showed that there was broad support for the proposed assessment criteria.[17] There were however a large number of comments, including suggestions for additional criteria and ways of applying criteria. These comments were taken into account as CoRWM developed its thinking on the criteria and sub-criteria that would be used in options assessment[18] (see Section 2 of Annex 4).

Participatory processes for options assessment

31. CoRWM's proposals for options assessment and the ways in which people might be involved were also discussed in PSE2. Some reservations were expressed about MCDA, but the method also received significant support. There was strong support for the use of a second assessment method running in parallel to the MCDA. The principle of participation was embraced enthusiastically by the majority of participants,[19] with those involved in nuclear site round tables being particularly keen to meet again and for longer if possible. Citizens' Panel participants also felt strongly that they had an important role to play and should have an ongoing involvement throughout the process. They specifically asked to be given access to specialists before any involvement in the assessment process. Almost the whole of the first day of the second panel was therefore devoted to interaction with specialists. Participants in events, and respondents to the consultation document, provided suggestions on broadening public participation, placing particular emphasis on the need to engage with young people which was already being planned. Some also requested the opportunity for a formal organisational response which was provided through bilateral meetings and written submissions. There was widespread agreement that the options assessment process must be conducted in an open and transparent way, which led CoRWM to conduct its MCDA in public. These, and many other comments,

helped shape CoRWM's planning for options assessment,[20] and the process that was ultimately used is outlined in Chapter 11.

Ethical issues

32. Discussion of the ethical issues associated with the management of radioactive wastes was an important component of activities in PSE2 and PSE3, but they inevitably pervaded all phases of PSE. During PSE2 a series of ethical questions were posed to stimulate discussion.[21] The feedback from this discussion [22] helped inform CoRWM's workshop on ethics.[23] The output from the workshop was then fed into CoRWM's options assessment.[24] During PSE3, ethical issues were inherent in making judgements on the importance of criteria, and were a specific element for discussion in some events. CoRWM members paid particular attention to the ethical positions held by participants, and observed how those values influenced their thinking and judgements. The way in which CoRWM tackled ethical issues is described in Chapter 6.

Implementation issues

33. Discussion about the issues involved in implementing long-term management options was also started in PSE2.[25] The findings from these discussions[26] were used to inform the preparation of a paper for CoRWM's workshop on implementation issues. The output from this workshop[27] provided the basis for CoRWM's recommendations on implementation issues. The public, members of existing partnerships, regulatory authorities and many other organisations such as local authorities, trade unions, community councils and NGOs have played a key role in shaping how CoRWM's recommendations could be implemented. Details of their contributions are contained in outline in Chapter 17, and in more detail in the accompanying Implementation Report.

Criteria weighting

34. A major part of PSE3 focussed on enabling participants to express views on the relative importance of the different assessment criteria. Five types of PSE activity generated criteria weights - use of the Discussion Guide, the Schools Project, the Citizens' Panels, the Nuclear Site Stakeholder Round Tables and the National Stakeholder Forum. The findings were collated and summarised for use in CoRWM's MCDA,[28]. The report of CoRWM's MCDA explains how the findings were used in sensitivity testing,[29] and section 5 of Annex 4 gives a brief outline. The results from the Citizens' Panels, Discussion Guide and Schools Project showed a remarkable amount of broad consistency, although it was noticeable that the latter two placed lower importance on 'burden on future generations' and 'flexibility'. This may have been because they had less opportunity to deliberate on these issues; an example, perhaps, of the value of intensive engagement and deliberation. There was more variation in weights from the stakeholder meetings due to the various sectors represented at each event, but it was possible to detect trends within each sector. CoRWM members used these outputs in two ways. First, to inform their own judgements as they undertook the weighting of criteria in the MCDA, and second, to investigate the impact of varying the weights on the model outputs in sensitivity testing. The feedback from PSE was used to identify the outer limits of variation of those weights. Further details can be found in Chapter 11.

Specialist judgements of option performance

35. PSE3 provided opportunity for participants to comment on the scores that specialists had given to the options against the criteria. While many of these scores were based on a high level of technical knowledge, some also involved

ethical judgements. These comments were made at stakeholder events and through a web-based opportunity to comment. A relatively small number of specific changed values for scores was suggested, but from the comments received it was possible to make a judgement on an appropriate revised score. These revised scores were then used to conduct specific sensitivity tests on the scores[30] during the MCDA.[31]

Preferences for long-term management options

36. Participants in PSE3 were also encouraged to express views on which of CoRWM's shortlisted management options they preferred. There was a desire from stakeholders to establish a policy on long-term management as soon as possible, but there was divergence between the majority who felt that this meant geological disposal and a smaller number who preferred continued storage. The Citizens' Panels made their assessment after a discussion on the ethical dimensions of the issue,[32] clearly favouring forms of geological disposal. The Schools Project delivered an almost unanimous vote for geological disposal, which was also favoured by a large majority of those using the discussion guide. The findings from the Panels, and from other PSE3 activities, were collated into an overview report[33] that was then used by Committee members when they conducted their own holistic assessment.[34]

Draft recommendations (PSE4)

37. The main purpose of the fourth round of public and stakeholder engagement was to seek views on CoRWM's draft recommendations, and how public confidence might be increased. Although limited time was available, the NSF held its fourth meeting, the nuclear site round tables sent participants to combined meetings in either London or Glasgow, participants from the Citizens' Panels met in London and Glasgow, a number of bilateral meetings were held, and around 100 responses were received via the website. The great majority of participants and respondents were very supportive of the draft recommendations.

Conclusion

38. It is not possible for everyone in the country to be involved in an engagement process, nor would they wish to be. Within the time and resource constraints under which CoRWM operated, the large number (5000 or so) of people who have been involved is indicative of the efforts made to develop a substantive public and stakeholder programme. Many PSE participant and specialists have commended CoRWM for its attempts to be as inclusive of all views and opinions as possible.

39. CoRWM has listened to what the public and stakeholders have said, has discussed the implications in open plenary meetings, and has sought to explain the basis for its subsequent decisions. The fundamental role of the public and stakeholders in the four periods of PSE has been to help shape the formulation of CoRWM's recommendations by influencing both CoRWM's programme and its assessment process. A key feature has been the attempt to integrate the views of the public with the views of those having specialist knowledge. The mutual learning that this has provided has done a great deal to build confidence in CoRWM's recommendations.

40. Based on its direct experience of engaging with the public and stakeholders, CoRWM believes that its recommendations can inspire public confidence.

'CoRWM's PSE programme is the most elaborate and extensive to have been carried out for this kind of policy issue ... Overall, CoRWM has attempted to adopt a highly reflective approach to its task, scrutinizing its own assumptions and methods to an extent that contrasts markedly with the technocratic approach taken in the past.'[35]

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Chapter 8 CoRWM and science

CoRWM recognised from the outset that its recommendations have to be scientifically and technically robust if they are to withstand challenge during implementation. The science strategy adopted was to use the best available scientific knowledge at appropriate stages of the CoRWM process.

The science strategy

1. CoRWM was deliberately established with a broadly based membership to consider a range of issues, including scientific, technical, ethical, legal, economic, and social ones. It was not set up as a traditional scientific committee. While several CoRWM members have relevant scientific expertise, the Committee always recognised that it essentially had an oversight role and would need to bring in relevant expert knowledge, as and when required.

2. There was insufficient time in the programme to commission new original research. It was decided that if unresolved scientific issues remained, any need for new research could be included in the recommendations of the Committee. The process of implementation will in any event require active research and development and the site evaluation stage will need much detailed scientific work.

3. The basic premise was to use the best available existing scientific knowledge. This was drawn together, firstly through literature review, in a series of documents at various stages of the programme by a number of specialist consultants. A 'peer review' panel from academia, industry and the regulators was established to assist with the technical review of documents and work packages. The quality of the papers was variable, but the Committee had access to peer review comments to assist in their judgements. For the later stages in the CoRWM programme, particularly the option assessment phase, CoRWM established panels of scientific specialists to bring together the latest relevant scientific opinion. Each person was appointed for their individual knowledge and expertise in the disciplines relevant to CoRWM's assessment criteria.

4. In the early stages of CoRWM's work, the main focus was on developing an inclusive and innovative public and stakeholder engagement programme. CoRWM was always clear that science was going to play a key role in its work, but this was not fully articulated in these early stages. This led to some criticism[1] which the Committee subsequently sought to address. The early scientific input to CoRWM related mainly to the inventory and this is detailed in Chapter 2. A more substantial input came in support of the shortlisting process and helped justify the selection of the management options taken forward for full assessment. The bulk of the scientific input came in respect of the option assessment processes and in particular the specialist judgement of option performance for the MCDA. At each stage of CoRWM's work, the level of detail entered into was designed to be sufficient for the task in hand. Sporadic criticisms as to the comprehensiveness of the scientific programme continued but following a subsequent joint meeting of the House of Lords Science and Technology Committee and the House of Commons Environment Food and Rural Affairs (EFRA) Select Committee, the House of Lords was encouraged by CoRWM's emphasis on scientific and technological input.[2]

5. In order to ensure the scientific strategy was sufficient, Defra's Chief Scientific Advisor, Professor Howard Dalton FRS, set up a specialist panel to advise him. Members of this panel have advised CoRWM on the quality assurance and peer review processes, and the membership and scope of the specialist panels.

6. Since science would play a vital role at several stages of the programme if the recommendations were to gain public and stakeholder confidence, CoRWM instigated, through its Information Working Group, a process to gather and assess information early on in its programme. This drew on the considerable amount of international and UK research into the long term management of radioactive waste that has been conducted for many years. The Working Group also considered previous work commissioned by Defra[3] to identify the status of information on radioactive waste management and then commissioned work by external specialists to fill any gaps identified.

Initial review of the science of radioactive waste management

7. The position with respect to the science of underground radioactive waste disposal to the end of the 1990s appears in the review of the Parliamentary Office of Science and Technology in 1997.[4] In particular this considered the uncertainties in the science that contributed to the failure of the Nirex RCF planning application.

8. The review outlined previous work of the Royal Society[5] involving analysis of the science involved in repository (post closure) performance assessment. Such assessments cover characterising the rocks and geological regions around a repository (the geosphere); modelling chemical changes during radioactive decay; modelling of radionuclide transfer to the geosphere; modelling radionuclide movements into the wider geological environment; and understanding the behaviour of radionuclides in the biosphere (in the soils, seas, rivers, atmosphere, etc) and thus their impact on man.

9. The POST report also discussed uncertainties relating both to the inherent unpredictability of future events and the mathematical modelling of the various transfer processes listed above.

10. Despite the uncertainties, the Nuclear Energy Agency (NEA), the agency of the Organisation for Economic Cooperation and Development (OECD) responsible for promoting nuclear energy, stated that 'there is a high level of confidence among the scientific and technical community engaged in waste disposal that geological disposal is technically safe'.[6] However, it also noted that 'the common perception amongst the public that there is a strong body of technical opinion challenging the feasibility of safe disposal does not reflect the reality of the debate. The number of sceptics is relatively small in the broader technical community, whereas there is a wide consensus of the safety and benefits of geologic disposal within the technical community of waste management experts.[6]

11. The NEA also expressed the view that there had been significant progress in relevant scientific understanding and in the technology required for geological disposal in the ten years up to 1999.[7] This included a deeper scientific understanding of the processes which determine the effectiveness of repositories in isolating the waste over long periods; improved characterisation and quantitative evaluation of the ways in which the engineered barriers and surrounding rock contribute to safety; and also experience with practical aspects of underground engineering and implementation.

Information on the inventory

12. In the identification of potential wastes in the early stages of the programme, the Committee drew on the scientific and technical expertise of waste producers, managers, regulators and environmental groups. The robustness of their data and conclusions was tested, among other ways, by seeking comments from other specialists and organisations (see Chapter 2).

Shortlisting process

13. The short-listing process involved the critical review of the long list of options. As part of this review CoRWM commissioned summary technical briefing papers to bring the committee up to date with recent developments affecting the range of options potentially available, including some of the more unconventional options, such as disposal in space and in ice sheets[8 9]. In particular the papers considered the findings of recent safety assessments in the UK[10] and in overseas countries developing forms of geological disposal – Sweden,[11 12] Finland,[13] Switzerland[14 15] and France,[16] as well as other programmes[17 18 19] and the uncertainties associated with the science.[20 21]

14. CoRWM also reviewed other UK and international knowledge and experience of the long list of options. In-depth science was not required at this stage, only sufficient information to discriminate between options and eliminate non-viable ones. Time constraints prevented the pursuit of a conventional scientific 'peer review' process in this stage of work but the extensive feedback CoRWM members received on the scientific work showed it to be fit for purpose. At the end of the short-listing process, experts, stakeholders and the public agreed, with very few exceptions, that the CoRWM shortlist was appropriate and reasonable.

The specialist panels

15. As reported in Chapter 11 the options assessment process involved evaluating the performance of the various shortlisted options against 27 different performance criteria. Many of these assessments required robust scientific and technical judgments to be made, for example on worker and public radiation exposure, security issues and environmental performance.

16. CoRWM established seven specialist (or expert) panels appropriate to the disciplines required by the assessment criteria. Advice on the composition of the panels was provided, among others, by eminent independent academics on CoRWM's Quality Assurance group and the Defra Chief Scientific Advisor's panel. Around 70 specialists were involved and they gave appropriate, effective representation across disciplines. As an example, the health and safety panel included expertise at internationally recognised senior academic level on radiation effects, health and safety, radiation protection, regulation, engineering, geology, geochemistry, hydrogeology and transport. Efforts to involve scientists from the environmental groups – particularly in the 'safety' area - were hampered by limited availability of the comparatively small number of experts the NGOs have to field. However, some of the independent specialists who had carried out work for the environmental groups in the past offered a critical perspective during the panel sessions.

17. The specialists met initially to develop performance scoring schemes and determine any outstanding information needs. Work was commissioned to provide the necessary information and briefing papers were written to support the scoring workshops. The allocation of option scores against criteria was typically undertaken in open forum where the specialists' judgements were discussed in front of approximately 10 other specialists, CoRWM Members and scientific observers and consensus sought.[22] Members of Professor Dalton's panel attended many of the workshop sessions.

18. As background material for the initial specialist workshops on safety, two papers were commissioned, one from IDM[23] and the other from Enviros.[24] These included reviews of the safety of geological disposal[25] and highlighted areas of disputed knowledge including the debate on dose-risk relationships.[23]

Other events reviewing the safety of geological disposal

19. CoRWM also invited individual specialists to attend Plenary workshops[26] at which critically important areas of the long term safety of geological disposal and the issues associated with storage were discussed. These debates provided important information when CoRWM evaluated its options through the holistic assessment method and integrated the knowledge from other areas of work.

The Royal Society

20. The Committee has benefited from support from the Royal Society, during its work. The Royal Society hosted a meeting on 7 November 2005 chaired by Professor Geoffrey Boulton, FRS (an independent member of CoRWM's QA group). Fellows, whose expertise ranged across science and engineering, discussed key issues relating to CoRWM's use of science and the shortlisted options. Their advice was taken into account in the later stages of the specialist workshops and in planning the later engagement with the scientific community. In particular, the Committee invited comment on the performance scoring results from the scientific and engineering community and others, to test the results of the scoring process, and several hundred people and organisations responded (see Chapter 11).

21. The Royal Society in the report of the seminar in November 2005 made the following recommendation to CoRWM: 'The confidence that could be placed in geological disposal in UK sites has been understated. A criterion for site selection should be the capacity to demonstrate, from geological evidence, the stability and integrity of the site over a past timescale significantly greater than the required isolation periods of wastes to be disposed'.[27]

22. It based this statement on the observation that 'The geological structure of many parts of Britain has been stable for very long periods of geological time and is likely to remain so into the distant future. Seismic events, and chemical, mechanical and physical changes on the Earth's surface are attenuated at greater depths. They pose a greater risk to surface stores than to deep repositories. Many deep geological environments are extremely stable with regard to surface climate change - the most likely cause of environmental instability in the UK over a timescale of tens to hundreds of thousands of years. Studies have identified sedimentary rocks whose internal physio-chemical conditions have been stable for many millions of years. Wastes emplaced in such formations would remain undisturbed over these time periods into the future and the hydro-chemical processes that could lead to radionuclides being mobilised through them take place at extremely slow rates, such that it would take millions of years to move into surrounding rock formations. The movement of groundwater is potentially an important means of transporting radionuclides towards the surface. However, the use of geochemical tracers makes it possible to reconstruct the history of past groundwater movement, or lack of it, and can provide a powerful baseline for forecasting its behaviour in the future'.

The Geological Society

23. In 1999 The Geological Society gave its verdict that 'only deep geological disposal can provide a long-term, safe and sustainable solution for radioactive waste' in a statement following a joint meeting of the Geological Society and British Geological Survey in 1999.[28]

24. The Geological Society hosted an international meeting on radioactive waste management on 9 January 2006 'Geosciences and the Long-term Management of Radioactive Waste', and this came essentially to the same conclusion. In

particular a paper by Chapman and Curtis[29] at that meeting took as a major theme the aim of the containment system to prevent the return of radioactivity until such a time that radioactive decay has reduced the activity to a similar level to that which exists naturally in the environment (a 'back to nature cross-over time'). It suggested, for example, that in respect of spent fuel (which contains some very long-lived radionuclides), around 300,000 years would have to pass until radioactive decay would be sufficient for the activity of the fuel to return to that of the natural uranium ore from which it was originally produced. At that point in the future, the hazard posed would be broadly similar to that from natural uranium. High level waste, from which uranium and plutonium has been removed, has less contribution from long lived radionuclides in the far future, so the 'back to nature' time is reduced from a few hundred thousand years to a few thousand.

25. Participants at the meeting noted how relatively little account has been taken of data from natural analogues, for example the near-surface uranium deposit at Cigar Lake in Canada and that at Oklo in Gabon. In the very long geological past, the latter site (often called a "natural nuclear reactor") appears to have experienced a natural thermal critical event. The resulting fission products and the existing uranium nuclides only migrated a few tens of metres through the surrounding rock in 2000 million years.[30]

Other Views on the Science of Radioactive Waste Disposal

26. The House of Lords Select Committee on Science and Technology took evidence from regulators, nuclear industry, and environmental groups[31]. Their Lordships found that the majority view from the scientific and technical community was that wastes should be emplaced in deep geological repositories. They also noted that the Radioactive Waste Management Advisory Committee[32] (RWMAC) advised Government to reaffirm a policy of deep disposal. The minority view, held particularly by members of environmental groups, is that wastes should be stored on or near the ground surface indefinitely, while a research and development programme is conducted to find the best means to manage them in the longer term.

27. The responses to CoRWM's stakeholder engagement show the general position to be unchanged.[33] The Environment Agency welcomed "the central recommendation from CoRWM that geological disposal of long-lived radioactive waste is the best available approach. We believe this is a sustainable solution to the long term management of the waste".[33] The Scottish Environment Protection Agency (SEPA), which possesses similar statutory powers, indicated the recommendations provided a clear basis from which the Government would be able to update policy on higher activity waste.[33]

28. A response to PSE4 from the Health Protection Agency stated: ' ...any disposal of radioactive waste should meet the radiation protection criteria of optimising exposures below the relevant dose and risk criteria. HPA considers that CoRWM's choice of geological disposal as the long term management option could be implemented to satisfy these radiation protection criteria.[33]

29. The environmental groups take a different position. For example, Greenpeace considers that 'deep disposal is not a solution for the UK's nuclear waste because leaking radioactive wastes from a deep nuclear waste dump will inevitably contaminate the environment and pose a persistent, irreversible threat to future generations. The overwhelming weight of evidence is that this threat is poorly predictable, impossible to assess with current scientific understanding and likely to remain so for an indefinite period, despite many decades of expensive scientific research.[34]

Review of use of science

30. CoRWM invited a number of senior external scientists and engineers, including members of Professor Dalton's panel, to a one-day meeting to review CoRWM's use of science. The review was conducted on a non-attributable basis and although a full note was taken, this is not a public document. A short summary note[35] is available. The conclusion was that the work carried out by CoRWM appeared to be fit for the purpose of the recommendations and the accompanying Report.

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Chapter 9 Learning from overseas

International experience has played a major role in developing CoRWM's understanding of the options, the method used to assess them, and CoRWM's recommendations on implementing policy.

Understanding the options

1. It became apparent early on that all countries with a nuclear power programme that have made decisions about long term management of radioactive waste have adopted a strategy of interim storage followed by geological disposal, although the Netherlands has decided to postpone disposal for at least 100 years.[1] Recently, both Canada and France have adopted a policy of interim storage followed by geological disposal.[2]

2. CoRWM's terms of reference required a review of options for managing solid radioactive waste in the UK, starting effectively with a blank sheet of paper. In order to assess the shortlisted options against specific criteria, as described in Chapter 11, examples of each generic option had to be considered.[3] Nirex has been developing repository concepts for ILW for several decades, but nearly all the development of concepts for the disposal of HLW and spent fuel has been done overseas. The Swedish concept for the disposal of spent fuel was chosen to be the main example, because development work has been carried out for several decades and it is the concept that is likely to be operational first. When considering details, such as the ease with which the waste can be retrieved, other concepts were also considered, such as the Cavern Retrievable (CARE) concept (see Chapter 15 and report of specialist workshops[4]). This concept is being developed in Japan.

3. When considering the options for the management of short-lived ILW from nuclear reactors, one option was the shallow cavern design that has been constructed in Sweden and at both the reactor sites in Finland.

4. The options for central storage of the waste were based on the concept of the long-term national store that has been built in the Netherlands and on the national interim store for spent fuel in Sweden. For the detailed assessment, the base case was the modern store for spent fuel at Cadarache in France.

5. All members had the opportunity to visit Sweden and Finland to gain first-hand knowledge of the progress in disposing of spent nuclear fuel, the central facility for the storage of fuel and the repositories for reactor waste and the process that was used to implement a repository for spent fuel in these countries.[5] Some members have also visited the repositories for long-lived waste at Gorleben and Konrad in Germany and the proposed site at Bure in France, the repositories for short-lived waste at Cap de la Hague in France and El Cabril in Spain and the national store in the Netherlands. This information was fed into various plenary meetings to inform members.[6]

Assessing the options

6. A major input into the assessment of the options was how other countries had developed their strategies[1]. Some members had previously carried out research in this area and use was made of the considerable amount of literature that is available, such as the European Commission COMPAS project, which reviews the bases for the strategies that have been adopted in the European Union.[7] Members

have also attended the OECD Nuclear Energy Agency sponsored group of 'Chairs of National Advisory Bodies to Government', on which the overseeing bodies for France, Germany, Japan, Sweden, Switzerland and the USA are represented. Overall, this experience influenced the development of the original long list of options, the criteria that were used for shortlisting as well as the detailed evaluation of the shortlisted options.

7. The method that was used to assess the shortlisted options (see Chapter 11) was developed as a result of a review of experience worldwide and the one that was used was developed from the Co-operative Discourse Model.[8] The selection of the method to evaluate the options against individual criteria was done in consultation with experts from Germany and Canada,[9] where a major evaluation of options for the management of spent fuel was completed in 2005.[10] The Committee has had several meetings with the Nuclear Waste Management Organization of Canada, which performed this review. This Canadian experience informed CoRWM's approach to assessing the options and the principles that should be adopted when the recommendations are implemented.

8. The factors that influenced the development of strategies overseas were taken into account in developing the criteria against which the shortlisted options were assessed.

9. Many of the specialists who assessed the technical performance of the options have considerable experience in working on the long-term waste management of waste in Japan, the USA and several European countries, and several travelled to the UK to participate. The French research into disposal and storage over the last 15 years has been an important source of information.[11] A member of the Dutch Environment Ministry with responsibility for radioactive waste explained, at a plenary meeting, the reasons why the Netherlands has adopted a strategy of delayed implementation of geological disposal following 100 years of storage, when all other countries with a nuclear power programme have adopted a strategy of implementing geological disposal as soon as practicable. The factors behind the Dutch decision appear to be public acceptability, cost and the relatively small volumes of waste that have to be managed.

10. Overseas experience has been an essential input to the evaluation of the timescale for implementing a repository in the UK.

Implementing the recommendations

11. Japan, the USA and all the countries of western Europe which have a civil nuclear power programme, have experienced severe setbacks in implementing repositories for radioactive waste. Most of these countries have analysed the reasons for past failures and are moving forward with new programmes for siting a repository.

12. Some CoRWM members took part in the European Commission COWAM 2 (Community Waste Management) project, which evaluated past experience in implementing waste management projects and developed guidelines for successful implementation in the future.[12] The parallel CARL project (see Glossary) was also monitored. One member took part in a discussion on long-term criteria for the disposal of spent fuel and long-lived radioactive waste at an NEA regulators forum.

13. At several plenary meetings, the progress that has been achieved in Belgium, Canada, France and Germany was reviewed, as well as that in Scandinavia, and the sociopolitical context in each of these countries was evaluated and compared with that in the UK. This has enabled the important principles that are necessary

to ensure the successful implementation of the recommended options to be identified (see Chapter 17).

Conclusion

14. Knowledge of international experience has contributed greatly to CoRWM's work. It has shown that, outside the UK, all countries with a nuclear power programme have selected interim storage followed by geological disposal as their strategy for managing long-lived waste,[1] and that the past practice of deciding where repositories should be built without an extensive engagement with the local community has always failed.[13]

References

1 for details of this and other experience referred to in this Chapter, see: Committee on Radioactive Waste Management, "Summary of international experience of radioactive waste management", document 1688.1, 2006.

2 for details of experience in these and other countries referred to in this Chapter, see also the European Commission links to individual organisations' websites: http://ec.europa.eu/energy/nuclear/links/index_en.htm

3 Committee on Radioactive Waste Management, "Thumbnail descriptions of the CoRWM short-listed options", document 1421, November 2005.

4 Catalyze Limited, "CoRWM Specialist Workshops, December 2005", Catalyze report COR004, document 1502, January 2006.

5 Committee on Radioactive Waste Management, "Report on visit to Sweden and Finland, 27-30 September 2004", document 715, 2005.

6 for example: Committee on Radioactive Waste Management, "Information for CoRWM on international experience: France", document 1385, 2005.

7 Dutton L M C et al., "The Comparison Of Alternative Waste Management Strategies for Long-lived Radioactive Wastes" (The COMPAS project). European Commission Report (EURATOM) EUR 21021 EN, 2004.

8 Renn, O. "Analytic-deliberative Processes of Decision Making: Linking Expertise, Stakeholder Experience and Public Values", document 847, 2004.

9 for example: McDaniels, T. "Peer Review Comments on: Review of Options Assessment Methodologies and their possible relevance to the CORWM process", 2004.

10 Nuclear Waste Management Organization, "Choosing a way forward - the future management of Canada's used nuclear fuel", November 2005.

11 for example: Committee on Radioactive Waste Management, "Results of French Research into Storage", document 618, 2005.

12 see COWAM website http://www.cowam.com/

13 Committee on Radioactive Waste Management, "Moving forward: CoRWM's proposals for implementation", document 1703, July 2006.

Chapter 10 Identifying and shortlisting waste management options

From a long list of options that CoRWM identified for the possible long-term management of waste, CoRWM used ten criteria to eliminate those that held out least promise for the UK. It developed a shortlist of four main options and subdivided them into 14 variants.

1. **CoRWM's terms of reference** made it clear that the Committee would need to start from a 'blank sheet of paper' in considering which radioactive waste management option or options to recommend to Government. This chapter describes how CoRWM identified its long list of options and then systematically evaluated them. This evaluation led to the screening out of most options on this long list, thus eliminating them from further consideration in the options assessment process. The result of this stage of CoRWM's work was the identification of a shortlist of options, and the next chapter describes how these shortlisted options were assessed. The whole process of shortlisting is described in more detail in 'How CoRWM short-listed the options'.[1]

2. **Identifying a long list of options.** Between April and September 2004, the Committee formulated a long list of potential management options, drawing on an earlier report to Government[2] and on advice from Nirex.[3] In formulating this list, CoRWM ensured that all options that had been given serious consideration by the international scientific community were included. Some options had been rejected elsewhere, in some cases because they breached international agreements, but the commitment to considering all options from a fresh stance led CoRWM to evaluate them all. The Committee considered whether or not it could rapidly eliminate impracticable options and whether this could be done simply, on a 'common sense' basis, or whether it needed information and a systematic process on which to base its decision. In order to provide a clear and unambiguous audit trail, the Committee decided that the process of elimination should be done systematically.

3. The draft long list of options was drawn up in September 2004. The PSE 1 consultation document (November 2004)[4] asked whether CoRWM had identified and adequately described all relevant options. The draft long list of options, as described in the consultation document, is shown in Box 10.1.

Box 10.1 CoRWM's long list of options

The options on CoRWM's long list were:
1. interim or indefinite storage on or below the surface
2. near surface disposal, a few metres or tens of metres down
3. deep disposal, with the surrounding geology providing a further barrier
4. phased deep disposal, with storage and monitoring for a period
5. direct injection of liquid wastes into rock strata
6. disposal at sea
7. sub-seabed disposal
8. disposal in ice sheets
9. disposal in subduction zones
10. disposal in space, into high orbit, or propelled into the Sun
11. dilution and dispersal of radioactivity in the environment
12. partitioning of wastes and transmutation of radionuclides
13. burning of plutonium and uranium in reactors
14. incineration to reduce waste volumes
15. melting of metals in furnaces to reduce waste volumes

4. **Defining an options shortlisting method.** The Committee developed a set of 'screening criteria' to eliminate those options on the long list that offered the least promise for the UK. These screening criteria were statements against which to judge options on a pass/fail basis. Box 10.2 describes these criteria. CoRWM's PSE1 consultation document sought views on these and on the proposed methodology for shortlisting. Early application of screening criteria allowed the screening process to start. This included: (a) feedback on the draft long list and proposed shortlisting criteria and methods from the first round of Public and Stakeholder Engagement (PSE1); (b) results from the commissioning of a total of 31 brief studies designed to help the Committee better understand key aspects of some of the options; and later (c) feedback on a proposed shortlist from PSE2. After assessing both PSE feedback and the results of the commissioned work, CoRWM was able to arrive at its shortlist by eliminating options which it regarded as unfeasible as they did not pass the screening test.

Box 10.2 Screening criteria that CoRWM applied to its long list of options

An option would be shortlisted if:

i. There is no 'proof of concept'
ii. It causes a breach of the duty of care to the environment outside national boundaries
iii. It causes harm to areas of particular environmental sensitivity
iv. It places an unacceptable burden on future generations, in terms of cost, effort or environmental damage
v. It involves a risk to future generations greater than that to the present generation that has enjoyed the benefits
vi. It results in unacceptable risk to the security of nuclear materials
vii. It poses unacceptable risk to human health
viii. The cost is disproportionate to the benefits achieved
ix. It breaches internationally recognised treaties or laws and there is no foreseeable likelihood of change in the future
x. It would involve implementation overseas when implementation could, in principle, be achieved in the UK (added as a result of public engagement).

5. Members of the public and stakeholders consulted in PSE1 generally felt that CoRWM had included all relevant options in its long list, although some had not been described with enough clarity. The screening criteria were also broadly endorsed, though there were suggestions from some respondents that extra criteria should be added. In particular, comments from participants in PSE1 strongly encouraged the Committee to consider explicitly the issue of the need to shortlist options which could in principle be applied within the UK's borders. CoRWM considered all suggested additions, but decided that only one – criterion 10 above – was important enough to add to the original nine.[5]

6. CoRWM refined the description of options throughout the shortlisting process, partly in response to PSE1 feedback. This included adding variants of some options and clarifying others. The most important example refers to option 1, storage. The Committee decided to draw a clear distinction between interim and indefinite storage and introduced two variants on storage described as option 1a, long-term interim storage, and option 1b, storage forever.

7. The 31 commissioned studies helped CoRWM to evaluate whether options would pass or fail the screening criteria. Most were subject to two peer review reports. Where, on the basis of information provided by the relevant study, CoRWM favoured the elimination of an option and the reasons for doing so were confirmed by initial peer review, no further scrutiny was, in general, carried out. CoRWM was concerned about the degree of criticism of the studies in some of the reviews. Of this process, the CoRWM external evaluator said:

> 'There was little chance of reports commissioned in this way and written at this speed meeting the standards that peer reviewers of this sort – and indeed stakeholders more generally – would probably have been expecting and many reviews were critical, pointing out significant omissions. … Even though the reports were fairly basic and the quality was variable, they seem in the end to have been adequate for their purpose.'[6]

8. **Deciding the shortlist**. Between November 2004 and February 2005, the Committee drew up a proposed shortlist of options for public consultation in April 2005 as part of PSE2. The shortlisting was a lengthy and deliberative process, including facilitated discussions at three plenary Committee meetings (November 2004, and January and February 2005). It was supported by substantial input and advice from working group meetings, especially the Information working group.

9. Plenary meetings considered each option in turn against all screening criteria to decide, with increasing conviction at each plenary, whether an option should be eliminated, or carried forward on the shortlist, for detailed assessment. The Committee decided that no option would be screened out unless it was unsuitable for all of the waste streams.

10. In the course of discussing the status of the long-listed options, CoRWM decided that the last four options were not complete waste management options in themselves. Rather, they were nuclear or waste process treatments that in some cases were already available to nuclear operators. These four options were therefore ruled out of the shortlisting process. Partitioning and transmutation was ruled out for the additional reason that there was no proof of concept and that the cost would be disproportionate to benefits derived. Having divided storage into the two distinct categories of interim storage and storage forever ('forever' replacing 'indefinite' in the original list of 15), 12 options were finally considered for shortlisting.

11. In the process of screening, each member was asked for views on all criteria in relation to all options. In the event, the decision on all shortlisted options was unanimous, while for those options eliminated, the decision was unanimous on seven out of eight cases, with two members dissenting in the case of sub-seabed disposal.

12. The CoRWM decision at the February 2005 plenary meeting was that four options should be shortlisted and eight options eliminated. The four that were provisionally proposed for the shortlist were:
    - **long-term interim storage**
    - **deep geological disposal**
    - **phased deep geological disposal**
    - **near surface disposal of short-lived wastes**.

13. Table 10.1 shows the eight eliminated options and the criteria which at least one member, in each case, cited as a reason for elimination (see reference[1] for more detail, as well as Annex 4)

Table 10.1 Criteria applied to screen out various options

Option	Criteria applied to screen out
Storage forever	Unacceptable burden to future generations Unacceptable risk to security of nuclear materials Unacceptable risk to health

Option	Criteria applied to screen out
Direct injection	No 'proof of concept' Causes harm to areas of particular environmental sensitivity Risk to security Risk to health
Disposal at sea	Breach of duty of care to the environment outside national boundaries Breach of internationally recognised treaties or laws and no foreseeable likelihood of change in the future
Sub-seabed disposal	Breach of duty of care to environment Harm to environmentally sensitive areas Involves a risk to future generations greater than that posed to the present generation that has enjoyed the benefits Breach of internationally recognised treaties or laws and no foreseeable likelihood of change in the future
Disposal in ice sheets	No 'proof of concept' Breach of duty of care to environment Harm to environmentally sensitive areas Risk to future generations Breach of internationally recognised treaties or laws and no foreseeable likelihood of change in the future
Disposal in subduction zones	No 'proof of concept' Breach of duty of care to environment Breach of internationally recognised treaties or laws and no foreseeable likelihood of change in the future
Disposal in space	Breach of duty of care to environment Harm to environmentally sensitive areas Risk to security Risk to health Cost disproportionate to benefits received
Dilution and dispersal	No 'proof of concept' Breach of duty of care to environment Breach of internationally recognised treaties or laws and no foreseeable likelihood of change in the future

14. At the July 2005 plenary meeting, CoRWM reviewed these provisional decisions on the shortlist, which are described in detail in reference[1]. To assist the Committee's review, the Information working group had carried out some further work to resolve some uncertainties identified earlier. The working group also looked again at the commissioned studies in light of the peer reviews, concluding that while none of the provisional decisions made in February needed to be revised, the points made in the reviews of the options proposed for shortlisting should be referred forward for use in subsequent option assessment.

15. The July 2005 plenary meeting also benefited from the results of PSE2 responses which, together with the working group's advice, were fed into the discussion. CoRWM decided that there should be no substantial changes to the provisional shortlist agreed in February. Few PSE respondents had argued for the reinstatement of options eliminated from the long list and none of the arguments made was considered substantial enough to require the reintroduction of eliminated options. Significant numbers of respondents had expressed

reservations about each of the shortlisted options, but CoRWM decided that these arguments could be more fully addressed at the detailed assessment stage. Some respondents had raised the issue of deep boreholes and the Committee agreed that these would be considered as a variant of geological disposal. Other respondents were concerned about the apparent finality of options' 'elimination' and CoRWM agreed that it would consider, later in its process, recommending that Government keep a 'watching brief' on some eliminated options (especially sub-seabed disposal and partitioning and transmutation).

16. CoRWM therefore confirmed that the first three options on the original shortlist – long-term interim disposal, deep geological disposal and phased deep geological disposal – were to be shortlisted. Document 1340[1] describes these deliberations in detail. However, some PSE respondents expressed uncertainty about the fourth option, the near surface disposal of short-lived ILW. In part, these uncertainties were shared by CoRWM itself, particularly the question of whether there was sufficient waste of this kind in the waste inventory to justify the possibility of including the option in the final shortlist.[7] CoRWM requested the Information working group to provide advice and deferred final consideration of the issue. At the October plenary meeting, CoRWM decided to shortlist 'near surface disposal of reactor decommissioning waste', an option description which replaced the earlier 'near surface disposal of short-lived wastes'.[8] This option can also be described as 'non-geological disposal' as it uses only engineered barriers, rather than the combination of engineering and geology, to provide for the containment of waste – some of which is long-lived – arising from decommissioned nuclear reactors. If regulatory agreement and public acceptance could be secured, this route might be preferable to the disposal of high volumes of waste in central facilities. A detailed account of why CoRWM decided to assess the non-geological disposal of reactor decommissioning waste is set out in CoRWM document 1381.[9] This document does not include the possibility, which CoRWM understands is undergoing preliminary assessment by the NDA, of decontamination and reuse of suitable reactor decommissioning waste, including graphite, steel and concrete.

17. **The final version of the shortlist**. Before moving to comparative assessment, CoRWM decided that it needed a more precise definition of the options. In light of important feedback from its PSE process, a decision was taken to define variants of the shortlisted options. For example, in the case of long-term storage, many people said that the transport of radioactive waste should be minimised, so storage at or very close to the sites where the waste is produced or currently located, as well as centralised storage, was included as a variant. Most people considered that the waste should be protected from attack by terrorists and so variants where the protection that is provided in the existing stores is enhanced to withstand potential attacks, as well as additional protection applied to new stores, was added to the shortlist. Some respondents thought that the waste should not be stored underground, so two concepts of providing enhanced protection were considered. In the first, it would be provided by an engineered structure on the surface; in the second, the waste would be stored underground and the protection would be provided by the overlying rock.

18. In the case of geological disposal, CoRWM also considered boreholes for the most active waste streams, since they have the potential to achieve better isolation of the waste from humans and the environment than conventional geological disposal. Boreholes have been considered as an alternative to geological disposal in countries overseas such as Sweden. CoRWM did not consider local geological repositories for the higher activity wastes, since building a geological repository at every site would be prohibitively expensive and the geology might not be suitable.

19. However, in view of the importance that many people attach to minimising the transport of radioactive material, CoRWM did consider local near surface

repositories for reactor decommissioning waste (see section 6 of Annex 4), which, unlike the waste from reprocessing, contains only small quantities of long-lived radioactivity. Near surface vaults like those at the LLWR near Drigg in Cumbria constitute one concept, but they could be susceptible to coastal erosion at many existing sites. The Committee therefore also considered the design that is being used for short-lived waste in Sweden and Finland, which is below ground but at a much shallower depth than for a geological repository for long-lived waste. CoRWM also considered the concept of using the biological shield of the reactor as the engineered barrier developed in the UK in the 1990s and known as 'mounding over' reactors.

20. These deliberations led, in November 2005,[10] to the headline description of shortlisted options and variants shown in Box 10.3.

Box 10.3 Headline descriptions of CoRWM's shortlisted option and their variants

Long term interim storage

1. Interim stores, above ground, at or near current locations of waste and protected to current standards
2. Interim stores, above ground, centralised and protected to current standards
3. Interim stores, above ground, at or near current locations of waste and protected
4. Interim stores, above ground, centralised and protected
5. Interim stores, underground, at or near current location of wastes and protected by ground cover
6. Interim stores, underground, centralised and protected by ground cover

Geological disposal

7. Geological disposal
8. Deep borehole disposal

Phased geological disposal

9. Phased geological disposal

Near-surface disposal of short-lived wastes

10. Near surface engineered vaults, at or near current locations of waste, protected
11. Near-surface engineered vault, centralised, protected
12. Mounded over reactors
13. Shallow vault disposal, centralised
14. Shallow vault disposal, at or near current locations of waste

CoRWM dropped the description 'deep' from options 7 and 9 as the term had no clear meaning, and all future references in this report are to 'geological' disposal. The term 'deep' is reserved for boreholes.

21. **Conclusion**. CoRWM drew up a long list of waste management options in September 2004 and then deliberated at length on both the process and substance of shortlisting. It used two rounds of Public and Stakeholder Engagement and some brief commissioned studies to inform the deliberations. The shortlist for detailed assessment, broadly confirmed in July 2005, contained three options that could in principle apply to the whole of the CoRWM inventory – interim storage, geological disposal and phased geological disposal – as well as near surface disposal for decommissioning wastes. The Committee subdivided these options into a total of 14 variants that went forward for more detailed assessment, as explained in the next chapter.

References

1 Committee on Radioactive Waste Management, "How CoRWM short-listed the options", document 1001.4, May 2005 and Committee on Radioactive Waste Management, "Outcome of short-listing", document 1340, September 2005.

2 Wilkinson Environmental Consulting Limited, "Information Needs Research Project - Identification of Information Needed to Decide with Confidence on the Long Term Management Options for Long Lived Radioactive Waste", Defra Report No: DEFRA/RAS/02.014

3 UK Nirex Limited, "Description of Long-term Management Options for Radioactive Waste Investigated Internationally" Nirex Report N/050, May 2002.

4 Committee on Radioactive Waste Management, “PSE1 Consultation Document”, document 831, November 2004.

5 Committee on Radioactive Waste Management, "Minutes of the February 2005 plenary meeting", document 1002, April 2005.

6 Faukland Associates, “CoRWM Phase 2 Evaluation”, October 2005.

7 Committee on Radioactive Waste Management, "Minutes of the July 2005 plenary meeting" document 1311, July 2005 and Committee on Radioactive Waste Management, "Outcome of short-listing", document 1340, section 3.12, September 2005.

8 Committee on Radioactive Waste Management, "Minutes of the October 2005 plenary meeting", document 1362, October 2005.

9 Committee on Radioactive Waste Management, "Why CoRWM short-listed the non-geological disposal of reactor decommissioning wastes", document 1381, October 2005.

10 Enviros, "Summary descriptions of CoRWM's short-listed options", document 1420, November 2005.

Chapter 11 Assessing the shortlisted options

CoRWM used Multi-Criteria Decision Analysis to conduct a thorough performance assessment of its shortlisted options for the entire waste inventory, against a number of criteria. It complemented this with an holistic assessment of the options, and compared the outcomes of the two assessments.

Method

1. CoRWM developed a bespoke options assessment process in close consultation with decision analysts, experts in process design and specialists in stakeholder engagement. The outline process was put out for public and stakeholder comment in PSE2, and resulting feedback was used by CoRWM to develop the detail of the process. The underlying philosophy was to draw on both scientific and technical inputs and views expressed by the public and stakeholders, using the principles of deliberation whenever appropriate. The Committee agreed early on that its role was not merely to collate and pass on the views of others, but that it would make its own judgements, fully informed by those views. The principles that were adopted for options assessment were:

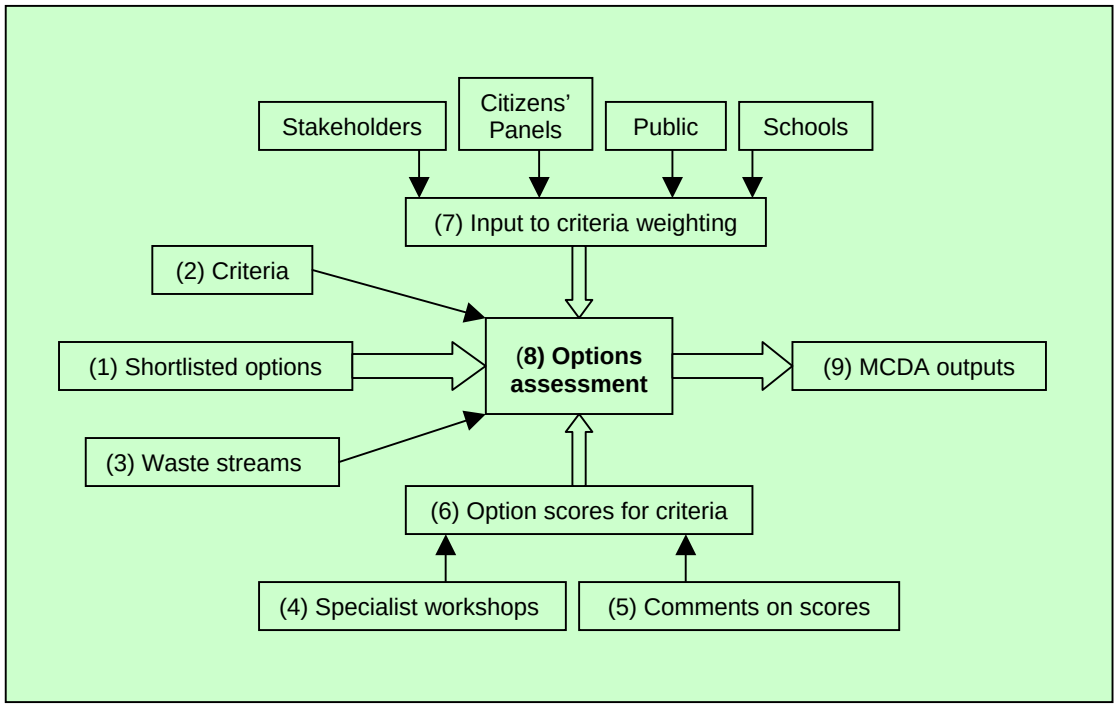
    - a rational and systematic approach, using the best available specialist inputs, with scope for iteration at key points, within a discursive, ethically informed, and integrative framework

    - transparency and traceability, so that the way in which the decisions were arrived at was clear

    - robustness, including the means of taking public and stakeholder engagement and specialist outputs into account.

2. Two complementary assessment methods were adopted. An MCDA technique[1] enabled the shortlist of options to be assessed against those criteria judged to be important by citizens of the UK, as identified, for example, by the Citizens' Panels (see Chapter 7). This allowed rigour to be applied in an open and transparent way that could provide an audit trail of the judgements and decisions made. This bottom-up and relatively mechanistic approach was complemented by a more holistic approach in which the options were assessed as a whole. The rationale for the linking of the two methods, and the way in which they were conducted, was consistent with Renn's Cooperative Discourse Methodology.[2] Additional detail on options assessment is given in Annex 4.

Figure 11.1 Overview of the MCDA assessment process



3. MCDA allows three important and distinct analytical processes: (a) specialists or experts to deliberate and reach quantified judgements about the performance of options against the set of agreed criteria; (b) societal judgements to be applied to determine the relative importance to attach to each of the criteria; and (c) a combination of these two earlier processes to produce a picture, part scientific and part value-driven, of the overall ranking of each option. Such MCDA processes cannot make the choice between options, but they can provide a wealth of useful and structured information and judgement, deepen understanding and raise important questions for further deliberation.

4. Figure 11.1 shows CoRWM's MCDA assessment process in more detail. It involved assessing the shortlisted options (1) against a set of criteria (2) identified as being important through engagement with stakeholders and the public. This assessment was done initially for HLW and then for each of the other waste streams (3) by considering what changes in the assessment might arise from the characteristics of that waste. The scoring (quantified performance assessment) of the options against the criteria was carried out by specialists with appropriate expertise and knowledge (4) and there was an opportunity to comment on those scores (5). The scores were fed into the Hiview model, a software programme that was being used for the MCDA assessment (6). The relative importance of the criteria used to assess the options is a value-laden judgement. While CoRWM made the final judgement on the weight that should be given to each criterion, a wide selection of stakeholders and members of the public provided input that was taken into account (7). CoRWM undertook the options assessment in public (8), producing baseline models for each waste stream, and exploring the implications of varying option scores and criteria weights in sensitivity testing. The outputs of the MCDA (9) were analysed and discussed, providing a good understanding of how each of the options was expected to perform, and where the strengths and weaknesses of each lay.

The waste streams

5. The assessment of the options was carried out for each waste stream. There were originally seven waste streams or materials that were scored by the specialists, each of which, it was believed, had sufficient unique characteristics to merit separate assessment. This could either be because they might score differently against some of the criteria, or because those criteria might be weighted differently for some types of waste. As an example, preventing the theft of plutonium was considered to be particularly important compared to the theft of other materials. The rationale for selecting these waste streams can be found in Section 3 of Annex 4. The original seven waste streams or materials were:

   - high level waste
   - spent nuclear fuel
   - plutonium
   - highly enriched uranium
   - intermediate level waste and low level waste not suitable for the low level waste repository near Drigg (intermediate level waste and non-Drigg low level waste)
   - depleted, natural and low enriched uranium
   - reactor decommissioning waste.

6. During public and stakeholder engagement it was pointed out that the small amount of highly enriched uranium in the inventory would be mixed with the other uranium streams making just one category of uranium for potential disposal. [3]

The assessment criteria

7. The options were assessed against criteria that the public and stakeholders considered to be important. These were developed with input from many sources and modified as a result of the public and stakeholder process as described in Chapter 7 As a result, a 'value tree' (see Section 2 of Annex 4) was compiled that captured the majority of the issues that people considered to be important and these were grouped into the 11 headline criteria and their associated 27 sub-criteria as shown in table 11.1.

Table 11.1 Value tree of assessment criteria

Headline Criterion	Sub-Criterion	Extent to which the option is expected to …
1 Public Safety, Individual – short term (up to 300 years)	1 Radiation	protect individual members of the public from exposure to radiation during the first 300 years
	2 Non-radiation	minimise the numbers of deaths and serious accidents by the public (attributable to its construction and operation)
2 Public Safety, Individual – long term (longer than 300 years)	3 Radiation	protect individual members of the public from exposure to radiation beyond 300 years
3 Worker Safety	4 Radiation	protect workers involved in its operation from exposure to radiation

Headline Criterion	Sub-Criterion	Extent to which the option is expected to …
	5 Non-radiation	minimise deaths, industrial and occupational diseases and serious injuries as a consequence of its construction and operation
4 Security	6 Misappropriation	prevent unauthorised removal of hazardous material
	7 Vulnerability to terrorist and other attack—pre-emplacement of waste	withstand reasonably foreseeable malicious and purposeful attacks, taking into account transport and emplacement timescales
	8 Vulnerability to terrorist and other attack—post emplacement of waste	withstand reasonably foreseeable malicious and purposeful attacks
5 Environment	9a Radiological pollution <300 years	minimise radioactive releases that could have harmful effects on ecosystems, flora and fauna, and/or the built environment over a timescale less than 300 years.
	9b Radiological pollution >300 years	minimise radioactive releases that could have harmful effects on ecosystems, flora and fauna, and/or the built environment over a timescale beyond 300 years.
	10 Chemical pollution	minimise chemical releases that could have harmful effects on ecosystems, flora and fauna, and/or the built environment over the timescale of interest.
	11 Physical disturbance	minimise the effects of noise, vibration, light pollution and earthworkings on ecosystems, flora and fauna during construction, operation and post-operation
	12 Use of natural resources	minimise the use of natural resources, including energy, construction materials, packaging materials and water;. also consider change of land use and indirect impacts
6 Socio-Economic	13 Employment	employ people over the option's lifetime
	14 Spin-off	create, in addition to direct employment, significant spin-off opportunities: e.g. jobs, skills, knowledge in both technology and business, and investment
7 Amenity	15 Visual	create a visual impact
	16 Noise	create a noise impact at the boundary of the site for a single instance of the option
	17 Transport	create a transportational impact outside the site boundary for a single instance of the option
	18 Land take	create an impact at a single site on a single individual through surface land take
8 Burden on Future Generations	19 Cost	reduce the financial liability (whole life costs) imposed on future generations
	20 Effort	reduce managerial effort for all aspects of implementation imposed on future generations, including the pre-operational phase
	21 Worker Dose	reduce exposure of the workforce imposed on future generations

Headline Criterion	Sub-Criterion	Extent to which the option is expected to …
	22 Environmental impact	reduce the environmental burden imposed on future generations, taking into account pollution, physical disturbance, use of natural resources, visual impact, noise, transport and surface land take
9 Implementability	23 Technical	employ currently established, tested and proven technical methods for the design, construction and operation of the option, including decommissioning, if relevant
	24 Regulatory requirements	be fully consistent with international, EU and national law and regulatory requirements
10 Flexibility	25 Flexibility	allow for future choice and respond to unforeseen or changed circumstances over the 300 years
11 Costs	26 Costs	minimise total costs of the final management of wastes, taking into consideration: • development • implementation • operation • closure • monitoring

Time periods

8. The nature of the shortlisted options is such that they cover different timescales. A decision was needed on how to compare options that were designed to be permanent with those designed for a finite period after which further management action would be needed. In order to make a fair comparison between the storage options and the disposal options, this period of storage had to be quantified. Criteria that measured impact over longer periods would then not be used in the multi-criteria analysis, as this analysis could only compare options over the period of time that they would all be operational. CoRWM decided on a 'reference case' of storage for a maximum of 300 years. This took into account various factors, including the practicability of maintaining institutional control over stores and refurbishing and rebuilding them as necessary. UK regulators are unlikely to accept a safety claim for institutional control for a period of greater than 300 years. This is also the period of time over which short-lived ILW from reactor decommissioning decays to non-hazardous levels. For the purposes of the comparative assessment in the MCDA, both disposal and storage options were therefore evaluated over only a relatively short (300 year) period. While this clearly limited the scope of the MCDA, it did not invalidate its use as a tool for comparing the options over this period. Indeed, it focussed the Committee's attention on the need to fully assess the impact on public safety and the environment of the disposal options beyond 300 years, and whether this might be a burden on future generations because of the possibility that generations in the far future might experience serious health consequences as a result of repository failure.

Judging option performance: scoring the options

9. One of CoRWM's guiding principles is 'to aim for a safe and sustainable environment … by applying the best available sound science and other specialist input'. The Committee therefore decided that the task of scoring the options should be undertaken by specialists.

10. CoRWM consulted widely to identify specialists from a range of disciplines and viewpoints with demonstrable in-depth knowledge of the various aspects of the value tree. Those who agreed to participate were organised by CoRWM into criteria-specific workshops. CoRWM appointed, on the basis of competitive tender, a decision analysis consultancy (Catalyze) to help design and run the workshops. The Committee took the view that, even at the sub-criterion level, responding to the mix of concerns required a multidisciplinary approach. Thus, the composition of the specialist groups assembled to carry out the specialist strand of the MCDA drew on many different scientific and technical backgrounds. Membership of the workshops was designed to allow the representation of a spectrum of opinion, including both the nuclear industry and the environmental NGOs, as well as various 'non-aligned' groups such as the regulators. While a good spread of expertise was achieved in most of the workshops, NGO representation was less than had been hoped for, particularly in the safety workshop. This may have led to greater consensus on the scores than might otherwise have been the case. This was mitigated by providing an opportunity for people to comment on the scores, and for those views to be taken into account during sensitivity testing (see paragraphs 23 onwards).

11. The first task for the specialists was to create scoring schemes for each of the sub-criteria. The specialists were then asked to score each of the options against each of the sub-criteria, ensuring that their rationales were fully recorded.[4] These scores were put out for comment and the resulting feedback was used to compile a comprehensive report on scores that was used during the conduct of the actual multi-criteria analysis.[5] Further details on the specialist workshops can be found in section 4 of Annex 4.

Weighting the criteria

12. The Committee wished to ensure that the importance, or weight, that was given to each criterion reflected the values and ethical positions of the public and stakeholders by taking their views into account. A large element of PSE3 therefore involved different organisations or individuals giving their views in ways that were appropriate for them. This included:

    - The four Citizens' Panels that gave their views on the relative importance of the 11 headline criteria.[6]
    - The National Stakeholder Forum and Nuclear Site Round Tables that carried out a more detailed exercise providing input for all 27 sub-criteria.[7]
    - A Discussion Guide that enabled several thousand members of the public, including schools, to meet in groups and to use the guide to steer themselves through a discussion, the results of which they reported back to CoRWM. This provided views on the relative importance of headline criteria.[8]
    - A project with schools in Bedfordshire that allowed 15 schools to provide input gained from consulting with their peers on the relative importance of headline criteria.[9]

13. While criteria have an intrinsic value or importance, the weight they are given in a relative assessment of options needs to take into account how much of a discriminator they are between those options. As an example, cost may be a very important criterion when buying a new car, but if all the cars under consideration cost much the same, then other criteria become more important as discriminators. CoRWM members therefore engaged in a 'swing weighting' process, guided by Professor Larry Phillips (Catalyze Limited). This involved making judgements on

the relative importance of sub-criteria, once the difference between the top and bottom of the scoring scales for those criteria was taken into account. Thus the question to be answered in each case was: How big is the difference between the top and bottom of the scoring scale, and how much does it matter? Once the sub-criteria had been given relative weights, another process was used to aggregate the weights up to headline criteria level, undertaking frequent checks to ensure logic/rationality. Throughout the exercise, CoRWM members drew on the input from PSE3.[10] The full swing weighting process was carried out in public.[11]

14. The relative weights CoRWM gave to the headline criteria are shown in Table 11.2.

Table 11.2 Relative weights given to headline criteria

Headline Criterion	**Weight (%)**
Public Safety, individual, short term (up to 300 years)	23.3
Security	23.3
Burden on Future Generations	16.0
Flexibility	16.0
Worker Safety	7.7
Environment	7.1
Implementability	4.0
Amenity	1.7
Socio-economic	0.9
Total	**100**

15. It must be remembered that the weights in the table are relative weights, and that judgements were being made on these criteria as discriminators between the generic options. It should not be taken to imply, for example, that amenity and socio-economic issues are not important. Such issues will increase in importance and be addressed through the siting process. Even during the scoring workshops, the specialists commented that it was difficult to score those criteria that depended to a large extent on the specifics of the site.

16. Two headline criteria are missing from the above weighted list of criteria:

- **Public Safety, individual, long term (greater than 300 years).** As explained in paragraph 8, disposal and storage options were compared over the short term (300 years) in the MCDA, and assessments on the long term safety of the disposal options were conducted elsewhere.[12]

- **Cost.** The specialists considering the cost of the options provided their best estimate of the cost of each option. There was a great deal of uncertainty associated with their figures, and a resulting large spread between the low and high estimates. There was also less difference between the options than expected.[2] CoRWM therefore decided to keep the cost criterion separate from the other criteria in the MCDA, and to assess the impact of cost through a form of sensitivity testing.

It is noteworthy that CoRWM's weights were largely consistent with many of the views on weights received during PSE3. Stakeholders provided input on the weighting of sub-criteria.[11] Table 11.3 provides an overview of the input of citizens and young people.

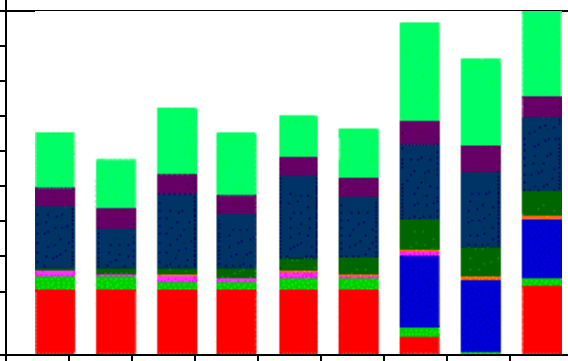
Table 11.3 Overview of the input provided by citizens and young people

Rank	CoRWM	Citizens' Panels	Schools' Project	Discussion Guide
1	Safety short term	Security	(Safety long term)	Environment
2	Security	Safety short term	Safety short term	Security
3	Burden	(Safety long term)	Environment	(Safety long term)
4	Flexibility	Burden	Security	Safety short term
5	Worker safety	Flexibility	Worker safety	Flexibility
6	Environment	Environment	Burden	Burden
7	Implementability	Worker Safety	Socio-economic	Worker safety
8	Amenity	Implementability	Amenity	Implementability
9	Socio-economic	Socio-economic	Implementability	Socio-economic
10	Safety long term and Cost not weighted – see paragraph 15	Amenity	Flexibility	(Cost)
11		(Cost)	(Cost)	Amenity

High level waste outputs

17. The specialist scores for HLW and the CoRWM swing weights were entered into the Hiview programme to create a model for HLW. This was called the baseline case on which the majority of the sensitivity testing was carried out. Table 11.4 shows how the various options performed for HLW.

Table 11.4 HLW baseline case with specialist scores and CoRWM swing weights

Criteria	Option	Cumulative Weight
Safety <300 yrs		23.3
Worker Safety		7.7
Security		23.3
Environment		7.1
Socio-Economic		0.9
Amenity		1.7
Burden on Fut Gen		16.0
Implementability		4.0
Flexibility		16.0
	1 2 3 4 5 6 7 8 9 Storage / Disposal	
Total		**100.0**

18. The coloured portions of the bar chart show the relative contributions of the headline criteria to the totals. For example, the borehole option lacks flexibility, so no red portion shows. The large blue sections, showing a high score for the burden criterion, and therefore a lower burden on future generations, are a major reason for the higher total scores for the geological disposal options. Even if the weight on the burden headline criterion were halved, making the blue portions half as long, the geological disposal options would still achieve higher overall scores than the storage options. The short-term safety criterion is also an important discriminator because of the vulnerability of storage options if there was a loss of institutional control.

19. Phased geological disposal achieves the highest weighted score, though geological disposal is similar. The main discriminator between the two is the amount of flexibility provided by each. The judgement of some specialists was that phased geological disposal provides even higher levels of flexibility than storage, because storage would need significant further action before a genuinely long-term option could be implemented, whereas a repository could be closed relatively simply. At the same time, phasing is deemed to reduce the burden on future generations to almost the same degree as geological disposal, even though the latter involves early closure of the respository. This starts to reveal the complexity of the arguments surrounding the burden and flexibility criteria, discussion of which was developed during the holistic assessment.

20. All the geological disposal options score better than the storage options, mainly due to the reduction in burden and increase in safety. The operation of the burden on future generations criterion is based on the assumption that geological disposal reduces the burden whereas storage does not. This assumption is challenged by at least one member of CoRWM who believes, first, that geological disposal may create a burden if anything goes wrong and, second, that institutional arrangements and storage design could reduce the burden associated with storage.

21. Current site storage options all score better than their associated centralised options. The largest contributor to this difference is the security criterion, reflecting a judgement that transporting waste to a central location creates a greater risk of terrorist attack. The best performing storage option is above ground enhanced

protection, at current sites, reflecting the specialists' judgement that this is the safest of the storage options.

22. Overall:

- The key discriminators between geological disposal and storage options were burdens on future generations and public safety (up to 300 years). This was because the specialists had judged that, within the limitations of the assessment process, disposal options perform significantly better than storage options against these criteria and they were highly weighted by CoRWM.

- Phased geological disposal ranked slightly higher than geological disposal because, based on the specialist scores, the former performs better against the flexibility criterion, which was weighted heavily.

Sensitivity testing

23. In both the scoring of options and the weighting of criteria, judgements were being made. CoRWM had asked specialists to score the options using their knowledge and expertise. The resulting scores depended on the best judgements of those attending the specialist workshops. They were used to construct the baseline case, as described earlier, from which the impact of variations in scores could be explored. Similarly CoRWM members used their best judgements to provide criteria weights for the baseline model from which the implication of varying those weights could be explored.

24. The large amount of material from PSE weighting exercises and from the opportunity to comment on specialist scores was collated into two papers. [13] [14] The lowest and highest scores and/or weights favoured by participants and respondents were identified, and the relative strengths of the various views could be assessed. It was not possible to test every individual viewpoint in the model, and there were differences of view within sectors (for example not all NGOs made the same judgements), however sector trends could be identified. These trends were represented by picking scores and weights that were judged to reflect the upper and lower limits of the sector views. This was called the 'limiting case' as it reflected the most severe test for each of the sectors' views. Table 11.4 gives the scores for each of the options for HLW, with the original base case shown for comparison.

25. Although some scenarios included large changes to individual criteria weights, these did not change the overall ranking of geological disposal and storage options. In all instances, the geological disposal options were ranked higher than the long-term storage options, although in some cases the 'gap' between them was significantly reduced.

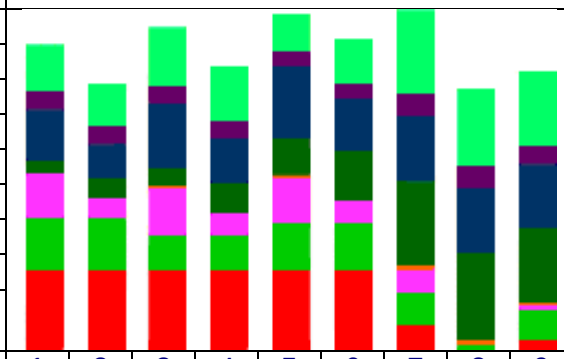
26. For the sensitivity testing of the cost criterion, the highest cost estimates for disposal and the lowest cost estimates for storage were fed into the model. The storage options, despite their lower costs, continued to perform less well than disposal.

NGO limiting case

27. The most severe test was provided by a combination described as the 'NGO limiting (bounding) case'. This involved much more weight being placed on environment, amenity, flexibility and implementability criteria. These weights, combined with reduced scores for geological disposal options against burden on future generations to the same levels as for storage options, reflected concerns

that disposal options could impose substantial burdens on future generations if poor repository performance resulted in substantial negative environmental impacts and clean-up effort in addition to a negative impact on human health. The score for flexibility for phased geological disposal was reduced to the same as that for geological disposal to reflect a view that social and political hurdles could prevent retrieval of wastes during the open phase of a repository. Even in this case, geological disposal still ranked highest, though followed extremely closely by underground local stores. The two criteria that caused this storage option to perform better than the previous top scoring storage option (above ground local stores with enhanced protection) were implementability and the environment. The increased weight on these criteria enhanced the difference in scores between the two, with the underground option judged to be more easily implementable and more sympathetic to environmental concerns. Phased geological disposal ranked below some of the storage options mainly due to the reduction in scores for this option against flexibility and burden criteria. This was the only sensitivity test that placed any storage options broadly on a par with geological disposal options.

Table 11.5 HLW NGO Limiting Case

Criteria	Option	Cumulative Weight
Safety <300 yrs		15.6
Worker Safety		5.2
Security		15.6
Environment		15.6
Socio-Economic		0.6
Amenity		10.7
Burden on Fut Gen		10.7
Implementability		10.7
Flexibility		15.6
	1 2 3 4 5 6 7 8 9	
	Storage / Disposal	
Total		**100.0**

Results for other waste streams

28. The criteria weights derived for HLW were entered into the models for the other waste streams, and sensitivity tests were conducted to reflect views on whether different weights should apply to some criteria for different waste streams. The ranking of the options for HLW, spent nuclear fuel, and plutonium were virtually identical. For uranium, the gap between the storage and disposal options was much narrower, and small changes in weights for the burden and flexibility criteria would lead to an overall preference for underground central storage. The reason for this result was that the level of hazard is potentially lower than for other materials and that it is possible to recycle uranium in future fuel. For ILW, geological disposal ranked highest, followed by phased geological disposal. This was mainly due to lower specialist scores for short-term safety of ILW when a disposal facility is left open. For reactor decommissioning wastes, shallow vault disposal ranked very similarly to geological disposal, mainly reflecting confidence in the safety of non-geological disposal options for this type of short-lived waste.

29. The outputs from the MCDA highlighted those criteria that were acting as discriminators between the options, and drew attention to those that were particularly sensitive to variation. The exercise also identified several issues that required further clarification and debate within the Committee.

Multi-Criteria Decision Analysis – conclusions

30. It is important to recognise that MCDA models are not intended to provide the 'right' answers. They are a tool to aid exploration and not a means to identify a result. When dealing with the future, there is considerable uncertainty and conflicting objectives. Models are only approximations of the reality they attempt to represent; real-world elements are omitted, complex relationships are simplified, and distinctions are blurred. The model was used as an aid to thinking, first serving as a means to add depth to the options-and-criteria framework that CoRWM had already adopted, adding the principles of scoring and weighting. MCDA provided a means for the many pieces of the complex problem to be dealt with separately, with data and judgements exercised about the pieces. Next, it reassembled the pieces according to multi-criteria decision theory. Finally, the role of the model shifted as model outputs were revealed, and sensitivity testing enabled MCDA to serve as an aide to decision making.

31. The MCDA did have some limitations specific to CoRWM's issue. It was unable to accommodate the differing timescales over which the options operate, leaving a critical aspect of the radioactive waste problem to be assessed separately (see paragraph 8). Another important issue, that of cost, was also dealt with in a different way to the other criteria. The nature of the problem with seven waste streams, 14 options, and 27 sub-criteria, plus the involvement of so many different people, proved challenging but not insurmountable. In the words of CoRWM's independent evaluator, 'Despite the inherent limitations and some implementation issues raised by ourselves and others, our conclusion is that the MCDA was valid, had value, and can make a significant contribution to the decision-making'.[15]

The MCDA analysis led to three conclusions:

- Overall, geological disposal options ranked higher than storage options.
- The difference in ranking between geological disposal and storage is substantial for most waste streams and for most of the limiting case sector scenarios.
- Generally, the borehole option is the lowest ranked geological disposal option.

32. The four headline criteria that generally received the highest weighting were: safety during the first 300 years, security, burden on future generations, and flexibility. The significance of different views on the way these criteria interact is discussed in Chapter 13 where the limitations of the MCDA and thus the value of the outcomes from it are examined.

33. The higher ranking of phased geological disposal compared to geological disposal for all waste streams, except ILW depends mainly on the specialist view that the phased concept gives much more flexibility. This is due largely to the fact that phased disposal is assumed to enable retrieval of waste although most members of CoRWM, and many stakeholders, argue that, once emplaced, waste is unlikely ever to be retrieved. If phased geological disposal is given a low score for flexibility then geological disposal would, overall, be ranked higher than phased geological disposal. Likewise, the assumption that disposal removes the burden on future generations is not universally accepted.

The holistic assessment

34. MCDA is a useful tool in decision making because it can accommodate both quantitative data derived from science, and qualitative data based on values and ethical considerations. CoRWM also wished, however, to compare the shortlisted options in the round (rather than by criteria), in a less constrained way. The use of a second, more holistic assessment, run in parallel with an MCDA, is entirely consistent with Renn's Cooperative Discourse Model. The proposal to include another method of assessment alongside the MCDA also received support from the public and stakeholders.

35. The steps in the holistic assessment were:

- A number of discussions over a period of several months on specific aspects of the problem, at workshops, in plenary discussions, and using panels of specialists. Each discussion was supported by briefing papers, and conclusions reached were recorded.

- Sessions during PSE3 that allowed participants to express their option preferences and reasons for their views. This was done at the National Stakeholder Forum, at the eight Nuclear Site Round Tables, at the four Citizens' Panels, during the Conference at the end of the Bedfordshire Schools' Project, and by the groups using the Discussion Guide. The outputs were used to inform CORWM members when undertaking their own assessment.[16]

- Additional discussions to clarify views on critical issues immediately prior to the actual assessment by CoRWM.

- A visual representation of CoRWM members' views of their provisional option preferences.

- Discussion of those views and the underlying rationales.

36. The discussions and/or panels on specific issues included:

- **Long-term safety of geological disposal.**[17] (see Chapters 8 and 13).

- **Ethical considerations**.[18] A crucial issue is how the well-being of future generations should be protected (i.e. intergenerational equity). As discussed in Chapter 6, the key question is whether one should 'deal with the waste now or later'. In the case of radioactive materials that are considered to be waste (i.e., they have no value), most members considered that there is a case for starting to implement some form of geological disposal as soon as practicable because this would reduce the burdens handed on to future generations. These burdens included the need for refurbishing stores and repackaging the waste as both deteriorate with time. However, placing the waste 'out of sight' should not result in it being 'out of mind'. Ensuring that this does not happen in the foreseeable future will involve monitoring, marking of the site and ensuring documentation is handed down from generation to generation. While monitoring would be useful to maintain knowledge of repository performance, it would probably have severe limits, as it is difficult to imagine the conditions under which waste from a repository would be retrieved once it was sealed. An alternative view was opposed to the need to begin disposal as soon as practicable because of the concern over imposing a burden of uncertain risks on future generations and a desire to maintain the active management of wastes for as long as possible. There was also a concern that potential options would be ruled out prematurely by moving too quickly to geological disposal.

- **Environmental principles.**[19] Most of the well-established environmental principles were discussed and were found not to discriminate between options. For example, the precautionary principle could be argued to support either long-term storage or geological disposal, depending on an individual's views on the nature and scale of the uncertainties and risks associated with each option. Similarly, the argument that the principle of 'concentrate and contain' favours storage rather than disposal (on the grounds that disposal inevitably results in eventual dispersal) can be countered by the argument that the vulnerability of storage to external risks meant that containment could not be guaranteed, and that the primary intention of geological disposal was to provide geological isolation on timescales sufficient to exploit radioactive decay. However these external risks in relation to storage could be mitigated by careful design and siting of stores, bearing in mind potential risks from climate change.

- **Institutional control**. The Committee commissioned papers on 'Institutional Control'[20] which were reviewed[21] and used as the basis for a plenary discussion on the subject in January 2006. The main points from this discussion were that it was difficult to argue that institutional control could definitely be maintained, even over periods measured in decades, and that both storage and phased geological disposal depended on institutional control being maintained.

- **Lifetime of stores**. A number of organisations were consulted for their views on the maximum lifetime of stores, and a panel was convened to discuss storage at the plenary in February 2006. Current stores are designed to last 50–100 years and require internal refurbishment of equipment approximately every 25 years. Research into longer life stores is ongoing but there was general doubt about stores having a lifetime beyond 300 years due to concerns including potential loss of institutional control.

- **Lifetime of waste packages**. The lifetime of waste packages was covered at the same panel discussion on storage in February 2006[22] There was a firm view from the regulators that package lifetimes are currently about 150 years, and that further research and development would be required if there was a need to extend this.

- **Retrievability**. The subject of retrievability was first discussed at a plenary on 16 September 2005 (and was revisited at the plenaries in December 2005 and February 2006). The reasons why many members of the public and stakeholders favoured retrievability were discussed, and whether these requirements could be provided by phased geological disposal or whether they really indicated that storage would be more appropriate. This dichotomy has already been reflected in the way flexibility was handled in the MCDA, and is discussed further below and in more extended form in Chapter 15.

37. As part of the holistic assessment process, members indicated their provisional option preferences for each waste stream. This helped to build up a picture of which options were more favoured than others. The picture that emerged showed that:

    - For HLW, spent fuel, ILW and plutonium, a large majority of members indicated a preference, as a starting point, for forms of geological disposal, reflecting the majority view of confidence in long-term safety and views on intergenerational equity. Some members preferred the borehole option for spent fuel and plutonium because it would provide the maximum protection against the misappropriation of these sensitive materials. The remaining preferences were for forms of storage, reflecting a lack of confidence in the long-term safety, and intergenerational issues, and a reluctance to deny future generations the option of finding alternative management methods as well as the possibility of using the waste as a resource.

- For uranium, less than half the preferences were placed under forms of geological disposal and the picture reflected mixed views about the potential use of the uranium as a resource, and awareness that these forms of uranium are relatively low hazard materials.

- For reactor decommissioning wastes, just under half of the preferences were for shallow disposal at or near existing sites. There was an implicit assumption that any such site would be suitable in terms of its resistance to climate change and/or coastal erosion. The preferences reflected a view that – where appropriate – such facilities could be utilised for short lived ILW from reactor decommissioning, in part to avoid the transport of relatively bulky material to a central facility but would have to be subject to an approved safety case and public acceptability.

38. Through discussion of provisional views on options, the assumptions that members had made about the wastes and/or the options were uncovered, leading to more intensive deliberation about the underlying issues. Reasons for agreement, and particularly disagreement were investigated. [23] The main outputs included:

- The two storage variants based on protection to current standards did not receive any support for any waste category. It was therefore agreed that these variants should not be recommended as options for the long-term management of radioactive wastes. It was noted, however, that in the shorter term such stores already exist and could form an integral part of a strategy for implementing a long-term management policy.

- There was a wide range of views on phased geological disposal and the Committee returned to a discussion of this option on a number of occasions. Some members were highly sceptical about the value of leaving a repository open for an extended period prior to closure arguing that it imposes cost and effort burdens on future generations for little real gain thereby undermining the removal of burden principle upon which the case for disposal partly rests. They felt that it would not offer any real prospect for reducing the uncertainties associated with long-term safety, that the flexibility provided would be unlikely to be exercised in the real world, and that sufficient flexibility to meet public concerns could be achieved through a staged process of decision making during siting of non-phased disposal. One member felt that if flexibility was a very strong concern, then long-term storage should be pursued, not phased disposal. Others felt that phased disposal attempts to strike a balance between reducing burdens on future generations and maintaining flexibility for a period of time, and that it had received majority support at the Citizens' Panels, from groups using the Discussion Guide, and in the Schools Project. It was argued that this reflected a strong public desire to start out on a path that would reduce burdens on future generations, at the same time as enabling an extended period of learning, confidence building and potential to pursue a better option if it became available, even though members believe there are real difficulties in accepting that phasing genuinely provides for both flexibility and removal of burden (see Chapter 15). However, for most of these members, a decision about whether to recommend geological disposal or phased disposal did not need to be taken now, but could involve further debate, including discussions with potential host communities during the siting process. This could empower local communities, increasing the prospect for successful implementation.

- An area of uncertainty uncovered by the debate on phased geological disposal concerned the reasons why some PSE consultees had expressed a preference for this option. If their primary concern was to provide the ability to retrieve the waste, then this desire might be best served by storage rather than disposal. The Committee agreed that clarification of the reasons for preferring phased geological disposal would be a suitable issue for the final round of PSE.

- The role of storage in any UK strategy was discussed. Members preferring forms of geological disposal saw an important role for storage options as part of an overall strategy. As an integral part of a long-term management strategy, storage could help to manage uncertainties in the timetable for implementing disposal, or act as a fall back should the implementation of disposal fail. As pointed out by security specialists during the multi-criteria analysis, there was a need to review security vulnerabilities associated with current storage arrangements and, potentially, to enhance interim arrangements in some instances.

Comparison of multi-criteria and holistic assessments

39. In accordance with the Cooperative Discourse Methodology, members then compared the MCDA and holistic assessments, noting the consistency between the two, and discussing the reasons for any inconsistencies. The main points noted were:

- There was consistency between the provisional preferences of the majority of members for some form of geological disposal for most waste categories, and the outputs of the multi-criteria analysis.

- Those members who stated a preference for geological disposal did so having expressed confidence in the long-term safety of geological disposal. This judgement was consistent with the high scores given to the long-term safety of geological disposal by the safety specialists in the MCDA.

- The absence of support for long-term stores with current standards of protection, as a long-term management option, was consistent with the outputs of the multi-criteria analysis, where those options had the lowest ranking.

- In the holistic assessment, members gave significant support for local, shallow disposal on the assumption that the sites involved would not be subject to coastal erosion. There was consistency between this view and part of the MCDA outcome, which also ranked local, shallow disposal options highly. However, the MCDA also ranked geological disposal highly for Reactor Decommissioning Waste (RDW), in contrast to members' holistic views. However, the basis of the two assessments was not identical as specialist scores assumed that coastal erosion could be significant. It was acknowledged that preferences for some form of on-site disposal were driven by a desire to reduce the transport of waste. Members realised that what was not known was the balance of opinion between willingness to accept a local shallow disposal facility and willingness to accept transport of waste away from the site. This was an area where the NDA was already heavily involved, especially in its consultation on local site end states.

- The small but significant level of potential preferences for boreholes for plutonium and spent fuel was not consistent with the multi-criteria rankings, which placed the option third, significantly behind the other geological disposal options. It was recognised, however, that this was driven by a low score for implementability because the technology for boreholes was still developing and that they could become a more important element in the future.

- The importance attached to flexibility in discussions about the relative merits of storage and different forms of geological disposal in the holistic assessment may at times be much greater than the weight accorded to it in the multi-criteria analysis. In the latter case, the weight accorded to flexibility would have to be increased to approximately 35% of the total weight accorded to all criteria in order for storage options to rank higher than geological disposal.

40. The purpose and result of the multi-criteria and holistic options assessment was to identify which options performed best in which circumstances. CoRWM then needed to identify the best combination of options, taking account of all waste streams and covering the timescales over which geological disposal or interim storage would need to be implemented. The way that this was done and how it led to the final recommendations is the subject of Chapter 12.

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Chapter 12 How CoRWM reached its recommendations

During the final stage of its process, CoRWM brought together the various strands of its work to produce its final recommendations. This chapter shows how CoRWM's strategy evolved through a series of key decision making meetings to produce the set of integrated recommendations on options and implementation to present to Government.

1. CoRWM's decision making process was developed over a period of two and a half years (November 2003 to March 2006) and has been described in the preceding chapters. During that time the Committee considered the existing scientific and technical knowledge (Chapter 8) both in the UK and overseas (Chapter 9); undertook an intensive public and stakeholder engagement programme in three phases (Chapter 7); conducted a series of bilateral meetings with key stakeholders, governmental, regulatory and other bodies; developed a Multi Criteria Decision Analysis with input from specialist panels (Chapter 11); undertook an holistic assessment (Chapter 11); articulated its thinking on ethical issues (Chapter 6); and developed ideas on how its eventual proposals could be implemented (Chapter 17). By the Spring of 2006 the Committee reached the point where its wide-ranging considerations needed to be brought together in formulating its final recommendations for reporting to Government at the end of July 2006.

2. From the outset it had been recognised that CoRWM had been presented with an important but difficult task and should take responsibility for the final recommendations. The intention was to achieve a consensus among members if at all possible. This does not necessarily mean complete agreement or unanimity, rather an agreement to support a set of recommendations. Given the diversity of perspectives about the issue of radioactive waste in society at large, and within the Committee itself, the task was likely to prove challenging. To achieve what CoRWM's Guiding Principle 5 calls a 'conclusive process' it would be necessary to ensure that the range of viewpoints had been covered and all conclusions were effectively justified.

3. The decision making leading to CoRWM's final recommendations took place over a period of five weeks during March/April 2006 in a series of three plenary meetings (three days, two days and three days respectively) held in public with a private preparatory meeting (two days) in between. At the first of the plenary meetings, held in Brighton,[1] the Committee undertook its MCDA and the outcome of this is reported in Chapter 11. The second plenary in Edinburgh[2] was devoted to an holistic assessment and comparison with the MCDA. The outcome of this concludes the previous chapter. This present chapter, beginning with the third decision making meeting, also held in Brighton,[3] sets out how CoRWM reached its decisions. It also shows how the set of recommendations were developed and refined as a consequence of PSE4 and discussion of key issues. Two issues in particular stimulated continuing debate. One was the question of whether and to what extent phasing should be built into geological disposal. Another was to consider the role and significance of interim storage. A third issue, which emerged relatively late, was how to deal with Reactor Decommissioning Wastes (RDW). The debates on these issues are considered at various points in this Report. Here, the concern is with how these issues were resolved.

4. At the conclusion of the second plenary in Edinburgh, Committee members had indicated their provisional preferences in respect of different waste streams. These are summarised in the previous chapter. Broadly, there was a general preference for geological disposal for most waste streams with a minority

favouring interim storage. There was minority support for boreholes for wastes containing plutonium and a variety of views on the best ways of managing RDW. At this point preferences were indicative, not definitive, though there were different degrees of commitment to specific options among members. The next, and crucial, stage was to translate these tentative preferences into draft recommendations.

5. CoRWM approached its final decision making in two ways, initiated at a preparatory private meeting held at Meriden before the third decision making public plenary in Brighton.[4] The first was to consider how far options for different waste streams might be combined to provide management routes for a variety of wastes. A small group of members had been working on issues surrounding option combinations for several months and had prepared background material on factors that would affect option combinations. When at Meriden members reviewed this work and considered how option combinations might be feasible across waste streams, it became clear that combinations of this kind would be unlikely to be attractive for the great majority of wastes in the inventory, the relatively less significant waste stream of RDW being the only possible exception. For all other waste streams it seemed more likely that CoRWM would recommend pursuit of either one of the storage options or one of the geological disposal options. This Option Combinations approach clarified a number of issues.[5]

6. Taking storage options first, current methods of storage were not favoured. In response especially to security concerns, enhanced storage was preferred as an end point for a minority of members and also possibly for centralised interim storage of spent fuel. The need for storage in the event of failure of a repository programme was recognised. In terms of disposal options, geological disposal was widely supported on grounds of long-term safety and ethical perspectives on intergenerational equity, although it was recognised that social and political concerns would necessitate a staged process of implementation. The option of Phased Geological Disposal (PGD) had attracted considerable support from the public and stakeholders for its apparent ability to deliver flexibility while reducing burdens on the future. Consequently it was an option that must be considered on grounds of public acceptability. Boreholes attracted support from some members for their potential ability to provide isolation of the most hazardous wastes. Lastly, a number of possible variants for managing RDW were recognised but, at this stage, no firm conclusions were reached.

7. The Option Combinations approach prepared the ground for final decision making by identifying the parameters for decision making in terms of the options that were realistically available. But the exercise did not indicate how the different possibilities could be brought together nor identify the grounds on which a consensus might be constructed. For this, a second approach proved necessary. This was to develop a ‘strategy’. At the Meriden meeting one member tabled a so-called ‘Rough Strategy’ (see Box 12.1). Essentially this was designed to provide an integrated set of proposals that took into account the different perspectives of members but to which all might subscribe. The strategy proclaimed geological disposal as the ‘best approach’ within ‘our present knowledge’ but also recognised there were social and ethical concerns surrounding the method. In addition, it was very clear that it would take many decades to implement geological disposal. Consequently, in order to build trust in the approach, there would need to be a commitment to interim storage, the need for continuation of research into alternative methods of management and a continuing public and stakeholder engagement programme. A staged process of decision making would also be necessary.

Box 12.1 Rough 'Strategy'

1. At the present time and with our present knowledge CoRWM considers deep geological disposal to be the best approach for the long-term management of the UK's high level wastes.
2. Therefore, we recommend that the government proceeds to a process of staged implementation which will lead ultimately the deep disposal of high level wastes.
3. However, we also recognise that there are social and ethical concerns surrounding deep disposal sufficient to prevent a societal consensus in its favour at the present time.
4. We also recognise that the process of implementation of deep disposal will inevitably take a long time, possibly one or two generations before emplacement of wastes can begin.
5. Therefore, we recommend a staged process of implementation consisting of the following elements:
   a. a commitment to ensuring the safe and secure storage of wastes during the interim period before emplacement in a repository
   b. a continuation of research into alternative (i.e. additional to geological and long term interim storage) methods for the long-term management of radioactive wastes
   c. a continuing public and stakeholder engagement process aimed at building trust and confidence in the proposed long-term management approach
   d. a set of decision points providing for a review of progress with an opportunity for re-evaluation before proceeding further

CoRWM considers that an essential precondition to successful implementation will be the achievement of societal consensus, that is, sufficient agreement to proceed

8. The Options Combinations and Rough Strategy approaches formed the basis for discussions on the preferred strategy at the third decision making plenary at Brighton in April 2006. The meeting also considered a draft Implementation Report which had been prepared by a Working Group over the previous nine months. That Report [6] accompanies this one, and a summary is presented as Chapter 17 of this Report. The implementation proposals, following CoRWM's Guiding Principles, focussed on achieving intra-generational equity in the siting of radioactive waste facilities. The key proposals were: community involvement should be based on a willingness to participate as well as a right to withdraw; participation should be developed through partnerships expressing an open and equal relationship between a host community and the implementing body; packages should be provided for partnerships to support participation in both the short and long term; and important decisions should be ratified by the appropriate democratically elected body/bodies. In general, these proposals, as well as the more detailed recommendations in the full Implementation Report, carried the support of the full Committee. There were a number of important issues that required further debate and development as part of the implementation process which would follow the Government's response to CoRWM's proposals. But it was agreed that the key recommendations on implementation, as outlined above, should form an integral part of the package of proposals to be put to Government in July 2006.

9. The Brighton decision making meeting was presented with a Draft 'Strategy' comprising a slightly amended Rough Strategy and the key proposals for implementation. During the course of debate over two days, this strategy was further amended and developed. In particular, there were amendments proposed by one member which sought to question the confidence in disposal and to strengthen the role of interim storage. Some reorientation of the proposals was made as a result. Another member offered a series of detailed amendments, some

of which were incorporated. The whole Committee debated the set of proposals clause by clause in coming to its final recommendations.

10. The main points emerging from the discussion of the Draft Strategy were as follows:

    - The choice of disposal should be justified by reference to its being the best available option when compared with the risks associated with other options.

    - In emphasising the role of interim storage, members felt that there was a need to stress the issue of the time taken to implement geological disposal as well as the uncertainties, technical, social and ethical, that might be associated with the approach.

    - The proposals for interim storage needed strengthening to take account of security concerns, packaging, and avoiding unnecessary transport of wastes. There was a need to strengthen the commitment to research on storage and disposal as well as keeping open the possibility of alternative methods.

    - The proposals for implementation were generally supported, though some detailed amendments relating to clarification and emphasis were made. It was recognised that there were issues that would need to be further considered during the implementation process itself. Among these were: the definition of 'community'; the relationship between communities, partnerships and democratically elected bodies; the composition of partnerships; how and by whom invitations to participate are issued; who has the right to withdraw and when the right can be exercised. Some of these matters were considered further during PSE4 and by the Committee.

    - There was one area, absent from the Draft Strategy, which exposed fundamental differences among the members. This was the issue of repository design, more especially whether there should be provision to leave the repository open for several hundreds of years after emplacement of the wastes (often referred to as 'phased disposal', but see Chapter 15 for discussion of definitions) and, if so, who should take the decision. This debate is rehearsed at various points in this Report, notably in the Overview, in Chapter 6 and in the following Chapter 13. Basically, one group of members felt CoRWM should take the responsibility and recommend in favour of closing the repository as early as possible; not to do so amounted to avoiding the issue and placing a burden on future generations. Another group felt strongly that the views of PSE should not be lightly set aside and that potential host communities should have a role in decision making about the form of geological disposal.

11. On this issue it proved impossible to reach agreement. Accordingly, it was agreed to add a further paragraph indicating that the form of geological disposal should be a matter for debate in the ensuing round of PSE.

Box 12.2 Draft recommendations agreed by CoRWM on 27 April 2006

Since 1997, there has been a vacuum in UK policy on the long-term management of long-lived and more highly active radioactive wastes. CoRWM has drafted the following integrated package of recommendations. This is the start of a process, leading to CoRWM's final recommendations. Once made, they should be acted upon urgently.

1. Within the present state of knowledge, CoRWM considers geological disposal to be the best available approach for the long-term management of all the material categorised as waste* in the CoRWM inventory when compared with the risks associated with other methods of management.

2. CoRWM recognises that there are social and ethical concerns that might mean there is not sufficient agreement to implement geological disposal at the present time. In any event, the process of implementation will take several decades. This period could last for as long as one or two generations if there are technical difficulties in siting or if community concerns make it difficult, or even impossible, to make progress at a suitable site.

3. These uncertainties surrounding the implementation of geological disposal lead CoRWM to recommend that a programme of interim storage is required as a contingency and therefore must play an integral part in the long-term management strategy.

4. Therefore, CoRWM recommends a staged process of implementation, incorporating the following elements:

   a. A commitment to the safe and secure management of wastes through the development of an interim storage programme that is robust against the risk of delay or failure in the repository programme. Due regard should be paid to:

      - reviewing and ensuring security, particularly against terrorist attacks;
      - ensuring the longevity of the stores themselves;
      - minimising the need for re-packaging of the wastes; and
      - addressing other storage issues identified during CoRWM's public and stakeholder engagement process, such as avoiding unnecessary transport of wastes.

   b. A commitment to an intensified programme of research and development aimed at reducing uncertainties at a generic and site-specific level in the long-term safety of geological disposal, as well as better means for storing wastes in the longer term. Appropriate R&D should be undertaken into alternative management options.

   c. A commitment to ensuring that flexibility in decision-making within the implementation process leaves open the possibility that other long-term management options (for example, borehole disposal) could emerge as practical alternatives.

   d. A continuing public and stakeholder engagement process aimed at building trust and confidence in the proposed long-term management approach, including the siting of facilities.

Box 12.2 Draft recommendations agreed by CoRWM on 27 April 2006 (continued)

e. A set of decision points providing for a review of progress with an opportunity for re-evaluation before proceeding to the next stage, or before foreclosing alternatives.

5. CoRWM has not yet decided whether to make recommendations regarding the precise form of geological disposal. This will be an element in the next round of public and stakeholder engagement.

6. If a decision is taken to manage uranium, spent nuclear fuel and plutonium as wastes, they should be added to the inventory and immobilised for secure storage followed by geological disposal. There must be clarity about the inventory that is to be disposed of by the time that communities are invited to express a willingness to participate in the implementation process (see below). Any additions to that inventory should be the subject of an additional stage in the process.

7. Community involvement in any proposals for the siting of long term radioactive waste facilities should be based on the principle of volunteerism, that is, an expressed willingness to participate. Participation should be based on the expectation that the well being of the community will be enhanced.

8. Willingness to participate should be based on the provision of community packages that are designed both to facilitate participation in the short term and to ensure that a radioactive waste facility is acceptable to the host community in the long term.

9. Community involvement should be achieved through the development of a partnership approach, based on an open and equal relationship between the potential host community and those responsible for implementation.

10. At the end of each stage of the decision making process there should be provision for a review and the right of communities to withdraw from the process before proceeding to the next stage, up to a pre-defined point.

11. In order to ensure the legitimacy of the process, the key decisions at each stage should be ratified by the appropriate democratically elected body(ies).

12. CoRWM considers that an open and transparent process is an essential precondition to successful implementation of these recommendations.

CoRWM takes no position on the desirability or otherwise of nuclear new build. We believe that future decisions on new build should be subject to their own assessment process, including consideration of waste. The public assessment process that should apply to any future new build proposals should build on the CoRWM process, and will need to consider a range of issues including the social, political and ethical issues of a deliberate decision to create new nuclear wastes.

12. The discussions and consequent amendments were incorporated into a 'Draft for Decision' which was put to the members on 27 April 2006. It was endorsed by the whole Committee with one member indicating 'fundamental concern that the long-term safety of geological disposal, that underpinned the draft recommendations, had not been sufficiently demonstrated'.[3] The agreed recommendations are set out

in Figure 12.2. It was agreed that rationales should be developed for each of the recommendations and that they should be presented for comment to a further round of PSE.

13. CoRWM had taken its main decisions at the third decision-making plenary at Brighton. The recommendations represented a synthesis of knowledge, experience, values and understanding developed over the course of the CoRWM process. They also reflected an integration based on deliberation, negotiation, compromise and consensus achieved by the members. Once drafted it was unlikely that the recommendations would be subject to fundamental change. However, there were some issues, notably the form of disposal, that were open to further debate. And, in view of the importance of PSE to the whole process, it was felt important that opportunity should be given for a final round of comment, this time on the proposals themselves to which the public and stakeholders had contributed. In addition, comments (for clarification) would be sought on the MCDA/holistic processes. PSE4 would also provide a first opportunity to gather comments on CoRWM's draft implementation proposals.

14. The main outcomes of the PSE4 round have been presented in Chapter 7 and specific detailed comments are contained in the reports of the Citizens' Panels, stakeholder meetings, website responses and bilateral meetings with key organisations and institutions. A brief account of the main responses is given here. Most stakeholders and citizens were supportive of the draft recommendations. Although environmental groups supported many elements in the package they were mostly opposed to the proposed end point of geological disposal. Many participants felt that the recommendations should be seen as an integrated package and support would diminish if specific elements were 'cherry picked' by the Government or an implementing authority. The emphasis on flexibility and management of uncertainties was welcomed.

15. On the issue of the form of geological disposal, most participants wanted CoRWM to say more about its own thinking, though they did not want the Committee to make prescriptive recommendations. Another area where clarity would be welcome was whether the proposed implementation measures would also apply to interim storage arrangements.

16. There were also observations on how CoRWM could build further confidence in the recommendations. These included: clarifying and justifying the timescales on implementation; encouraging good practice in the interim management of wastes; identifying what steps could be taken to ensure that disposal would not be 'out of sight, out of mind'; considering communities affected by proposals as well as host communities; recommending a central role for an independent overseeing body that is open and transparent and committed to public and stakeholder engagement; and emphasising that the recommendations should address currently committed wastes and not those that might arise from any new build programme.

17. Overall, there appeared to be widespread satisfaction with the way CoRWM had reached its recommendations as is evident from the comment in Box 12.3.[7]

Box 12.3 Comments on the recommendations

'All groups expressed confidence in the twelve draft recommendations as a whole package. The recommendations addressing implementation issues were seen as essential to the success of the recommendations addressing options. It was considered that CoRWM had conducted a legitimate decision-making process, resulting in a sound set of draft recommendations, and that appropriate account had been taken of input from Citizens' Panels. CoRWM was seen as having set high standards of openness and transparency through its public and stakeholder engagement processes. It was considered important that these ideals and practices should be continued into and throughout the implementation phases. It was thought that an independent body, like CoRWM, should be formed to oversee the implementation process'.[7]

18. As a result of PSE4, CoRWM again debated the form of geological disposal rehearsing by now familiar arguments.[8] While there was general agreement favouring early closure of a repository, the Committee remained divided on the question of whether to make early closure a recommendation. Those favouring early closure argued that CoRWM should stand by its conclusion that keeping a repository open for several hundred years would impose burdens on future generations and a safety case might be hard to achieve. Other members considered phased disposal should not be ruled out particularly in the light of the PSE response. Leaving the issue open would be in the spirit of participation emphasised throughout the process. It was eventually agreed that CoRWM would make no specific recommendation on the form of disposal. Instead, it would indicate its unanimous preference for early closure whilst recognising the debate would continue.

19. PSE had also supported the role of interim storage both as an integral element in the strategy and as a contingency in the event of failure of the repository programme. A range of detailed points had been made in reference to the generic recommendations on storage, covering such issues as the longevity of stores, the need to achieve passive safety and the desirability of avoiding unnecessary transport of wastes. Whilst recognising the role of the NDA in relation to storage on many nuclear sites, the Committee discussion of the PSE responses led to a more detailed development of its recommendations on interim storage (see Chapter 16). The discussions raised issues about the siting of stores, notably whether they should be central or dispersed at existing local sites. This introduced a conflict between the desire to minimise transport (dispersed locations) and the need to secure public acceptability (possibly more difficult to achieve at a number of sites as the failure to find sites for LLW in the 1980s had demonstrated). The recommendations on stores emphasise that they should be designed to avoid major refurbishment or replacement for the period up to emplacement of wastes in a repository, and should also be able to withstand terrorist attack over this period. There are also recommendations on interim storage for different waste streams, notably the possibility of a central store for spent fuel and secure arrangements for the storage of plutonium if it were to be declared a waste.

20. The final issue to be resolved on management options concerned RDW. The short lived ILW and LLW not suitable for disposal at the LLWR was only a small part of CoRWM's inventory. There were a number of possibilities for this waste, including: co-disposal with the remainder of CoRWM's inventory in a geological repository; or co-disposal with LLW in shallow facilities at existing or new sites (if these facilities were developed following the LLW Review). The Committee agreed to

introduce a facilitative recommendation on RDW which indicated the need to consider available management options.

21. The proposals for implementation secured general agreement among the Committee members. There were three reasons for this. One was the general support for the proposals from stakeholders and the public who had been involved in discussion and responded to the proposals. A second reason was the widespread recognition that, given past failures at siting, there was a need for a fresh start based on co-operation and community participation. Third, the proposals in the main presented a process rather than a set of definitive recommendations. They offered the prospect of further debate, clarification and refinement as the implementation process got under way. The PSE4 responses emphasised the need for implementation to be seen as part of a whole and indivisible package, and urged the setting up of an independent overseeing body without delay. There was a very strong message that the Government should continue the momentum achieved by CoRWM.

22. In reaching its recommendations CoRWM had fulfilled its terms of reference 'to recommend the option, or combination of options, that can provide a long-term solution, providing protection for people and the environment'. It had done so, as required, in an open, transparent and inclusive manner. It had engaged with the public and stakeholders throughout. Moreover, it had also pointed the way forward indicating to Government the steps that need to be taken to implement its proposals. The Committee had achieved consensus on the recommendations and had met its commitment to report to Government by July 2006.

References

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Chapter 13 Confidence in geological disposal

To determine its recommendations, CoRWM needed to decide whether or not it had sufficient confidence in geological disposal to consider making this option a part of its overall package of recommendations. This chapter sets out arguments for and against geological disposal derived from ethics, overseas experience, PSE and science.

Introduction

1. Chapter 12 describes the process by which CoRWM reached its recommendations, but only in part deals with their substance. To determine its recommendations, the Committee needed to make a decision on a major and controversial area in radioactive waste management policy – namely whether or not CoRWM had sufficient confidence in geological disposal to consider making this option a part of its overall package of recommendations. To make this decision, CoRWM considered all the relevant streams of knowledge that it had gained, deriving from ethics, overseas experience, public and stakeholder engagement and science. This chapter considers each of these in turn and shows how they were combined to contribute to the substantive recommendations described in Chapter 14. It sets out the arguments for and against geological disposal as the end point of strategy.

Ethics

2. The long-term safety of geological disposal matters because of ethical concerns over the impact of radioactive waste on future generations. Consequently, ethics were an important component in the CoRWM decision as to whether or not there could be sufficient confidence in geological disposal (Chapter 6). The critical issue that emerges from ethical deliberation is ‘deal with it now’ or ‘leave it till later’. This is based on the ethical idea of fairness between generations (intergenerational equity). The difficulty lies in knowing how to achieve this fairness.

3. The ethical consideration behind dealing with it now is that it is the responsibility of the present generation, which has used nuclear energy, to deal with the waste created as soon as it can. The objective here is to minimise the burden facing future generations. A decision on how this can best be achieved will be greatly influenced by the confidence that is placed in the long-term safety of geological disposal. If there is high confidence that geological disposal genuinely removes burdens from future generations then the disposal option is likely to be the favoured way of dealing with it now. If there are doubts about the ability of geological disposal to remove these burdens, then dealing with it now would lead to a commitment to getting the waste into safe storage as soon as possible and to researching better methods of finding long-term management routes.

4. The ethical consideration behind leaving it until later is that it enables the current generation to avoid constraining the choices facing future generations. This is important because it is impossible to predict the needs and aspirations of future generations. There is also an ethical argument that it is wrong to lose control over hazardous material irrespective of long term safety and environmental expectations. Storage might provide a safe method of managing the waste in the interim while maintaining flexibility for the longer term so that future generations can make their own decisions. Geological disposal can also provide a degree of flexibility up to the point of closure.

5. From this brief discussion it is evident that a variety of ethical principles may apply to questions of 'dealing with it now' or 'leaving it till later'. Although some ethical positions can in isolation lead more or less directly to a pro-storage or pro-disposal preference, others do not. The preferred option may significantly depend on a judgement about the degree of confidence held in the long-term safety of geological disposal or continuing institutional control, and on the ethical stances adopted by the individual.

Overseas experience

6. Overseas experience (reported more fully in Chapter 9) was another ingredient in the decision-making process about geological disposal and storage. There is a clear dichotomy between experience and intention in the overseas experience of managing radioactive waste. In the 60 year history of waste management, experience is more or less exclusively of storage of various kinds. There is an operating geological repository in New Mexico (Waste Isolation Pilot Plant - WIPP) for military-origin wastes, and although a facility at Konrad in Germany has been licensed, there is no currently operating civilian radioactive waste repository. While the history of storage has been mixed and early storage practices fell far short of current safety standards, radioactive waste storage has generally been safe. Even though the kind of extended storage envisaged by proponents of storage is not yet tested (for example, the need for store refurbishment and major waste re-packaging), the pro-storage argument emphasises that little new technology is needed and that storage is established and safe practice. Geological disposal by contrast is as yet broadly untested.

7. However, in those countries that have made firm decisions on long-term waste management strategy, all have decided that geological disposal is the best way forward. In the case of Finland, there has been a start on a repository at Olkiluoto and in Sweden two communities are willing to host a proposed geological disposal site. In addition, the NWMO in Canada has recently recommended geological disposal as the best long-term option for managing spent fuel. The Netherlands is a partial exception to these decisions in favour of geological disposal. Its decision is to store for 100 years and then move to geological disposal when enough funds, and wastes, have accumulated. The pro-disposal argument puts weight on this dominant acceptance internationally of geological disposal as a future strategy and emphasises the risk that institutional control may be lost.

Views of the public and stakeholders

8. CoRWM gave much weight to its engagement with the public and stakeholders (PSE - see Chapter 7). While the Committee was always explicit that it would make its own decisions on which option or options to recommend, and would not simply act as a conduit for any particular view expressed, citizen and stakeholder views remain of great importance. If CoRWM contemplated recommending an option in the face of widespread public and stakeholder hostility, the chances of implementation would clearly be negligible. This section therefore considers what CoRWM learned about public and stakeholder views on this subject, as one part of its decision making process.

9. Within responses from citizens, the views of Citizens' Panels are especially interesting, because participants had more opportunity to acquire a deeper grounding in relevant issues than any other groups. The Panels provided a good understanding of the range of views that would exist among the general public (Chapter 7). The majority view of the Citizens' Panels was that some form of geological disposal should form part of the overall strategy. The CoRWM Schools projects, which had important but less extensive deliberative elements, also

delivered a strong opinion in favour of disposal. A large majority of those who used the Discussion Guide also favoured disposal.

10. Stakeholder views were more mixed, although a majority of stakeholders also expressed approval for geological disposal. Among the various 'sectors' of stakeholders the following groups all favoured disposal as end-point: regulatory and advisory agencies – the Environment Agency, Scottish Environment Protection Agency and Health Protection Agency; the nuclear industry; substantial sections of local government; trades unions; and learned societies and professional bodies. The views of environmental NGOs sharply contrasted with those above. Greenpeace, Friends of the Earth Scotland, and the Welsh Anti-Nuclear Alliance strongly opposed geological disposal.

11. The interpretation given to the preferences expressed in the three main deliberative processes, i.e. the Citizens' Panels, the Discussion Guide and the Schools Project, was considered carefully by CoRWM. The choices made by members of the public were not starkly between geological disposal and storage. Participants were invited to express more detailed preferences: between geological disposal, meaning early closure of a repository; phased geological disposal, delaying potential closure by up to 300 years; and variants of interim storage. Phased disposal appears to offer both the advantage of removal of burden through early action and flexibility through the possibility of gaining access to wastes over relatively long periods. The question is then whether citizens who preferred phasing were more influenced by the possibilities of flexibility and retrievability (also offered to an even greater extent by storage) or whether they were more influenced by the idea that phased disposal represented early action that was intended to lead to disposal (also offered by geological disposal). It is also likely that they were attracted by the prospect of getting the 'best of both worlds' - of flexibility and removal of burden - even though in practice the attractiveness of phasing, as discussed in Chapter 15, is less than it first appears.

12. There is almost certainly no definitive answer to these questions. One interpretation, supported by one member of CoRWM, is that a preference for phasing amounted primarily to wanting retrievability. If the preferences for storage and phased disposal are added up, then in each of the three citizens' deliberative activities, 61%, 61% and 58% respectively wanted retrievability.[1] Storage options also provide flexibility and retrievability, and more effectively than phased disposal. On this view, then, citizens showed majority support for options with characteristics best displayed by storage. However during PSE4, citizens were able to review this issue and they appeared to confirm that their preference was indeed for some form of disposal.

13. Another interpretation, supported by several other members of CoRWM, is that in prefering phased geological disposal or geological disposal, members of the public were supporting early action to build a repository to one kind of detailed design or other. Citizens had the opportunity to opt for storage if flexibility was uppermost in their minds, and a minority chose to do so. If preferences for the three disposal options (including boreholes) are added up, then in the same three citizen processes between 60%, 63% and 97% wanted geological disposal. On this interpretation a majority of citizens do want early action involving geological disposal of one type or another.

14. The precise proportions shown above are not important. Public views on long-term management options show considerable subtlety and it is impossible to capture all the nuances involved in the process by which they expressed preferences between options. There is a continuum of opinion between the desire to maximise flexibility on the one hand and the desire to remove burdens from future generations as quickly as possible on the other. Most CoRWM members, while recognising this continuum, nevertheless were persuaded that a significant

majority of those members of the public with whom CoRWM engaged were in favour of moving towards geological disposal of one kind or another as soon as practicable. Most members of CoRWM therefore concluded that there would be a basis for public confidence if geological disposal was part of its recommendations.

Specialist opinions: the CoRWM MCDA

15. An important test of confidence in geological disposal for CoRWM's decision making process was the expected safety and environmental performance of geological disposal over the very long-term.

16. The first way in which CoRWM assessed this was through its MCDA. The overall MCDA result, combining specialist performance assessments and weighting of assessment criteria (see Chapter 11) showed the two main geological disposal options as ranking well ahead of all the storage options. It needed a very large set of changes in both performance measures and weights in a systematic pro-storage direction for the storage options to reach parity with disposal. In this sense, the MCDA produced a robust outcome in favour of disposal across eleven different assessment criteria even if the application of some criteria, especially burden on future generations and flexibility, is the subject of some controversy (see Chapter 11).

17. But MCDA has limitations and cannot provide 'answers' to questions of choice between options. Analysis of the overall MCDA results by relevant criteria shows the degree of confidence that specialist opinion, as used in the MCDA, had in geological disposal. For long-term confidence, the key criteria for performance assessment are public safety and environmental performance.

18. For public safety in relation to radioactivity, the results were that geological disposal options were rated in the range 'very strong' to 'inherently resilient' to possible adverse events in the period up to 300 years into the future. For storage options in the period up to 300 years, the rating was that they would provide intermediate resilience to adverse events but contained some weaknesses, partly due to the need to refurbish stores and repackage wastes, increasing worker exposure to radiation. For the period beyond 300 years, geological disposal options were expected to provide very high confidence in their ability to protect the public against radiation for all waste streams except ILW, where confidence was high, rather than very high, mainly due to uncertainties about the potential gas pathway for radionuclides to the biosphere.

19. In the case of environmental protection from radiation (in other words, for non-human species), the expectation of the specialists was that for the first 300 years geological disposal options would provide between very strong and inherent resilience while storage options would give poor resilience. In the long-term, beyond 300 years, it was expected that geological disposal options would provide high to very high confidence that radiation releases to the biosphere would be minimised.

20. Overall, for the period up to 300 years, where direct comparison between geological disposal and storage options was possible, the geological disposal options were expected to give better safety and environmental protection than storage options. For the period beyond 300 years, confidence in the performance of geological disposal was high or very high.

21. Even though the overall MCDA result and the performance assessment within it of safety and environment suggested a high degree of confidence in geological disposal, and higher than for storage, a pro-storage case can nevertheless still be constructed from the overall MCDA. On some assessment criteria, especially

flexibility, storage options performed better than disposal. If flexibility is weighted high enough relative to all other criteria, storage options would, overall, be rated higher than some disposal options in the MCDA. Wider pro-storage arguments set great weight on flexibility, often because of a belief that the irreversibility of disposal denies future generations the right to choose how to protect themselves against radiation exposure at levels they may find unacceptable. The pro-disposal argument would instead place significant weight on the higher safety scores for disposal than storage, the better security scores for disposal on most security criteria and the much higher disposal scores for 'burden' (effectively, removal of burden). More generally, the pro-disposal argument is that geological disposal minimises the period into the future when institutional control is required to ensure safety and security, and believes it unwise to rely on a continuation of the high levels of institutional control several hundreds of years into the future.

22. But the burden criterion is contentious. Scoring geological disposal options high in burden terms effectively amounts to a high degree of confidence in the long-term safety of geological disposal, and the pro-storage argument is sceptical of such claims. For further insight into the very important issue of confidence in long-term safety of geological disposal CoRWM turned to an assessment of the nature and credibility of evidence from the wider scientific community.

The wider science community's views and challenges to those views

23. To assess confidence in the safety and environmental performance of geological disposal, CoRWM sought knowledge from as wide a range of scientific expertise as possible. The MCDA specialists believed that a high level of confidence was justified, but these specialists – while a distinguished group of scientists – were necessarily a limited sample and did not include representation from the NGOs. CoRWM needed to collate evidence from a much wider range of sources on this subject. There are a number of general issues to be considered first.

24. The first issue is that of potential bias. Much of the international scientific community's work in this area has been carried out within, or under contract to, organisations which are pre-disposed towards nuclear power – for example the Nuclear Energy Agency of the OECD (NEA) and the International Atomic Energy Agency (IAEA). These organisations have consistently expressed their own confidence in the long-term safety of geological disposal.[2] Within the UK, a good deal of scientific expertise has resided within Nirex, the body - originally owned by the nuclear industry and now by Government - that has had responsibility for most of its life for finding suitable UK sites for geological disposal of ILW. It too has often expressed a high level of confidence, especially in relation to its own preferred design for a phased repository, capable of staying open after emplacement of waste for several hundred years.[3]

25. The fact that scientific expertise is 'owned' by such bodies can cause suspicion of bias, but it does not necessarily invalidate the views expressed by those scientists. Their institutional affiliations must be noted and considered, but the views expressed need to be tested in the same way as any scientific views and not automatically discounted because of institutional affiliation. But this also means that it is important to establish support or verification for such views from sources of expertise that are independent of such institutional interests. For these reasons, CoRWM canvassed opinion among members of the 'learned societies', which contain a significant number of distinguished and independent scientists and held meetings specifically designed to hear such opinion at first hand (for example the Royal Society November 2005 meeting, the Geological Society international event in January 2006) Bias can, of course, also in principle be present because of the institutional affiliations of those who work for anti-nuclear groups but, as above, this is not a reason for necessarily discounting any view expressed.

26. The second issue concerns the nature of the assessment that CoRWM had to make. The Committee is required to recommend generic options, not specific design concepts. Much detailed design work and investigation will be needed if geological disposal were to be pursued by Government. During such site investigation and design work it could become clear that any individual site is unsuitable for geological disposal for a variety of possible reasons. Many people in the earth sciences community expressed to CoRWM their view that while they had high generic levels of confidence in geological disposal, the suitability of any individual site could not be affirmed until much detailed site investigation had taken place. However, this is a question that later parts of the MRWS process would need to determine if geological disposal was pursued. It was never part of CoRWM's remit.

27. The third issue concerns uncertainty and its interpretation. Future events, even a few years hence, are inherently unpredictable, and for long-term radioactive waste management, the impacts of current decisions could be felt hundreds of thousands of years into the future. A substantial part of the argument between storage and disposal is about irreducible uncertainties in the long-term future. Modelling future behaviour of radioactive waste is an important component in assessing future safety levels and models have an important place in assessing overall confidence levels. However, it is impossible to have complete confidence in the precise predictions of such models. The pro-disposal argument is reassured by other less quantifiable indicators of confidence (see next paragraph). The anti-disposal view holds that knowledge about geological disposal is inadequate, so that delay in commitment to a disposal strategy is necessary until knowledge about long-term management options improves substantially .

What can confidence in long-term safety rest on?

28. In the context that sufficient confidence needs to be demonstrated over periods of up to a million years into the future, the main pro-disposal arguments are as follows:

- The design of a geological repository is a multi-barrier concept that can be fitted in detail to the particular (suitable) geology of a repository site, which can be crystalline rock, salt, shale or clay, all of which exist in the UK and underly over 30% of its area.[4] The waste form and packaging, the waste container, the 'backfill' material used and the geological suitability of the chosen site should all act to delay and retard the movement of radionuclides when, after a very long period, radioactivity escapes from the waste package and enters the geosphere.

- There is high confidence in the scientific community that there are areas of the UK where the geology and hydrogeology at 200 metres or more below ground will be stable for a million years and more into the future.

- Confidence in this expectation derives in part from a reconstruction of the historic records of geology in the UK and elsewhere. This work demonstrates that the geological structure of the UK at such depths has been stable for very long periods. Internal physical and chemical conditions in many such structures have been stable for many millions of years. Hydro-chemical processes that could lead to mobilisation of radionuclides would be extremely slow. The possibilities of disturbance from seismic or volcanic activity, or future climate change are, at such depths, negligible.

- Work on natural analogues show that geologies with a low water flow will retain radionuclides over very long periods. Natural analogue work in Canada and Gabon (the latter containing a 'natural nuclear reactor') suggests that even large events

involving nuclear criticality have resulted in the movement of fission products only a few tens of metres through surrounding rock over very long periods.

- When a repository is excavated there is inevitably a perturbation in the local geosphere. Research on this issue suggests that the local geosphere will recover from its initial perturbation within a few hundred years and remain stable thereafter.

- There is consensus in the scientific community (including the regulatory community) that the forms of radioactivity most likely to display high mobility have been identified, together with the uncertainties associated with their mobility.

- After taking account of the various uncertainties that still exist, regulators have been satisfied that risk targets can be met in all countries where individual sites have been examined.

- If these risk targets were met, using ICRP assumptions about the relationship between radioactivity and health impact, the uncertainties associated with predicting the amount of radioactivity and the time that it would take to reach the biosphere would mean that the maximum level of radiation exposure (approximately 10 millisieverts per year to the most exposed members of the population[5)] occurring 200,000 years in the future, would not exceed natural background radiation levels in some parts of the UK today. Ten millisieverts is approximately five times greater than the UK's average natural background level. By contrast the 'most likely' case suggests a negligible human dose over the relevant period of several hundreds of thousands of years. The decay of radioactivity means that its potential for harm eventually reduces to natural background levels. In the case of HLW, this 'crossover' time is a few thousand years, though for spent fuel the period is much longer, of the order of 300,000 years.

- As a result of the combination of design and geology, it is therefore considered very unlikely that radioactivity will reach the biosphere in quantities large enough to cause significant harm to human or other populations even over many hundreds of thousands of years.

- The Health Protection Agency's view is that the degree of uncertainty associated with ICRP dose coefficients varies with the radionuclide. For some radionuclides, e.g., isotopes of caesium and iodine, the uncertainties are of the order of two to three, but for other radionuclides, e.g., isotopes of plutonium, the uncertainties can exceed a factor of ten.

29. Those who are unconvinced of the above case for confidence in the long-term safety of geological disposal do not take the evidence on which it is based at face value. In the context of the need for confidence over a million years, they believe that the case is unverifiable and that this alone should rule out consideration of the option. They question the interpretation and application of evidence; whether or not all the assumptions are reasonable; and whether all relevant scenarios have been considered. Uncertainties are clearly manifold over so long a period into the future. Arguments against disposal include:

    - there may be significant problems within the waste containers, involving gas build-up and relatively rapid corrosion of container cladding, thereby invalidating calculations about the rate at which radionuclides reach the biosphere.

    - the materials expected to be used as backfill for repositories, for example cements and bentonite clay, may experience shrinkage or cracking respectively, thus accelerating both the ingress of water into the repository and the movement of radioactivity into the geosphere and biosphere, again invalidating modelling results. Assumptions about permeability, especially for some forms of backfill material, depend on extrapolations from existing data and may be unreliable.

- there may be poorly understood chemical and/or microbiological reaction or activity in relation to escaped radioactivity, for example on exposure to minerals and salts in the rock. Interactions between heat, water, radioactive decay, gas build-up and the presence of microbial organic matter are poorly understood, again potentially accelerating the return of radioactivity to the biosphere.

- both groundwater and gaseous pathways by which radioactivity may return to the biosphere cannot be fully understood and may again lead to acceleration in the process.

- the ability of the backfill material to trap sub-micron radioactive particles and the possibility of such particles returning to the biosphere has not been explored.

- the large-scale perturbations involved in constructing a deep repository may significantly undermine the high-quality geological conditions which underlay the original site selection by the creation of stress fractures and the resulting ingress of water to an area of low pressure created artificially. If the local geosphere does not return to a stable state as predicted in the pro-disposal argument, any of the above negative potential effects may be amplified.

- different waste types have differing technical requirements for ensuring safety and no generic safety case over a million years can therefore be made.

- in addition, it is impossible to know what future societies may learn about the impacts of radioactivity on human health. Radiological protection standards have become more stringent in the last 50 years and may become more so, especially if the human health effects of radiation are discovered to be more severe than currently understood. Future societies may also, quite separately from this argument, decide on much more stringent health and safety standards in respect of radioactive waste.

- the 'worst case' analyses quoted above depend on quantitative modelling that is necessarily highly uncertain and could easily be substantially wrong. If the Low Level Radiation Campaign (LLRC) were right that the health effects of given doses can in some cases be substantially more harmful than the International Commission on Radiological Protection (ICRP) suggests, the effects on human populations could well be substantially higher than modelling suggests.

30. The collective impact of these arguments is that while geological disposal aims to provide a means of 'concentrate and contain' for radioactive waste, it may end up as 'dilute and disperse', because even the pro-disposal models assume that some radioactivity eventually returns to the biosphere. Sceptics argue that comparing geological disposal against storage over 300 years is not relevant to the debate about safety and security up to a million years in the future. While support for disposal comes from the scientific community, overseas experience and public and stakeholder opinion, there remain doubts about the use of the ideas of 'burden' and 'flexibility' in pro-disposal arguments. Both sides believe that the opposite argument to their own represents a deferral of the problem.

31. The LLRC takes a different view about the dose/risk relationship to that of ICRP.[6] Work was carried out for CoRWM to test the effects of LLRC assumptions on the possible health effects associated with the 'worst case' described above. The first occasion that the implications of LLRC views were reported to CoRWM, the conclusion was that total risk, summed over all radionuclides, would rise by a factor of around two (from ten times the current regulatory dose limit to 20 times), compared to the worst case figures quoted above. However, LLRC subsequently presented, for uranium isotopes, much higher 'weighting' factors which would, if validated, increase risk by a factor of about 25. However the basis for these enhanced weighting factors has not yet been published (and so has not been appraised by the wider scientific community). Most members of CoRWM

do not therefore find these recent LLRC arguments convincing, especially in the light of the substantial weight of peer-reviewed evidence that points to very much lower doses. One member of CoRWM, however, believes that the LLRC views should be treated as potentially credible, arguing that the 'worst case' figures quoted above (five times the average UK natural background level) are themselves too great a risk to run. If the LLRC were to be right, the exposures of future populations would be much higher and this could make an strong case for caution and a continuation of interim storage while more evidence about radioactivity is accumulated.

32. There is no way in which the scientific debate between supporters and opponents of geological disposal can be definitively resolved now on the basis of incontrovertible evidence. There is an almost universal level of support among scientists in the UK and internationally that geological disposal is a sufficiently safe long-term option for managing higher-level radioactive wastes. This view is also taken by relevant regulatory and advisory agencies in the UK and internationally. But this is not definitive: neither side in the disposal/storage argument can 'prove' its case because in both cases, predictions are needed over either hundreds of years (storage) or hundreds of thousands of years (disposal). The anti-disposal case rests on doubts about the quality and reliability of evidence presented in favour of geological disposal. The pro-disposal case rests on a large amount of international scientific work, which generally regards the questions raised by the anti-disposal arguments as unlikely to shake the foundations of the disposal case together with serious doubts about the confidence there can be about the continuing high levels of institutional control necessary for storage to be credible. If the case for having sufficient confidence in the long-term safety of geological disposal is accepted, much further research is needed. An example derives from regulatory views of the Nirex concept of phased geological disposal for ILW, the most highly developed UK geological disposal concept to date. The Environment Agency, replying to Nirex's report on the viability of its concept believes that a safety case can be made, but that the present state of development of the concept leaves many key technical challenges to be overcome.[7]

Conclusion

33. The main arguments that CoRWM heard for and against confidence in geological disposal have been set out together with arguments for and against long-term storage. All were influential in the process by which CoRWM members made decisions on the potential role of geological disposal in its overall recommendations. There is a spectrum of individual views among CoRWM members on the degree of confidence they have in the long-term safety of geological disposal. However, the conclusion from the above arguments considering all knowledge streams together was, for the great majority of members, that they had sufficient confidence to consider geological disposal for recommendation to Government as an end-point, given the current state of knowledge.

34. However the final decision on whether or not to recommend geological disposal as an end-point for radioactive waste management depended on a comparison between the merits of geological disposal and of long-term interim storage, given that confidence in geological disposal, especially its safety characteristics, can never be absolute. The flexibility argument for continuing storage is attractive and there are ethical arguments in its favour as well. But the critical issue for most members of CoRWM, given their confidence that geological disposal would not constitute a significant burden on future generations, was that the safety of long-term interim storage depends on an expectation of continuing institutional control over several hundred years. The risk of loss of institutional control while waste is still in storage is that there may be potentially large safety and environmental consequences in the relatively near future. For the great majority of CoRWM members this was influential in judging the desirability of moving towards geological disposal as quickly as practicable while ensuring that a robust programme of storage is achieved until a repository is available. All CoRWM members were prepared to endorse the wider package of recommendations presented in Chapter 14.

References

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3 UK Nirex Ltd, ‘The viability of a phased geological concept for the long-term management of the UK’s radioactive waste’, Nirex Report N/122, November 2005.

4 UK Nirex Ltd and British Geological Survey, "A note by the British Geological Survey and Nirex on the Suitability of UK Geology for Siting a Repository for Radioactive Waste", document 1797, March 2006.

5 UK Nirex Ltd, ‘Biological uptake routes for worst case probabilistic realisations in the assessment of the groundwater pathway for the Nirex PGRC’, Nirex Technical Note 509002, July 2006.

6 Committee on Radioactive Waste Management, ‘CoRWM’s work and the views of the Low Level Radiation Campaign’, document 1633, July 2006.

7 Environment Agency/Nuclear Waste Assessment Team, “Review of Nirex Report: ‘The Viability of a Phased Geological Repository concept for the Long-Term management of the UK’s Radioactive Waste”, reference NWAT/Nirex/05/003, November 2005.

Chapter 14 CoRWM's recommendations

CoRWM is presenting an integrated set of recommendations, covering three interdependent strands. It recommends geological disposal as the end point for the long-term management of radioactive wastes and robust storage in the interim period, including provision of contingency against delay or failure in reaching the end point. The third strand focuses on implementation, including the need for a staged process, flexibility in decision making and partnership with communities willing to participate in the siting process.

1. The following are CoRWM's final recommendations. Our judgements are based on what we learned from a combination of scientific advice, overseas experience, public and stakeholder engagement (PSE), and consideration of ethical issues. Through its engagement with the public and stakeholders, CoRWM believes that its recommendations provide the basis for inspiring confidence. We commend them to Government as an integrated package and urge progress without delay so that the momentum established by the CoRWM process is not lost. CoRWM considers that continued openness and transparency is essential for the successful implementation of these recommendations.

Recommendation 1: Within the present state of knowledge, CoRWM considers geological disposal to be the best available approach for the long-term management of all the material categorised as waste in the CoRWM inventory when compared with the risks associated with other methods of management. The aim should be to progress to disposal as soon as practicable, consistent with developing and maintaining public and stakeholder confidence.

2. A large majority of CoRWM members have sufficient confidence in the long-term safety of geological disposal, and its ability to reduce the burden on future generations, to recommend it as the preferred end-point. This view took into account various factors, including specialist judgements during Multi-Criteria Decision Analysis (MCDA), the strong consensus that exists in the earth sciences community, and estimates of public exposure to radiation in the far future after repository closure. Most members considered that the risks from geological disposal were substantially smaller than those from long-term storage, which they considered to be vulnerable to terrorist actions, war, loss of institutional control, and severe environmental change. It was stressed, however, that absolute confidence in the long-term safety of geological disposal could not be assumed. One member challenged whether a judgement of sufficient confidence could be reached in the light of the uncertainties associated with repository performance and argued that the risks associated with storage could be mitigated in part by the type of storage regime adopted (siting away from the coast, underground, etc.).

Recommendation 2: A robust programme of interim storage must play an integral part in the long-term management strategy. The uncertainties surrounding the implementation of geological disposal, including social and ethical concerns, lead CoRWM to recommend a continued commitment to the safe and secure management of wastes that is robust against the risk of delay or failure in the repository programme. Due regard should be paid to:

i. reviewing and ensuring security, particularly against terrorist attacks
ii. ensuring the longevity of the stores themselves
iii. prompt immobilisation of waste leading to passively safe waste forms
iv. minimising the need for repackaging of the wastes
v. the implications for transport of wastes.

3. CoRWM recognises that there are social and ethical concerns that might mean there is not sufficient agreement to implement geological disposal at the present time. In any event, the process of implementation will take several decades. This period could last for as long as one or two generations if there are technical difficulties in siting or if community concerns make it difficult, or even impossible, to make progress at a suitable site.

4. The existing wastes in the CoRWM inventory are in storage on nuclear sites and future wastes, as they arise, will also be placed in storage. CoRWM recognises the work that the Nuclear Decommissioning Authority (NDA) and others are carrying out in relation to storage of radioactive waste on those sites for which they have responsibility. Over the timescale for implementing geological disposal, some of the UK's present stores may need to be refurbished or replaced and new stores for future wastes will be required. CoRWM's view is that arrangements are needed – as part of an overall strategy – to take account of the possibility that a repository may be delayed or may never be constructed and that there will be a need to keep the wastes secure and safe for longer than previously thought. The Government will need to take account of the specific issues raised by this requirement for interim storage:

   i. The design and engineering of new stores, and the refurbishment of existing ones, will need to take account of risks to the security of their contents, now and into the future. This includes, but is not limited to, the vulnerability of the waste form and the degree of protection provided against attack, including the possibility of putting stores underground or providing them with heavily reinforced walls and roofs.

   ii. The design lifetimes of new stores should cover a period of interim storage of at least 100 years to cover uncertainties associated with the implementation of a geological repository. The replacement of stores should be avoided if at all possible.

   iii. Regulators agree that wastes should be made passively safe as soon as practicable.

   iv. The repackaging of wastes is regarded by the regulators as inherently undesirable, mainly because of the risk of exposure of workers to radiation. They have also expressed concern about the ability of packages to contain intermediate level waste (ILW) much beyond 100 years.

   v. The transport of wastes is an important issue. In particular, the 'double movement' of waste should be avoided as far as possible, e.g., building interim stores at regional or central sites only to have to move the wastes for a second time in the event that disposal facilities are implemented elsewhere.

Recommendation 3: CoRWM recommends a flexible and staged decision-making process to implement the overall strategy, which includes a set of decision points providing for a review of progress, with an opportunity for re-evaluation before proceeding to the next stage.

5. Experience in the UK and overseas shows that implementation should be a staged process of sequential decision making, with the main elements and stages agreed as milestones by outcome, before the process starts, with clear and transparent roles for the participants. The process should be flexible and include the evaluation of ongoing research and development (R&D) and a review of progress, at pre-determined points, to establish whether there is sufficient agreement to move to the next phase and to decide whether to adopt any proposed alternatives.

Recommendation 4: There should be a commitment to an intensified programme of research and development into the long-term safety of geological disposal aimed at reducing uncertainties at generic and site-specific levels, as well as into improved means for storing wastes in the longer term.

6. CoRWM has made its recommendations on the basis of the best available scientific and societal information. It recognises that there is a need for further research into the characteristics of geological disposal in the UK and that this should address and seek to reduce the uncertainties surrounding long-term safety. More research is required into improving the robustness of storage.

Recommendation 5: The commitment to ensuring flexibility in decision making should leave open the possibility that other long-term management options (for example, borehole disposal) could emerge as practical alternatives. Developments in alternative management options should be actively pursued through monitoring of and/or participation in national or international R&D programmes.

7. CoRWM recognises that there are rapid developments in science and technology so practicable alternatives may become available in the period up to the closure of a repository. CoRWM therefore recommends a flexible approach; it would be wrong to deny future generations the opportunity to avail themselves of alternative methods because of too rigid a focus on the end-point of geological disposal. An example is boreholes where there could be benefits from the enhanced isolation and security offered for some wastes, but there is not sufficient knowledge to put the option forward at this stage. CoRWM is therefore recommending that appropriate research and development should be undertaken into alternative management options.

Recommendation 6: **At the time of inviting host communities to participate in the implementation process, the inventory of material destined for disposal must be clearly defined. Any substantive increase to this inventory (for example creation of waste from a new programme of nuclear power stations, or receipt of waste from overseas) would require an additional step in the negotiation process with host communities to allow them to take a decision to accept or reject any additional waste.**

8. Potential host communities will need to know the nature and the quantities of the waste before they consider possible participation in implementation. This was one of the key responses from PSE, both from the public and NGO stakeholders. If no decision has been taken about existing uranium, spent fuel and plutonium stocks by that time, or if additional materials or wastes are created for example, from nuclear new build, CoRWM is clear that these must be subject to a separate process.

Recommendation 7: **If a decision is taken to manage any uranium, spent nuclear fuel and plutonium as wastes, they should be immobilised for secure storage followed by geological disposal.**

9. In deriving its recommendations, CoRWM has assumed that all of the UK's un-reprocessed spent fuel, all the uranium and plutonium from reprocessing are managed as waste. Should they be declared as waste, they would have to be packaged and then stored, probably for several decades, before disposal.

Recommendation 8: **In determining what reactor decommissioning wastes should be consigned for geological disposal, due regard should be paid to considering other available and publicly acceptable management options, including those that may arise from the low level waste review.**

10. CoRWM makes a caveat regarding reactor decommissioning waste (RDW) some of which is likely to be short-lived ILW. CoRWM was not required to make recommendations about siting of facilities but notes that, if the option of disposing of low level waste (LLW) on site is publicly acceptable and is pursued, consideration should be given as to whether a safety case could be made for including appropriate RDW in order to avoid transport.

Recommendation 9: **There should be continuing public and stakeholder engagement, which will be essential to build trust and confidence in the proposed long-term management approach, including siting of facilities.**

11. CoRWM's experience highlights the importance of continuing to build trust and confidence through effective forms of public and stakeholder engagement.

Recommendation 10: **Community involvement in any proposals for the siting of long-term radioactive waste facilities should be based on the principle of volunteerism, that is, an expressed willingness to participate.**

12. Experience in the UK and abroad clearly demonstrates the failures of earlier 'top down' mechanisms (often referred to as 'Decide-Announce-Defend) to implement long-term waste management facilities. It is generally considered that a voluntary process is essential to ensure equity, efficiency and the likelihood of successfully completing the process. There is a growing recognition that it is not ethically acceptable for a society to impose a radioactive waste facility on an unwilling community.

Recommendation 11: Willingness to participate should be supported by the provision of community packages that are designed both to facilitate participation in the short term and to ensure that a radioactive waste facility is acceptable to the host community in the long term. Participation should be based on the expectation that the well-being of the community will be enhanced.

13. In the light of overseas experience CoRWM has concluded that communities are unlikely to come forward or agree to engage unless a comprehensive Involvement Package will be provided, which will, in turn, allow the negotiation of a Community Package. The scale and scope of the funding will need to be determined nationally and agreed beforehand in discussion with relevant parties. For the process to be fair, a local community hosting a facility should be better off after siting than before. This reflects and acknowledges the service that is being provided for society at large.

Recommendation 12: Community involvement should be achieved through the development of a partnership approach, based on an open and equal relationship between potential host communities and those responsible for implementation.

14. Some of the most promising programmes overseas are based on the potential host community working in partnership with an implementing body to achieve a successful outcome for both. One of the advantages of the partnership approach is that it achieves an environment in which host communities can engage with an implementing body without feeling victimised by a national process over which they ultimately have little control.

Recommendation 13: Communities should have the right to withdraw from this process up to a pre-defined point.

15. In processes that are successfully moving forward abroad, the right of the potential host community to withdraw from the process is an important factor in determining the willingness of communities to participate. This right has some limitations. There will come a point when the process of implementation has proceeded so far that withdrawal would not be possible.

Recommendation 14: In order to ensure the legitimacy of the process, key decisions should be ratified by the appropriate democratically elected body/bodies.

16. Democratic representation and ratification of decisions is necessary to achieve overall acceptability and legitimacy for decisions. What decisions require democratic endorsement, and at what level they should be taken, is a matter for further work.

Recommendation 15: An independent body should be appointed to oversee the implementation process without delay.

17. Given the long history of delay and deferment in the UK on the issue of radioactive waste management, it is clear that any new or revised institutional arrangements for progressing the radioactive waste management process in the future need to draw on the current goodwill and momentum achieved by the CoRWM process. There is a pressing need to establish an appropriate institutional basis to carry the process forward. CoRWM's view is that the staged decision-making process should be supervised by an independent body with overall responsibility for overseeing the research and development programme, the siting strategy and ensuring proper engagement with the public and stakeholders at each stage. Government should set up such a body without delay.

18. There should also be an implementing body responsible for the construction and operation of any necessary facilities, and related research and development. The roles of the overseeing body and the implementing body at each stage of the decision-making process must be clearly defined in advance. It is clear from previous UK experience and recent experience in Sweden and Finland, that the regulators have an important role in the successful implementation of the process.

CoRWM takes no position on the desirability or otherwise of nuclear new build. We believe that future decisions on new build should be subject to their own assessment process, including consideration of waste. The public assessment process that should apply to any future new build proposals should build on the CoRWM process, and will need to consider a range of issues including the social, political and ethical issues of a deliberate decision to create new nuclear wastes.

Chapter 15 Geological disposal

This chapter describes different forms and characteristics of geological repositories - about which many views have been expressed during public and stakeholder engagement. CoRWM's advice is intended to help people appreciate the implications of its recommendation for disposal.

1. CoRWM is recommending geological disposal as the end point in the long term management of radioactive waste. The Committee was not asked by Government to review or suggest specific designs for facilities. That will be the responsibility of the implementing body (see Chapter 17). Nevertheless, CoRWM has considered some of the fundamental differences in repository design concepts including their applicability to different waste streams and the extent to which they incorporate a degree of flexibility for management in the future. An explanation of CoRWM's rationale for its recommendations on geological disposal is provided in Chapter 13 and further elaboration on the uncertainties raised is given in Chapter 18.

Repository design concepts

2. Geological disposal in an underground repository is the waste management option that is currently favoured by many countries for spent fuel and HLW. These countries include Belgium, France, Finland, Germany, Japan, Sweden, Switzerland and the United States. No country is yet operating a geological repository for these materials but some, e.g. Finland and the US, have identified sites. Construction of the geological repository for spent fuel at Olkiluoto, Finland, has started and the repository is scheduled to become operational within the next 10 - 15 years.

3. Some countries, e.g. Switzerland and Germany, are also considering geological disposal for the management of long-lived intermediate level waste. The US is operating a geological repository, (WIPP in New Mexico) for the disposal of long-lived intermediate level waste from defence-related activities and Germany has recently licensed the Konrad mine facility, but no other country has yet commissioned a geological repository for intermediate level waste. Sweden and Finland have operated shallow facilities for short-lived operational intermediate and low level wastes for some time but these are not geological repositories and are better described as shallow vaults.

4. Geological disposal is based on the concept of the retention of the waste by a combination of engineered containment within a geological barrier. This provides a series of multiple engineered barriers comprising the solid conditioned waste-form, the waste container and any waste overpack (collectively referred to as the waste package), a buffer made of a material such as clay, grout or crushed rock that separates the waste package from the host rock together with any tunnel linings and supports. The geological barrier supports the engineered system and provides stability over the long term during which time radioactive decay reduces the levels of radioactivity. The geological barrier provides a stable environment over the long term and reduces the return to the biosphere of any radioactivity released from the engineered barriers.

5. CoRWM's list of options referred to deep geological disposal. The word 'deep' was used to distinguish this option from shallow burial. However, some PSE responses pointed out that the term 'deep geological disposal' was misleading; depth is not a key factor, it is the geology and hydrogeology that are of importance. Some repository concepts, such as that proposed for Yucca Mountain, are not deep below the surface. CoRWM therefore decided to refer to this option as 'geological disposal'. The actual depth of a geological repository will depend on a variety of factors, including the rock type (its strength and stability), and the local geological and hydrogeological conditions, but excavation would typically be to a depth of between 200 – 1000 metres. Geological repositories may be

constructed in a variety of rock types including crystalline rocks, clays and salt. Unlike some countries, such as Canada and Scandinavia, where there is a uniform underlying geology, the UK is underlain by a variety of different rock types. The British Geological Survey estimates that approximately 30% of the land surface may lie above geologically suitable rock formations.[1]

6. Concepts for geological disposal are based on an extremely long period of containment of the waste during which time its level of radioactivity will diminish through the process of decay. When, at some time far into the future, the engineered barriers fail and some radioactivity is slowly released into the surrounding rocks and groundwater and, ultimately, into the biosphere, the level of radioactivity is expected to be insignificant in terms of impacts on human health and the environment. It is apparent from PSE responses that some people are sceptical of this concept, pointing out that, regardless of other uncertainties associated with disposal, the engineered barriers could fail relatively quickly. Some even question whether this is really a 'disposal' concept because radioactivity ultimately comes back into the biosphere, albeit in a diminished form. Even those people who were broadly in favour of geological disposal often expressed reservations. One of the key messages coming from CoRWM's public and stakeholder engagement was the desire to balance the wish to dispose of the waste once and for all with the wish to allow for the possibility of getting the waste out again if this was considered necessary at some time in the future. This idea of disposal coupled with an element of retrievability has been adopted in most other national programmes in response to public concerns over the 'finality' of disposal. Many of the designs being developed in other countries incorporate some flexibility, both in the timing of closure and in the ability to remove waste once it has been emplaced, in order to address these concerns.

Retrievability and monitoring

7. CoRWM's short-list included three disposal options: geological disposal, phased geological disposal and boreholes. The Nirex phased geological disposal concept for ILW, which was the basis of CoRWM's phased geological disposal option, is one such design concept. It involves the incorporation of design features that would enable a repository to stay open and function as a storage facility for several hundred years – though it could be sealed much sooner, even vault by vault as each is filled. By contrast, CoRWM's geological disposal option is based on a direct disposal concept. It involves an intent to backfill and seal as soon as waste is emplaced, although the means of closure could vary from sealing each disposal vault once full, to sealing the entire repository once all the waste is emplaced. The geological requirements are broadly the same for both geological disposal and phased geological disposal[1] although the need to maintain large open vaults as a store in the phased geological disposal concept might preclude some particular geologies. There would also be some differences in the engineered components, relating to the need to provide for on-going maintenance and refurbishment while the facility operated as a store. However, these differences in design are regarded by many experts as matters of detail along a design continuum going from immediate disposal at one extreme to an integrated pre-determined programme of storage followed by disposal at the other. All of the design concepts incorporate some level of retrievability, in the broadest sense of the word.

8. CoRWM devoted considerable time to a discussion of retrievability in order to identify the possible reasons why waste might need to be retrieved, or ought not be retrieved, and to assess the extent to which options, in practice, allowed retrievability. The term 'retrievability' is used as a short-hand for a number of different ways of getting the waste out. At its simplest, the waste could be removed by reversing the original emplacement process. This form of retrievability, which CoRWM describes as reversibility, could be provided by storage facilities, for example. Under some repository design concepts, it would be possible to withdraw the waste by building in a methodology that would allow access to the waste even after vaults had been backfilled; for example by keeping access tunnels open for a period after emplacement and ensuring that the backfill could be removed. CoRWM describes this as retrievability. In addition to the 'built-in retrievability'

offered by these methods of removing the waste, CoRWM identified a third category, recoverability in which waste is recovered from a repository by mining or similar intrusive methods. Recoverability is not part of the design specification and would be likely to pose greater technical challenges and be more expensive.

9. CoRWM found it useful to consider concepts for geological disposal from the viewpoint of the extent to which they allow for the removal of the waste. These are described as they might be applied to ILW, but similar approaches could be developed for HLW and spent fuel. This approach categorised geological disposal in terms of four broad approaches to backfilling and sealing a geological repository:

   i. The vaults are each backfilled with grout (cement) as soon as they are full of waste. In practice, they would be backfilled in batches in order to keep the grouting process separated from the emplacement of waste in empty vaults. This approach creates a good chemical environment around the waste packages at the earliest opportunity and thus preserves the integrity of the stainless steel containers to the greatest possible extent. The removal of the grout by water jetting has been demonstrated. Thus, the waste is retrievable, in principle, until the repository as a whole is backfilled and sealed.

   ii. The first vault is backfilled when it is full of waste and the integrity of the waste packages is monitored. Backfilling of the remaining vaults is delayed until a point is reached when there is sufficient confidence to backfill the remaining vaults. This enables the monitoring of the first vault to be undertaken under conditions that represent those that will occur when all the vaults have been backfilled. Apart from the first vault, this approach provides reversibility.

   iii. None of the vaults are backfilled until all the waste is emplaced, when the whole repository is backfilled and sealed. This approach provides reversibility up until this point. In the meantime, the waste is monitored in the same way as it would be in a store.

   iv. After the waste is emplaced, the facility could function as a store and all backfilling could be delayed for up to a few hundred years (although backfilling could be carried out sooner if so desired). Nirex's phased disposal concept is an example of this approach.*

10. Clearly, then, a repository designed for phased geological disposal could also be operated so that it could deliver the other three geological disposal approaches. The main difference lies in the intention at the design phase. Phased geological disposal is intended to allow for a period of interim storage underground followed by disposal. The other approaches are intended to deliver disposal but incorporate a degree of flexibility that will permit retrievability.

11. Approach (iv) (phased geological disposal) requires the vault to remain open for a period of up to a few hundred years. Because of the need for geological stability during this period, the geological criteria may be more stringent for approach (iv) than for the others. It also requires the atmospheric conditions in the repository to be carefully controlled to preserve the integrity of the waste packages for as long as possible and minimise the extent of repackaging. Approach (i) (early closure) requires the shortest period of maintenance of the open vaults. Approaches (ii)

* In a recent report [4], Nirex states that "…some generic and much more site specific research is still needed before a phased geological repository can be implemented." In addition, the Environment Agency (EA), in critiquing [5] the Nirex 'Viability Report' for its phased disposal concept, said "We are concerned that plans for long periods of storage (in the phased deep geological option)…are not sufficiently underpinned technically." And that "…Nirex present an overly optimistic view…" The EA also listed a number of key technical challenges that it considers remain in developing the concept.

and (iii) lie between these two extremes but could require the vaults to be stable for the 65 years that Nirex estimate that it would take to emplace the UK's inventory of intermediate level waste[2].

12. If the repository is designed for approach (iv), the decision on what approach is taken can be postponed until the first vault is full. As discussed below, this is regarded as an advantage by some and a disadvantage by others, because it implies that a decision as to whether to store the waste for a long, but interim, period can be delayed for future generations to decide. If approaches (ii), (iii) or (iv) are selected, the decision on when to backfill and seal can be made at any time up to the design life of the repository. However, a decision on closure will also need to take account of the design life of the containers. CoRWM's understanding is that containers will retain their integrity for a period of about 100-150 years but there is a need for greater clarity on this point.

International Experience

13. In other countries where geological disposal has been selected as the long term management option it has been also recognised that there is a need to provide a degree of retrievability in order to meet public concerns. The challenge is to find a way of doing this without jeopardising the fundamental safety concept.

14. The Swiss concept of Monitored Geological Disposal for spent nuclear fuel involves the construction of a pilot vault alongside the main repository vault. The intention is that conditions within the pilot vault will be monitored for a period of between 50-100 years. Meanwhile, waste emplacement in the main repository vaults will proceed and individual vaults will be backfilled. This would not, however, preclude the removal of the waste should this be deemed necessary.

15. In the Scandinavian KBS-3V concept for spent nuclear fuel, the emplacement tunnels and the gallery are backfilled with clay but the main access ways and the access tunnel need not be backfilled until the repository is full. In principle, these can be kept open for several hundred years - as long as the period of storage envisaged in the Nirex phased disposal concept. The removal of the clay has been demonstrated. Thus, this concept provides retrievability until the repository is closed. It would also provide protection against misappropriation of the fuel and plutonium.

16. In the Belgian concept for HLW, the canisters are within stainless steel tubes, which need not be backfilled for some time. The tubes can be withdrawn. Thus, this concept provides a type of retrievability. It also provides some protection against misappropriation.

17. The Japanese nuclear management body has developed a range of repository concepts for HLW disposal as a 'catalogue' from which the most appropriate might be selected for specific sites. The Cavern Retrievable (CARE) concept provides the maximum flexibility and ease of removal. In this concept the fuel is placed in a stable matrix in thick-walled steel casks, which are placed in vaults. Any of the four approaches outlined above can be implemented. This concept, therefore, could be used to provide either reversibility or retrievability. It provides less protection against misappropriation.

CoRWM's view

18. Many citizens and stakeholders support the concept of phased disposal. What they have said is broadly consistent with earlier messages throughout CoRWM's programme: people generally support a management strategy aimed at reducing burdens on future generations while at the same time presenting sufficient

flexibility to address concerns about public confidence and enable retrievability in response to possible future technological advance or new information about risks and opportunities.

19. Others see phased disposal as a false reassurance that increases environmental, security and safety risks. There are concerns that, if a repository was left open for a period of interim storage, there would be an increased risk of release of radioactivity to the environment. There are also concerns, because of the need to maintain the facility in its storage phase, about the time period for which institutional control will be needed and that this will increase the risk to humans, including the workers who will have to maintain it for longer until it is sealed and brought to a state of "passive safety". It might also increase the vulnerability of the waste to terrorist action.

20. CoRWM's view is that leaving a repository open, for centuries after waste has been emplaced, increases the risks disproportionately to any gains.

21. Even if a form of direct geological disposal is chosen, it will be a hundred years or so before the waste is completely sealed in place and reversal or retrievability is no longer possible. This time delay may provide sufficient reassurance for those people who wish to retain the possibility of doing something else with the waste, for example, utilise better methods of waste management which have been developed in the meanwhile or because a use has been found for the 'waste'.

22. For some people, a period of monitoring the conditions within a repository is regarded as important to check that the performance of the repository in practice accords with the models forming the basis of the safety case. The Nirex concept and the Swiss concept are two examples where there is a built in period of monitoring conditions in a repository before and after vaults are backfilled. However, the concepts only provide for monitoring over a few hundred years at most, and cannot provide reassurance about repository performance in the long term, which is usually the period of greater concern because of the uncertainties over what will happen when the engineered barriers fail. Monitoring at the surface will be possible for any design of repository and it will be possible to continue this for as long as there is institutional control.

23. These concerns over the performance of a repository are considered in Chapter 18 on uncertainties, as well as in Chapter 13 which considers challenges to the conventional views about repository safety in the long term.

Repository designs for different wastes

24. Technically, geological disposal, phased or otherwise, could be applied to all the wastes in the CoRWM inventory; although the high cost of excavating a repository at some depth underground means that the option is sometimes considered only for wastes with long half-lives that need to be isolated from the surface environment for very long periods of time - e.g. HLW, spent fuel, long-lived ILW, plutonium and uranium.

25. Geological repository designs for HLW and spent fuel differ from those for intermediate level waste in terms of the construction materials, the geometry of the engineered barriers, and the backfill used to contain the waste. However, it may be possible to co-locate a UK geological repository for HLW and spent fuel with one for intermediate level waste so that only one site needs to be selected. The disposal vaults for different wastes would have to be kept separate, for example because the high alkalinity conditions generated by any cementitious backfill within an intermediate level waste repository can be detrimental to the stability of the buffer in the HLW repository.

26. The common feature of geological repositories for HLW and spent fuel is a series of long horizontal disposal tunnels, a few metres in diameter, into which the waste packages are emplaced.[3] Various ideas have been considered for the emplacement of the waste packages in these tunnels. In some designs, packages would be emplaced lengthways along the tunnels whilst, in other designs, waste packages are emplaced in short deposition holes drilled either into the floor or sides of the tunnels.

27. In most designs, the waste package is made from carbon or stainless steel but, in Finland and Sweden, it is proposed to encapsulate spent fuel in cast-iron containers surrounded by a 5 cm thick copper shell (due to its very slow corrosion). In the United States, it is proposed to use steel containers with a nickel-alloy shell. In most designs, the buffer will be compressed bentonite clay because this has a very low permeability and therefore the passage of radionuclides through the clay will be dominated by diffusion rather than by transport in flowing groundwater.

28. The common feature of geological repositories for ILW is an array of large disposal vaults, usually tens of metres long and several metres wide and tall. Intermediate level waste is much more chemically and physically varied than HLW, so there are many different waste package designs to allow for different waste characteristics. In most designs, intermediate level waste produced by reactor and fuel reprocessing operations is typically immobilised in individual drums or containers by mixing it with cement or bitumen. These drums and containers may then be grouted into larger boxes to form a discrete waste package. Larger intermediate level waste components from decommissioning may be grouted directly into larger waste packages. The waste packages are designed to be stacked in the disposal vaults. The void spaces between packages, and between packages and the host rock, are backfilled with a concrete or cementitious grout or clay buffer. In contrast, the WIPP repository for ILW in the United States is excavated in salt rock formations and uses crushed salt and bags of magnesium oxide for a backfill. Because ILW is chemically less stable, package integrity poses more of a problem than for HLW, especially where the repository design concept involves an extended delay of backfilling after emplacement of the packages.

29. CoRWM does not commend one design over another. Before decisions on this are made, it is necessary to identify sites that are suitable for a repository and whose communities are willing for detailed investigation to take place. Those investigations, together with other research and Government decisions e.g. on what materials to declare as wastes, will help to identify what specific designs are most suitable. The general approach to site selection is not to seek the best possible site from a geological point of view, because other criteria will also be important; but rather to identify a site that meets the necessary geological and other criteria and to engineer the design to the locality. Detailed decisions on repository design should not be made until potential host communities have been identified. Once this has been done, the repository can be designed with the local geology in mind and taking account of the wishes of the community.

Conclusion

30. Elsewhere in this report, CoRWM recommends that Ministers start the process of implementing geological disposal as soon as practicable. However, it is unlikely that underground investigations will start for at least 15-20 years, and a decision on the detailed repository design will not be needed until then. There are already several different repository concepts designed to allow for monitoring and possible retrieval before final closure and it is likely that thinking in this area will develop further. The delay before site investigations begin will allow time for further

research, discussion and agreement with potential host communities and others on the design features that should be included.

References

1 UK Nirex Ltd and British Geological Survey, "A note by the British Geological Survey and Nirex on the Suitability of UK Geology for Siting a Repository for Radioactive Waste", document 1797, March 2006.

2 CoRWM, “Timelines for Implementation”, document 1779, June 2006.

3 Enviros, "Summary descriptions of CoRWM's short-listed options", document 1420, November 2005.

4 UK Nirex Ltd, “Potential Areas of Future Geosphere Research”, Nirex document 494794, February 2006.

5 Environment Agency/Nuclear Waste Assessment Team, “Review of Nirex Report: ‘The Viability of a Phased Geological Repository concept for the Long-Term management of the UK’s Radioactive Waste”, reference NWAT/Nirex/05/003, November 2005.

Chapter 16 Interim storage

This chapter sets out CoRWM's views on the issues to take into account in reaching decisions about the arrangements that should be put in place to store radioactive waste until a repository is ready - about which many views have been expressed during public and stakeholder engagement.

1. In Chapter 14, CoRWM has recommended that, given the present state of knowledge, geological disposal of all the higher activity radioactive waste in the CoRWM inventory should be implemented as soon as practicable on a timescale that is consistent with developing and maintaining public and stakeholder confidence. However, CoRWM recognises that storage is central to its recommended strategy. This is because it will, in any case, be several decades before a repository or repositories can start to accept the waste and, until the necessary social, political and scientific requirements have been met, the implementation of a repository is not certain.

2. Adequate requirements for storage are, therefore, integral to the implementation of the recommendations. The process that CoRWM recommends for implementing a repository includes both engagement with the public and stakeholders at a national level during its earlier stages and the development of Community Packages at a local level within Partnerships. The latter will require deliberation and it is very important for the success of the implementation process that the longevity of storage gives sufficient time for this deliberation to be conclusive.

3. The Nuclear Decommissioning Authority (NDA) is managing the decommissioning and clean up of civil public sector nuclear sites including the treatment, packaging and storage of the radioactive waste that is produced. The NDA has published its strategy for carrying out this task[1], which includes the evaluation of options for siting ILW stores and the criteria that will be used in evaluating these options. The type and longevity of stores that will be required, given the range of materials and wastes for which the NDA is responsible, have to be factored into the strategy. Particular issues for storage are posed by plutonium, uranium and spent nuclear fuel that may, or may not, come to be managed as wastes in the future. Other producers, such as the Ministry of Defence and non-nuclear industries, have similar responsibilities for the radioactive waste and material that they produce.

Storage options

4. CoRWM's assessment of the options for the long-term management of radioactive waste included six storage options. Although the assessment was of long-term management options, information and comments obtained during the assessment of storage options are also applicable to a consideration of the role of storage as part of an overall waste management strategy. Many participants in CoRWM's PSE programme expressed the view that the Committee should report what it learned about the type and location of facilities that could be used for interim storage and that, as far as possible, it should set out its views on a storage regime that meets the requirements of the recommendations. Because some decisions on storage will be needed in the near future, CoRWM believes it is helpful to set out its thinking in some detail.

5. CoRWM short-listed the following six storage options[2]:

   i. stores with the current levels of protection against terrorist attack at or close to the sites where the waste is produced;

ii. stores with the current levels of protection against terrorist attack at a central location;

iii. surface stores with an enhanced level of protection against terrorist attack at or close to the sites where the waste is produced;

iv. surface stores with an enhanced level of protection against terrorist attack at a central location;

v. underground stores with an enhanced level of protection against terrorist attack at or close to the sites where the waste is produced;

vi. underground stores with an enhanced level of protection against terrorist attack at a central location.

Key issues in public and stakeholder input

6. Attention to what the public and stakeholders told CoRWM about storage was built into the evaluation of options at an early stage. Discussion of different types of stores featured, for example, in the first stage of PSE in which the merits and disadvantages of surface and underground stores were discussed[3]. Following CoRWM's decision to short-list the generic long-term interim storage option and some initial thinking of the kind of storage that would be needed[4], the public and stakeholders responded in more detail, adding further comments, for example, on the number and locations of the stores that might be required, the transport implications of centralised stores, and the vulnerability of some store designs to terrorism[5].

7. In the options assessment of short-listed storage options, all six were assessed in detail on the basis that, with necessary regard to care and maintenance of the structures, they could offer a stand-alone form of management for at least 300 years. The period of interim storage as one part, albeit an essential one, of the recommended strategy is envisaged to be much shorter (see discussion of timescales below) which means that some of the conclusions of the assessment exercise may not be applicable. Nevertheless, the assessment provides valuable information on the performance of storage options and, with this caveat in mind, it can be used to inform decisions on interim storage in the context of the strategy.

8. Throughout CoRWM's PSE process, participants identified safety, security and the environment as issues of major importance. Specific environmental impacts and loss of amenity can only be assessed for specific sites but security emerged as an important generic discriminator between the storage options in the MCDA process. Unsurprisingly, the organisations that, as waste owners, would bear the financial burden of storage, judged cost to be important, but cost was of lesser importance to other stakeholders and to the public. Lastly, the longevity of stores was identified as a central consideration to both the implementation process itself and as a contingency in the event of failure or delay in securing a repository site or sites.

9. A number of issues have emerged that, in CoRWM's view, inform the question of how waste should be stored. These are: the time period over which the stores will be needed; the type of store; the location of the stores; and the cost of stores. To some extent, these also provide a valuable means of discriminating between the six storage options.

The timeline for CoRWM's strategy

10. Annex 5 shows an indicative timeline for the implementation of CoRWM's strategy. The timescale for implementing disposal is a crucial factor in determining how many stores will be needed, where they should be located, and how long they will need to remain operational. Based on experience overseas and interpreting it in a UK context, Nirex provided information to CoRWM for use in the expert workshops on the time that it would take to bring a repository in the UK into operation and the time that it would then take to emplace the volume of waste and materials in the CoRWM inventory.[6] These timescales were 33 years and 65 years respectively. In its review of the material presented to the workshops,[7] the Environment Agency pointed out that there are considerable uncertainties associated with these timescales.[8]

11. CoRWM believes that adequate time also needs to be built into the timeline for a site selection process based on the agreement of a willing host community, as discussed in Chapter 17 on implementation.

12. For indicative purposes, CoRWM suggests that storage could be needed, before a repository is available, for a period of 40 years from now (i.e., about 2046) and before completion of waste emplacement for 105 years from now (i.e., about 2110).[9]

The type of store

13. Issues relating to the type of store – i.e. whether it should be above or below ground and what level of protection it should have – relate mainly to the question of security and, in particular, vulnerability to terrorist attack. The security of nuclear sites is regulated by the Office of Civil Nuclear Security (OCNS), which is responsible for ensuring that the risks from terrorist and other threats are regularly reviewed and that the necessary protective measures are put in place. During the second phase of CoRWM's engagement process (PSE2), responses from a variety of sectors, including local government and NGOs, argued in favour of stores which protect against the type of terrorist attack which took place on the World Trade Centre in New York in 2001. Enhanced protection can be provided by constructing surface stores with a thick reinforced concrete cover, or ground cover can be used to provide the protection. The Swedish national interim store for spent nuclear fuel (CLAB), which is located 30 metres below the ground, provides an example of the latter. An aversion to placing waste underground was expressed by some stakeholders early in CoRWM's process. For example, at CoRWM's meeting with NGOs in Manchester in November 2004, above ground storage was supported on the basis of concerns that underground stores could become defacto disposal facilities whereas above ground storage provides an incentive for the active monitoring of wastes and management of stores.

14. In the MCDA process, security specialists from the UK and overseas assessed the six storage options against the criterion of vulnerability to terrorist attack. As with most of the MCDA workshops, the specialists represented a range of affiliations from the national regulators, NGOs and independent security specialists. The specialists agreed the following statement:[10]

> "The security specialists appointed to the CoRWM Specialist Security Workshop recognise that CoRWM is not responsible for the priority that is being given to the conditioning and mode of storage of nuclear waste forms prior to their transportation to the selected storage/disposal facility that may not occur for some decades into the future. However, it is our unanimous opinion that greater attention should be given to the current management of radioactive

waste held in the UK, in the context of its vulnerability to potential terrorist attacks.

We are not aware of any UK Government programme that is addressing this issue with adequate detail or priority, and consider it unacceptable for some vulnerable waste forms, such as spent fuel, to remain in their current condition and mode of storage. We urge the Government to take the required action and to instruct the NDA, in co-operation with the regulators, to produce an implementation plan for categorising and reducing the vulnerability of the UK's inventory of radioactive waste to potential acts of terrorism, through conditioning and placement in storage options with an engineered capability specifically designed to resist a major terrorist attack."

15. For long-term storage, the security specialists expressed a preference for stores with an enhanced level of protection. They identified the difficulty of predicting terrorist capabilities in the future and considered that an underground facility would provide the greater security. It would also be likely to provide protection against a greater range of potential attacks. While these views were provided specifically in the context of storage for 300 years, they may also be relevant in the shorter term.

16. A spectrum of public and stakeholder views emerged from engagement on these issues. The majority supported enhancing security to the maximum extent practicable, but some maintained a preference not to store waste underground (see, for example,[11]).

17. The safety specialists scored underground storage lower for safety than above ground because the former relies on active pumping to prevent groundwater ingress, which would fail in the event of loss of institutional control. This was an important consideration when evaluating storage for 300 years, but is less relevant for shorter-term interim storage.

The location of stores

18. CoRWM's assessment of short-listed options made a distinction between local stores, constructed on or near to existing nuclear sites, and centralised stores where wastes from more than one site would be brought together. The main issues raised here were the safety, security and environmental implications of transport of waste and the intra-generational issues raised by moving waste to a new locality.

19. Most of those participants in CoRWM's PSE process who commented on the transport issue argued that the transport of radioactive materials should be minimised or avoided altogether[11]. The key concern appeared to be the vulnerability of waste transport to terrorism, together with concerns about safety, the environment, and the impact on particular communities of moving the waste from one site to another. For the most part, respondents argued against the movement of any wastes, but some respondents thought that the transport of some materials, such as spent nuclear fuel, to improved interim storage facilities was justified even if the transport of large quantities of relatively low hazard waste (such as decommissioning arisings) was not. Some respondents expressed the view that there is a danger in over emphasising the problems associated with transport.

20. CoRWM did not explore in depth the issues surrounding storage with local stakeholders at the reactor sites. Issues such as the disadvantages of transport, local aspirations to return the sites to their original condition, and willingness to

accept waste from other sites require additional exploration with local stakeholders and should form part of NDA discussions for local sites. They are, nonetheless, touched on in the later sections of this chapter which make some observations on the issues associated with deciding where waste should be stored.

Safety issues

21. The safety specialists assessed the implications of transporting all the waste in the CoRWM inventory to a centralised location in terms of the risk from radiation, including accidents, and the non-radiation risk due to accidents. Studies show that the probability of a theoretical death being caused by radiation during transport is four times less than the probability of a death due to transport itself[12]. The specialists concluded that transport issues were much less important than the ability of the options to withstand events such as the loss of institutional control[13]. The environmental specialists drew similar conclusions.

Security issues

22. Many of the security specialists considered that there is a significant vulnerability to terrorist attack and misappropriation during transport. The type of material being moved influences the desirability or otherwise of transporting it. Highly radioactive material, such as spent nuclear fuel and HLW, is regarded by some members of the public and stakeholders as an attractive target for terrorists, although the robustness of the transport packages, the form in which the waste exists, the dispersability of the radioactivity, the utility of the waste to terrorists, and the level of security arrangements, are all elements for assessment in respect of the potential dangers represented by transport. Less radioactive material may pose a lower health risk but is generally far larger in volume and would therefore involve higher levels of transport.

23. When assessing the options in terms of the vulnerability to attack during transport, the security specialists did not distinguish between the waste streams. Although they did make this distinction when they assessed the options in terms of vulnerability after emplacement, they found little difference across the waste streams because, in their view, the political impact of any attack on a store, or during transport, regardless of the relative activity of, or hazard posed by, the material involved "would be huge even if there were not a significant dispersal of activity."[10]

24. However, when assessing the options in terms of misappropriation, the specialists judged that spent nuclear fuel, plutonium and highly enriched uranium would be much more attractive to terrorists than any of the other materials. In the MCDA, the local storage options with enhanced protection were judged to be the best performing storage options against the criteria as a whole for the higher activity wastes such as HLW, spent nuclear fuel, plutonium and ILW. This is because of the high weight given to security and the high importance that the security specialists gave to the transport risks associated with the central options.[14] No other criterion discriminated between the storage options to the same extent.

25. The evaluation of the actual terrorist risk associated with the movement of radioactive materials is complicated. While avoiding transport is a principle that is generally subscribed to, it is only one of the factors that need to be considered. It is also important to consider the potential impact on communities of retaining waste on existing sites.

Coastal erosion and sea level rise

26. The information that CoRWM collated on coastal erosion and sea level rise was summarised in a briefing report.[15] Most of the UK's existing nuclear sites are located on, or close to the coast. Early technical studies suggest that some of these sites are likely to be vulnerable to coastal erosion and inundation by sea water to a greater or lesser extent during the period between about 100 years and about 300 years from now. The vulnerability of existing sites that could be used for interim waste storage will need to be carefully assessed as part of the NDA's strategy.

Environment and loss of amenity

27. Several participants in CoRWM's process identified environmental impacts as additional reasons why transport should be minimised.[11] The site specific environmental and amenity issues could not be assessed in the absence of a specific site but will clearly be important considerations when the environmental impact of any new stores is being assessed.

Cost

28. As part of the MCDA process, CoRWM asked a group of specialists to provide a best estimate cost for each of the options over a 300 year period together with an estimate for the upper and lower bound. The uncertainties associated with the estimates are considerable and the value of cost as a discriminator between options was limited. It is clear, however, that a strategy based on local stores would be more expensive than one with centralised stores. It is more difficult to draw conclusions on the relative costs of strategies based on above ground and underground stores because the cost estimates used in the assessment included costs of refurbishment over the 300 years. Cost did not appear to be a major concern of many respondents in early PSE rounds.

The generic requirements for interim storage

29. In recommending a robust programme of interim storage (Recommendation 2, Chapter 14), CoRWM emphasises the need for a continued commitment to the safe and secure management of wastes that is robust against the risk of delay or failure in the repository programme. It states that due regard should be paid to:

    i reviewing and ensuring security, particularly against terrorist attacks;

    ii ensuring the longevity of the stores themselves;

    iii prompt immobilisation of waste leading to passively safe waste forms;

    iv minimising the need for re-packaging of the wastes; and

    v the implications for transport of wastes.

Reviewing and ensuring security, particularly against terrorist attacks

30. In the light of the comments made by the security specialists (see paragraph 14), CoRWM concludes that in reviewing existing stores, special attention should be given to their ability to withstand a terrorist attack and the need to reassure the public on this matter. This review should be periodically revisited during the storage period to ensure that the provisions remain adequate to meet terrorist threats.

31. New stores should be designed so that they can protect the waste from foreseeable terrorist attacks over the period of storage required.

Ensuring the longevity of the stores themselves

32. New stores should be designed in a way that will obviate, as far as possible, the need for major refurbishment or replacement in the period before the waste can be emplaced in the repository. This should take into account the uncertainties associated with the time that a successful repository programme will take.

33. The NDA has pointed out that the current design lifetimes of 50 to 100 years for stores are consistent with an anticipated date of 2040 for a repository being ready to accept first waste emplacements and it does not consider that there is any additional requirement to extend the design life of future stores.[16] The shorter design lifetime of 50 years leaves little margin for delay in repository construction, however, and the longer one of 100 years leaves little margin for delays in emplacement. Some stakeholders, such as Friends of the Earth Scotland, Greenpeace and the Nuclear Free Local Authorities, consider that the design lifetime should be 150 years.[16] CoRWM concludes that storage in one form or another will be required for at least a century and a further period should be allowed for contingencies.

Prompt immobilisation of waste leading to passively safe waste forms

34. Immobilising waste and putting it into passively safe waste forms will reduce the potential for accidents and the reliance on institutional control.

Minimising the need for re-packaging of the wastes

35. Extended lifetimes for stores of about 150 years would challenge the objective of emplacing the waste in a repository before repackaging becomes necessary unless the design of stores and packages, including the use of appropriate materials to ensure such longevity, were taken into account sufficiently early. Given the uncertainties on timing, R&D aimed at achieving store and package lifetimes that are robust to all the uncertainties, is recommended by CoRWM.

Implications for transport of wastes

36. The issues surrounding the transport of wastes need to be considered as part of the decisions on the location of waste stores. These decisions should be taken in the light of feedback from a programme of public and stakeholder engagement.

37. The planning for new interim stores should reflect the right balance between the desire to minimise waste transport and the potential benefits to be gained from moving waste from its existing location. This includes avoiding, where practicable and desirable, the double movement of the higher activity wastes from their current locations to a store at a new location and their subsequent movement to a repository. It also requires consideration of disposing of short-lived waste at its current locations subject to its acceptability to the local community.

Observations on managing waste streams

38. The requirements of an interim storage programme set out above are, CoRWM believes, well founded in the views of the members of the public and stakeholders with whom it engaged. The understanding gained needs to be translated as far as is possible into a discussion on the management of particular waste streams, including the location of facilities. CoRWM cannot make recommendations on site selection for long-term management but it would diminish the value of the

engagement and of this report if the logic of locating interim storage at some existing sites was to be absent from its advice.

39. ILW, LLW that cannot be disposed of at the LLWR and reactor decommissioning wastes are currently stored, and will continue to arise, at a number of nuclear sites around the UK. By contrast, HLW, spent nuclear fuel, plutonium and uranium are, or will be, stored at only a few sites; HLW, for example, exists only at Sellafield. It is for these, generally higher active, parts of the CoRWM inventory that the Committee considers it would be particularly helpful to add to the detail of its views on storage.

High level waste

40. All the HLW in CoRWM's inventory has been, or will be, produced at Sellafield. It is placed in the existing HLW store at Sellafield and, although this store may need refurbishment or replacement in the period before a repository for HLW is operational, there is no apparent reason for considering alternative storage in the short-term. The speed at which the liquid HLW is vitrified is subject to regulatory scrutiny and oversight but CoRWM recommends that this activity be given the highest priority. It is important that the security aspects of the HLW store at Sellafield are regularly reviewed and that the public are reassured of the continuing security against threats from terrorists.

41. It is CoRWM's view that HLW should remain at its present location unless climatic impacts make this impossible or the long term safety of the waste (in the event of a repository not being implementable) could be better secured by storage at another location. In the latter case, the possible benefits of any other storage site would need to be carefully balanced against the potential transport problems associated with its removal.

Spent nuclear fuel

42. The existing contractual arrangements between British Energy (BE) and British Nuclear Group (BNG) require BNG to manage existing stocks and future arisings of all Advanced Gas-cooled Reactor (AGR) spent nuclear fuel including the spent fuel that may arise from extending the lifetimes of any of the AGR stations. Under these arrangements, all the AGR fuel will be transported to Sellafield. Beyond a certain base quantity committed for reprocessing, the amount that will be reprocessed is at the discretion of BNG and the remainder will be stored until a decision is made on its future.

43. These arrangements do not apply to any of the spent fuel that is produced at the Sizewell B Pressurised Water Reactor (PWR) station. This PWR fuel is stored in the pond at Sizewell. The spent fuel storage pond was designed to accommodate 18 years of spent fuel arisings and will be reconfigured to accommodate approximately 30 years of spent fuel arisings, subject to obtaining the necessary consents. Additional capacity will be required to accommodate the fuel that will arise from the further ten years or so of the currently planned reactor lifetime. BE's current assumption, which is subject to further option assessment and approval by the regulators, is for the construction of a dry store on the site. This will accommodate all the spent fuel arisings from the station, including those in wet storage.

44. The recommendation to review the security aspects of storage is particularly pertinent to Spent Nuclear Fuel (SNF), which was specifically mentioned by the security specialists. In addition, some local stakeholders in the Sizewell area consider that the existing fuel represents a major hazard to the community.

45. SNF is currently not classified as a waste and is therefore not encapsulated in a form that is suitable for disposal. Thus, the timescale for disposing of SNF, if it were to be managed as a waste, may be longer than that for HLW because it would include the period needed to come to a decision and the time to design, construct and commission an encapsulation facility[17]. In any case, there will be a need to store the SNF at Sizewell for a period that is longer than the remaining operational lifetime of the 'B' station.

46. However, the stores for spent fuel would have to address the same security concerns as those for HLW and would require a design life that includes a contingency for delays in the programme for its encapsulation and disposal.

47. In addition, it is clear from the views of some stakeholders (see Chapter 17) that CoRWM's recommendations for community involvement as part of the implementation process should be applied in the case of new centralised stores at new locations. Chapter 17 also points out that the extent to which CoRWM's recommendations on implementation may be applicable to other new stores and to changes to existing stores is a matter for further consideration.

48. If the current plans to store AGR fuel at Sellafield and PWR fuel at Sizewell do not materialise, there will be a need for alternative storage. The desire to avoid the unnecessary transport of SNF raises the issue of whether a new store for SNF should be co-located with the repository, which would avoid the potential necessity to move the fuel twice, or whether the new store should be constructed before the repository site is identified - a scenario which would involve double movement. In view of the need to provide storage for spent fuel that is robust against terrorist attack for at least 40 years, the double movement of spent fuel may be justified, but this requires further discussion.

49. At Dounreay, the United Kingdom Atomic Energy Authority's (UKAEA's) strategy is to pack SNF in special containers and store it on site until a repository is available.

Plutonium

50. The UK's stockpile of plutonium is stored at Sellafield and future arisings from reprocessing will be stored at the same place. The NDA is evaluating the options for managing this stockpile, which include several options for burning it in reactors and several options for encapsulating it as waste.[18]

51. It is not for CoRWM to make a recommendation on whether or not the UK's stock of plutonium should be classified as a waste. However, in the light of feedback from the public and stakeholders, the Committee endorses the recommendations made by stakeholders to BNFL during its national dialogue to the effect that an alternative management approach to continued storage of plutonium in powdered form needs to be developed so that conversion to a passively safe form, suitable for long-term storage or disposal, is underway within 25 years and complete within around 50 years. If it is decided that the plutonium should be managed as a waste, it should be immobilised and stored at or close to its point of origin until it can be disposed of in a geological repository.

Uranium

52. Uranium is stored at a limited number of BNG and UKAEA sites and future arisings from reprocessing will occur at Sellafield. As with plutonium, the NDA is evaluating the options for managing the uranium stockpile, which include several options for burning some of it in reactors and several options for encapsulating it as waste.[18]

53. The vast majority of the UK's stockpile of uranium is in natural, low enriched or depleted forms and thus the potential risks associated with this material are considerably less than most of the other materials in CoRWM's inventory. However, the implications of a terrorist attack on a uranium store or on uranium in transit, or the misappropriation of the material, are such that these have to be taken account of in storage arrangements. The volume of the low activity uranium stockpile appears to militate against new centralised storage on transport and cost grounds. CoRWM therefore believes that the management of uranium should be the subject of a study that identifies the best balance between avoiding transport and achieving secure storage.

ILW and CoRWM's LLW

54. A large proportion of current holdings of these wastes is already being stored at Sellafield and Dounreay. As decommissioning and clean-up proceeds at these sites, further stores will be required, but there seems little reason for these wastes to be moved elsewhere until a repository is ready to receive them.

55. Operational and decommissioning wastes are also stored or will arise at other sites around the UK. The NDA is considering a number of issues such as coastal erosion, site stakeholder end-site aspirations, public acceptability, waste conditioning and reduction techniques, transport implications, and security, in developing its strategy for the treatment and storage of these wastes, including the possibility of consolidating storage on a smaller number of sites. In addition, it will need to assess the implications of the mis-match between its aspiration to achieve the decommissioning of nuclear power stations within 25 years of closure, and the sort of timescale within which a repository might be constructed (potentially around 40 years from now).

56. Some of the decommissioning waste will be short-lived ILW which might be suitable for non-geological disposal. If this form of disposal is implemented for LLW at or near existing nuclear sites, consideration should be given to whether a publicly acceptable safety case can be made for including short-lived ILW in the same facility. This would reduce the need to transport this waste away from the sites for geological disposal elsewhere.

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Chapter 17 Implementing a management strategy

CoRWM's recommended long term management strategy can only be implemented successfully if communities are willing to be involved. Proposals for implementation indicate new and innovative ways of working with communities in the UK based on concepts of fairness, enhanced well-being and participation in decision making. This chapter presents CoRWM's recommendations for moving forward including advice on the partnership approach that, in the Committee's view, must define the relationship between potential host communities and the implementing body.

1. CoRWM's terms of reference invited it to consider such issues as 'whether local communities should have a veto or be encouraged to volunteer, and whether they should be offered incentives'. In response the Committee has developed its ideas on how its recommendations can be implemented. The detailed proposals, together with an analysis of how they were developed, are set out in the accompanying report on "*Moving Forward: CoRWM's Proposals for Implementation*".[1] CoRWM's overall approach to implementation is embodied in the series of recommendations 9 - 15 which are set out in the Overview and in Chapter 14. This chapter presents the context for CoRWM's recommendations on implementation which form an integral element in the package of proposals presented for Government to act upon. On the basis of its research and knowledge, the Committee considers its proposals for implementation will be both politically feasible and publicly acceptable.

2. In arriving at its proposals for implementation, CoRWM has drawn on overseas experience where progress has been made in a number of directions. While direct transfer of overseas experience may not prove possible in a UK context, there is considerable scope for the application of concepts, ideas and processes that are being developed elsewhere. Members have visited some countries specifically to gain insight and understanding of processes that are being introduced to ensure the successful implementation of programmes. The Committee has also engaged specialists as well as using its own expertise. A workshop was held for the Committee to discuss and develop its thinking on implementation. It has also sought views on implementation during its engagement with the public and stakeholders.

3. CoRWM's approach to implementation is novel in a UK context. The starting point was the failure of all previous attempts to make progress. Having explored the possibilities CoRWM concluded that the only way forward was through a process whereby communities were willing participants in a process which recognised them as equal partners with the implementing body. Moreover it was taken as axiomatic that communities should benefit from the process gaining in well-being both now and in the future. By 'well-being' we mean those aspects of living that contribute to the community's identity, development and sense of positive self-image. Well-being is a broad concept and not narrowly defined in terms of financial incentives or community facilities. A community's well-being may be realised in a variety of ways through economic development, through greater control over its affairs and through an ability to define and realise its own vision for its future. CORWM's recommendations on implementation apply to the implementation of geological disposal. In addition, it is clear from the views of some stakeholders that the recommendations on implementation must be applied to at least new central or major regional stores at new locations if CoRWM's recommendations are to inspire public confidence. The extent to which they may be applicable to other new stores and changes to existing stores is a matter for further consideration.

General Principles for Implementation

4. The Guiding Principles that CoRWM developed for its process of selecting a long-term waste management option are considered to be equally applicable to the implementation process.

5. Experience in the UK and abroad clearly demonstrates the failures of earlier 'top down' mechanisms (often referred to as 'Decide-Announce-Defend') to implement long-term waste management facilities. The principle of ensuring that the potential host communities are willing to participate in a programme to implement a repository has been an essential feature of the programmes to construct a repository for spent nuclear fuel waste in Finland and Sweden and the programmes to implement repositories for both low-level and high level waste in Belgium. It has also been an essential feature of the repository programmes in Japan and South Korea. In Finland and Sweden, the decision to be a willing community was expressed by the municipal councils. Members visited Sweden and Finland in 2004 to understand the processes that were adopted and were impressed by the high level of trust that both the local councils and the communities had in the national waste management organisation and in the national regulator.[2] The latter was seen as a guarantor that the safety of both the public and the workers would be ensured.

6. It is generally considered that a voluntary process is essential to ensure equity, efficiency and the likelihood of successfully completing the process. It has taken a number of years and many failed siting attempts for this to become widely accepted although it had already become apparent in the 1990s.[3] There is now a growing recognition that it is not ethically acceptable for a society to impose a radioactive waste facility on an unwilling community. CoRWM believes that

   - *engagement with local communities must be an integral and continuing element in any implementation programme; and*

   - *involvement in any proposals for the siting of long-term radioactive waste facilities should be based on the principle of volunteerism, that is, an expressed willingness to participate.*

7. However, for potential host communities to be willing to participate in a siting process, overseas experience shows that they must be provided with adequate resources in an Involvement Package designed to enable communities to engage effectively in the process[1]. There must also be an opportunity for them to negotiate a Community Package that will provide the support to help to ensure the facility continues to be acceptable.[4, 5] As a result, CoRWM considers that the following general principle should apply in the development of an approach designed to encourage community participation in the process to implement its recommendations:

   - *Community Packages should be provided so that the well being of potential host communities will be enhanced in both the short and longer term.*

The Principle of Partnership

8. Some of the most promising programmes overseas are based on the potential host community working in partnership with an implementing body to achieve a successful outcome for both. Belgium has proceeded furthest in developing and implementing partnerships which relate to the provision of low level waste facilities.[6, 7] This initiative followed earlier attempts which had been opposed by municipal councils and the public. In this respect the Belgian experience is closer

to that of the UK than the Scandinavian experience. Members visited two of the Belgian partnerships in 2005 and, based on their report, the Committee concluded that the Partnership approach should be the model for implementing a repository in the UK. The low-level waste programme in Belgium led to the announcement of the site for a low-level waste repository in 2006 and the Partnerships have been re-formed to address the issue of a repository for high level waste.

9. One of the advantages of the partnership approach is that it achieves an environment in which host communities can engage with an implementing body without feeling victimised by a national process over which they ultimately have little control[8]. CoRWM therefore believes that a partnership approach should be developed in order to achieve community involvement. Partnerships should be based on an open and equal relationship between the potential host community and the implementing body.

10. The principle of equity (in other words the idea of fairness) requires that, although individual communities will have different interests and needs, the process of establishing and supporting partnerships should not favour or disadvantage any type of community. To avoid this, it is necessary that the basis of the involvement should be framed and agreed on a national basis, in a consultation involving the public and all relevant stakeholders. This basic framework should include the partnership arrangements, which need to be developed nationally with all the interested parties but be flexible enough to accommodate the requirements of local communities.

11. The question of who should represent community interests in the partnership is a matter that will require discussion with relevant members of the public and stakeholders. It is important that the partnership includes a wide representation within the community and that it reflects the full range of interests in the community as far as practicable. In this regard, representatives may be drawn from within the host community and also from among those whose interests embrace a wider area.

Involvement and Community Packages

12. On the basis of its investigations, CoRWM has concluded that communities are unlikely to come forward or agree to engage unless a comprehensive Involvement Package is provided, which will, in turn, allow the negotiation of a Community Package.[1, 9] The Involvement Package must provide the necessary resources to enable participation. CoRWM therefore concludes that the agreement of an Involvement Package should be regarded as a condition of proceeding with the partnership.

13. In developing Involvement Packages it is important to demonstrate that all communities are on an equal footing and that certain areas or regions are in no way being targeted because of their relative economic status.

14. An Involvement Package should contain enough support for the potential host communities during the site selection process to ensure that they have the necessary resources to be involved in a meaningful and effective manner. This should include the ability of the Partnership to engage effectively with the community and to obtain independent advice and review of the proposals made by the implementing body.

15. For the process to be fair, a local community hosting a facility should be better off after siting than before. This reflects and acknowledges the service that is being provided for society at large.[10] A fair outcome requires, therefore, the local community's agreement on an acceptable Community Package. Research

suggests that communities rarely regard monetary incentives alone as a means of offsetting the loss imposed by a newly sited facility where a potential hazard is posed[11].

16. Provision should therefore be made for the negotiation of a Community Package to support the well-being of the community in the short and long-term and it must take into account the well-being of future generations as well as that of the present.

17. International research shows that it is important that the host community has a sense of ownership of the facility that will be built and is therefore involved as early as practicable in the generic technical aspects of the design.[12,3,4] CoRWM therefore concludes that representatives of the potential host communities should be involved in determining both the broad technical aspects of the proposed facility as well as the socio-economic aspects aimed at ensuring the well being of the community.

18. While the scale and scope of the funding to support the implementation process will need to be determined nationally in discussion with relevant parties, it is important that the Partnerships have the ability to determine how they make use of the resources included in the Involvement and Community Packages. They should have the freedom to determine the work programme, and the distribution of funds for the range of purposes agreed. It follows that the budget for the Involvement Package should be agreed with the relevant funding organisation before communities are invited to become involved. It must be accepted that safeguards will need to be incorporated into the process to avoid the misuse of funds.

Identifying potential host communities

19. Deciding how a potential host community should be defined will not be straightforward. One reason for this is that relevant communities may not coincide with local authority boundaries. Consequently CoRWM considers there should be scope for communities to be self-defining in terms of an initial willingness to participate. This has also been proposed in Germany.[7] There is also the question of who should represent the community. This is a matter for further consideration. Whoever represents the community, the decision to participate and subsequent proposals developed through partnership arrangements must be ratified by the appropriate elected representative body/bodies. However, in some parts of the UK, the areas that are covered by local authorities are so large that it may prove difficult to resolve conflicts between potential host communities and the wider area. In such cases, special arrangements for the ratification for the Partnership's agreement may be necessary.

20. In principle, every community should have the right to express a willingness to participate in the process but, in practice, some areas may be scientifically unsuitable for a waste facility. To ensure a fair process and create confidence, it is important that such areas are screened out before communities are invited to express a willingness to participate.

21. In many cases in the past, centralised authorities developed the screening criteria and stakeholders, including potential host communities, were unable to influence them. There is now growing evidence internationally that communities will only come forward or accept invitations to take part in the process if the criteria themselves are subject to open discussion and engagement.

22. CoRWM therefore concludes, that before any invitation to participate is issued, the screening criteria should be developed through an open and transparent engagement process. These broad criteria should be applied to screen out those

parts of the country where radioactive waste facilities would be unacceptable on scientific grounds. Within the remaining territory all communities that wish to express a willingness to participate should have the opportunity to do so. However, there should be no presumption that areas that have not been screened out are therefore suitable as locations for radioactive waste facilities. Suitability will depend on further scientific investigations.

23. In processes that are successfully moving forward abroad, the right of the potential host community to withdraw from the process is an important factor in determining the willingness of communities to participate.[1, 13, 14, 15] This right has some limitations. There will come a point when the process of implementation has proceeded so far that withdrawal would not be possible. Accordingly, CoRWM proposes that potential host communities should have the right to withdraw up to a pre-defined stage in the implementation process. The precise point at which a community might lose the right to withdraw requires further study.

24. Potential host communities are not the only local communities that need to be involved in decisions on the siting of waste management facilities. Principles of equity dictate that affected communities outside the local host community, such as those along transport routes, should also be involved in some way.[9, 16, 17] CoRWM is clear that there should be arrangements that enable affected communities outside the host community to be involved in the process if they so wish.

25. The implementation process will involve decisions that need to be taken at different levels. What screening criteria should be applied, the framework within which Partnerships will be established and the general structure and resources for packages are examples of decisions that that must be taken at the national level. Other decisions, such as expressing a willingness to participate and what constitutes an acceptable Community Package, are clearly to be decided at a local level. The appropriate level for some decisions is less clear and requires further discussion but, as a general principle, it is considered that decisions should be made at the lowest appropriate level.

Staged Process

26. Experience from overseas shows that implementation should be carried out through a staged process of sequential decision making.[18] The basic structure of staged decision making has been set out by the Nuclear Energy Agency:[19]

> '...development is by steps or stages that are reversible, within the limits of practicability. In addition to the institutional actors, the public, and especially the local public, is involved at each step and also in review of the results of decisions taken in a previous step. This is designed to provide reassurance that decisions are made in a transparent manner and can be reversed if experience shows them to have unexpected and unacceptable adverse effects'.

27. Some suggestions on the major stages and the roles of the main organisations in each stage are made in the text of the full Implementation Report. CoRWM concludes that any future implementation process should incorporate a staged decision making process which has the following elements:

- *Key decision points set out as milestones with opportunities for review.*

- *The main elements and stages in the process set out before the process starts, with clear and transparent roles for the participants. This does not mean that the process cannot be flexible but, if changes are made, they should be made with the involvement and agreement of the participants.*

- *At the end of each stage, there needs to be an agreement between the relevant parties to proceed, which is ratified by the elected decision making body/bodies, before proceeding to the next stage.*

- *The points at which there is a right to withdraw from the process should be clearly defined in advance.*

- *In order to be efficient and conclusive, the process should involve milestones at which major decisions will be made, which can be consolidated and only reversed subsequently by an agreed process or regulatory decision.*

Institutional Arrangements

28. Given the long history of delay and deferment in the UK on the issue of radioactive waste management, it is clear that any new or revised institutional arrangements for progressing the radioactive waste management process in the future need to draw on the current goodwill and momentum achieved by the CoRWM process. There is a pressing need to establish an appropriate institutional basis to carry the process forward.[20, 21, 22, 23]. It is CoRWM's view, strongly supported by the public and stakeholders, that the staged decision-making process should be supervised by an independent body with overall responsibility for overseeing the research and development programme and the siting strategy. Government should set up such a body without delay.

29. An integral part of the remit of the overseeing body should be to ensure that there is proper engagement with the public and stakeholders at each stage. Engagement must be conducted openly and transparently, so that the siting process inspires the confidence of all those involved.

30. There should also be an implementing body responsible for the construction and operation of any necessary facilities, and related research and development.

31. The roles of the overseeing body and the implementing body at each stage of the decision making process must be clearly defined in advance.

32. The involvement of the regulators has been crucial to the success, to date, of the implementation process in Sweden and Finland.[1, 18] In contrast, the lack of involvement by the environmental regulator in the process leading up to the Planning Inquiry into the rock characterisation facility at Sellafield has been heavily criticised.[20] CoRWM concludes that the environmental regulators should be involved in the implementation process at a very early stage and should continue to be closely involved throughout the process.

Future Work

33. The Implementation Report[1] provides a set of proposals which, CoRWM believes, will enable its recommendations for radioactive waste management to be carried forward. The proposals for implementation indicate new and innovative ways of working with communities in the UK based on concepts of fairness, enhanced well-being and participation in decision making. The basic principles set out here have to be transformed into working practice and CoRWM recognises there is considerable further work to be done. Throughout the report, CoRWM has identified areas for future work and the PSE process has indicated areas which need to be clarified or developed if a successful implementation process is to be achieved. The Committee sets out the areas for further work below.

National and local decision making

34. This concerns the level at which decisions should be taken. Among the areas for consideration here are: screening and siting criteria; invitations to participate; rights of withdrawal; setting up an institutional framework; framing of partnerships; allocation of resources; definition of packages; setting out stages in decision making. The process of implementation must begin at national level but the extent of subsequent devolution to local authorities and partnerships needs to be determined. Legal and administrative procedures (e.g. the planning process) will also need to be considered.

Screening

35. There will need to be early decisions on the criteria for screening out those parts of the country ineligible to participate in the implementation process. What kinds of criteria should be employed, how fine or coarse will the screening need to be? An issue here will be whether to use mainly scientific and technical criteria to define areas where geological disposal may be possible or to identify criteria that take into account the possible constraints on storage.

Identification of communities

36. This covers a number of issues including how to define host communities, whether and how they might be self-defining, how to inform communities and how to confirm a willingness to participate. How far should the interests of affected communities be taken into account?

The nature of partnerships

37. The membership, role and responsibilities of the potential host communities and the implementing body within each Partnership need to be determined. The extent to which existing regional and local strategic partnerships could provide the basis for the representation of the potential host community, and how the adequacy of the representation is judged, need to be considered. The size of each Partnership, which has to be both workable and adequately representative, needs to be established. There is also a need to determine a suitable structure, the membership of the executive body, the number of working groups, the issues that should be addressed and the time that each Partnership would reasonably require to complete its work.

The concept and composition of packages

38. The roles and potential content of Involvement and Community Packages need clear definition. There needs to be consideration of how budgets are to be established, sustained and administered. Where does budgetary decision making power reside? The possible constraints or opportunities relating to state aid will need to be considered. A significant issue will be whether the proposals create precedents and, if so, what are the implications of this.

Democratic representation and ratification of decisions

39. This is recognised to be necessary to achieve overall acceptability and legitimacy for decisions. What decisions require democratic endorsement, and at what level, requires further work. For example, where should authority lie for the decision to participate, the decision to withdraw or decisions about budgetary allocations? Should ratification be obligatory if decisions are endorsed by communities or partnerships? What rights of appeal or override might there be? A key issue is

how the interests of host and affected communities and partnerships can be democratically represented within local government decision making.

Staged decision-making

40. At an early stage in implementation, it will be necessary to set out the stages and key decision points and responsibilities for taking key decisions. There should be an indicative time-scale for decision-making and clear allocation of roles for achieving objectives.

Institutional context

41. The roles, responsibilities and membership of the overseeing and implementing bodies should be established at an early stage.

Planning and regulatory framework

42. An important question is how the CoRWM proposals relate to the planning and regulatory processes, including the implications of the requirements for Strategic Environmental Assessment.

Overseas experience

43. CoRWM has given detailed consideration to overseas experience in how communities are invited to express a willingness to participate, how this decision is made at the local level, partnerships and community packages. During implementation it will be important to continue research on developments in other countries.

Implementation plan

44. An early task (see also Chapter 19) will be to set out an implementation plan identifying priorities and resources. There will be a need for CoRWM and its successors to establish close working relationships with sponsoring Government departments and the devolved administrations as well as with key stakeholders. It is axiomatic that the open and transparent processes through public and stakeholder engagement must be continued if progress in implementation is to be maintained.

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Chapter 18 Addressing uncertainties

The future is inherently unpredictable and uncertain. Policy decisions need to be robust against reasonably foreseeable contingencies. CoRWM considers that uncertainties are a central issue in the long-term management of wastes that will remain significantly radioactive over many thousands of years. It believes that, from the outset, relevant uncertainties need to be identified and, as far as possible, managed. In this chapter, CoRWM identifies the main uncertainties, explains their possible consequence for the long term management of radioactive waste and, where possible, proposes how to address them.

1. CoRWM has based its recommendations on the best available information obtained from its review of the literature, contacts with specialists and engagement with the public and stakeholders. It believes that its recommendations are sound and robust when judged against this knowledge base. However, it acknowledges that there are limitations and uncertainties. These apply to both disposal and storage options. Previous chapters (8, 11 – 13) explain how CoRWM took account of these limitations and uncertainties in coming to its recommendations. This chapter considers the nature of the uncertainties in more detail and addresses ways to deal with them.

2. Decision makers can never know everything that could happen. This inability to predict the future with certainty is a particular problem when planning for the long term management of radioactive waste because of the need to model the performance of options over many thousands of years. CoRWM believes that it is important to identify and address uncertainties from the outset but recognises that it will not be possible to eliminate them altogether. Nevertheless, CoRWM believes that it is important to spell them out clearly so that proper consideration can be given to management in the face of continuing uncertainties.

3. The way in which uncertainties are addressed is, and will continue to be, closely linked to the public's confidence in proposals for the long term management of radioactive waste. People want to know the risks and benefits involved and they are more likely to have confidence in a proposal if the uncertainties surrounding these risks and benefits are spelled out and the approach to dealing with them is clearly explained.

4. In this chapter, CoRWM identifies the main uncertainties, explains their possible consequences for the long term management of radioactive waste and, where possible, proposes how to address them. The causes of uncertainty are many and varied and they cover both our current scientific and social knowledge. CoRWM found it helpful to group these for discussion purposes.[1] The chapter starts with the uncertainties over the inventory stemming from present Government policy initiatives and then looks at the uncertainties inherent in CoRWM's proposals for implementation. The next sections look in more detail at uncertainties relating to the performance and siting of facilities and the implications of possible future developments in science and technology. Finally there are some comments on uncertainties relating to institutional control in the future.

Uncertainties over the inventory for disposal

5. CoRWM's recommendations make some assumptions about the inventory for disposal. CoRWM's baseline inventory is described in Chapter 2 and in its Inventory Report.[2] However, CoRWM's remit covers only one aspect of radioactive waste management. Developments in other policy areas relating to the issues outlined below may also have an impact on the way in which CoRWM's

recommendations are taken forward because they will affect the inventory and the time when waste will be ready for disposal. The impact could be significant and could have consequences for the implementations of CoRWM's recommendations on storage and disposal.

6. The Government has now stated that it "believes nuclear has a role to play in the UK not only in reducing emissions but also to maintain the diversity or our electricity generation mix".[3] CoRWM is emphatic that the management of waste arising from a new build programme should be the subject of a separate process (Chapter 14). CoRWM members are unanimous in their view that the results of CoRWM's PSE programme cannot be taken to provide an endorsement that its recommendations should also apply to wastes from new build.

7. CoRWM made some baseline calculations on the volumes of extra waste that might need to be managed under a new build scenario so that it could obtain a better understanding of the waste inventory (Chapter 2). If a decision is made to build new power stations, there will need to be a detailed assessment of the waste inventory that will arise so that proper arrangements can be made for its management. At the very least, there could be an effect on repository design and size; there may also be a need for more management facilities including interim stores at new reactor sites. The construction and operation of a new generation of nuclear power stations will make it difficult to define a waste inventory once and for all; there will be uncertainties over the volumes of waste and the timescale over which they will be generated.

8. Similar uncertainties exist in relation to those materials that are currently regarded as having potential future uses rather than as wastes, namely spent nuclear fuel, uranium and plutonium. CoRWM has estimated the impact on the inventory if these are declared as waste but there are also wider issues of societal concern. The amount of these materials, both relative to each other and in absolute terms, will be determined by the extent to which they are used as fuel in nuclear power generation either directly or following reprocessing. The uncertainties over the possibility of a new generation of nuclear power stations are relevant here as well. It is CoRWM's view that communities are unlikely to express a willingness to participate in a siting process unless they have a clear understanding of the waste inventory they may be asked to accept.

9. The outcome of the review of LLW management[4] could have implications for the disposal of short lived ILW comprising reactor decommissioning waste. There may be opportunities to treat decommissioning LLW and some ILW waste streams together, thereby avoiding the need to put reactor decommissioning waste into a repository. A decision on this matter will be important in resolving uncertainties over the inventory of waste destined for geological disposal.

10. The consultation on the management of redundant nuclear submarine reactor compartments, ISOLUS,[5] took account of the fact that CoRWM's recommendations would be of relevance to this waste, for which the Ministry of Defence (MoD) is currently responsible. It will be for Government to decide how this waste is to be managed; until this is done there will be uncertainty over whether or not this waste is destined for geological disposal and, if so, how it will be managed in the interim.

Uncertainties relating to CoRWM's proposals for implementation

11. CoRWM has made a number of recommendations relating to the implementation of a long term waste management programme (Chapter 17). These focus on the need to identify a volunteer host community or communities to host a radioactive waste facility through a process in which communities that are willing to participate in site selection are engaged in a partnership. The rejection of the

previous 'decide-announce-defend' approach in favour of full public participation has implications for the timing of the implementation programme. While the old approach appeared to allow Government to keep full control of the process and impose a timeframe, the reality is that the process was likely to stall at any stage because of public resistance, throwing the programme off track. The staged approach proposed by CoRWM allows for the fact that it will be impossible to impose a fixed timeframe on the process but, because the overall approach is laid out from the start, it will be possible to measure progress and adapt timelines in response to the rate of progress at each stage.[6]

12. There are several ways in which uncertainties arising through the implementation process could be addressed. Much will depend on the quality of the public and stakeholder engagement that is used. It is essential that this should be open, participatory and fully inclusive and conducted in a way that recognises the status of the public and stakeholders as partners. A full and continuing commitment to the need to obtain the agreement of a host community is important. If a first round of engagement with communities willing to participate in the process fails to achieve a satisfactory outcome, there should be a commitment to go back a stage and try again; a return to 'decide-announce-defend' should not be an option. CoRWM recognises that progress with obtaining the agreement of a volunteer host community might be slow and that, in the worst case, it might be impossible to achieve at the moment. This is one of the reasons for CoRWM's recommendation that geological disposal should be seen alongside interim storage as part of an integrated management programme. The provision of facilities for interim storage will not only ensure that the wastes are managed properly until such time as a repository is available; it will also take some of the pressure off the process of site selection. It is important to proceed at a pace commensurate with the need to develop and enhance trust and confidence in a potential host community, rather than push forward plans for a repository against a fixed timetable.

13. CoRWM's Implementation Report[6] raises some of the uncertainties associated with a participative approach to site selection including defining what a 'community' is; how a community might express a 'willingness to participate'; and how a 'right to withdraw' might operate. The Committee recognises that there is a need for further work to flesh out the details of its implementation proposals and to address the uncertainties.

Uncertainties over the performance of repositories and stores

14. The regulatory regime in the UK requires the production of a satisfactory safety case before a facility for waste management can obtain a licence. The safety case for a repository will have to include an assessment of its performance over very long time scales. The assessment will be based on detailed knowledge of the local geology coupled with modelling of the performance of the component parts of the engineered barriers. Confidence in the safety case is crucial to the acceptability of a repository. The extent to which people have this confidence – even in the general concept of a repository, without looking at specific proposals – varies considerably from individual to individual and from sector to sector. These differences in perception of the reliability of calculations about long term safety account, in large part, for a preference for disposal over storage or vice versa.

15. It is essential, therefore, to reduce the uncertainties as far as this is possible. As part of the implementation programme, further scientific research should be undertaken to gauge the extent of the uncertainty around any particular aspect of repository design and then attempts should be made to reduce the uncertainties by improving the data that are fed into the models. It will be necessary, in this respect, to make full use of information obtained from overseas rock laboratories and from investigations into natural analogues.

16. It will be important to convey information to the public; people will want to know what the uncertainties surrounding predictions are and how confident the scientists and other technical specialists are in their assessments. They will also want to know what the consequences would be if the scientists have got it wrong. Where there are differences in scientific opinion, these should be fully aired. The use of joint fact finding exercises, in which those disputing the interpretation of data work together in an attempt to resolve the differences, is one way in which these issues can be explored in a non-confrontational manner.

17. Geologists and other scientists have expressed confidence in the generic concept of geological disposal (Chapter 13). However, there is only so far that scientists can go in reducing uncertainties in a generic concept. Much will depend on information gained from site investigations. Again, it will be essential to involve potential host communities in research programmes so that their concerns can be addressed. Because site investigation is so costly, there is a danger that the public will perceive it as an exercise with a pre-determined outcome, i.e. to demonstrate the suitability of the site for a repository. To avoid this, there needs to be a clear set of detailed objectives agreed prior to commencement in order to allow the public to understand what the purpose of the investigation is and how the data will be used.

18. One of the main areas of uncertainty around geological disposal raised during CoRWM's work, including its PSE programme, was the robustness of the repository concept, where questions were raised over the performance of the engineered barrier, the extent to which the geology can be relied on, groundwater modelling and the extent to which radioactive gases will be retained. Serious concerns were also expressed over the impact of any release of radioactive waste into the biosphere at some time in future. Here there are concerns that our current understanding of the impacts, especially of low level radiation, is incomplete. Taken together, these two areas of uncertainty can lead to an overall lack of confidence. CoRWM believes that confidence could be built if more effort was put into reducing the uncertainties through further research and explaining the implications of any new information.

19. No amount of site investigation or computer modelling can resolve all uncertainties about the future, especially in the very long term. We cannot know what the biosphere will be like hundreds of thousands of years from now and we cannot know what human communities will be like, if they exist at all. These uncertainties need to be acknowledged openly and the public needs to know how they are being addressed, through the use of worst case scenarios or other approaches. Again, joint working could be utilised, giving the public the opportunity to ensure that their concerns are addressed and their questions are answered.

20. Before approval is given for the construction of any repository, the regulators will have to accept the safety case submitted by the body responsible for implementation. CoRWM recommends that the regulators should be involved at the earliest possible stage so that the safety case can be built on a firm foundation of knowledge and regulatory expectations. It will be important for both the implementing body and the regulators to keep the public fully informed as the process goes on, explaining what the areas of uncertainty are and how they are being addressed.

Siting of Facilities

21. CoRWM's recommendations allow for the possibility of facilities on or near to existing nuclear locations (Annex 4). This possibility is dependent on the suitability of the individual sites as a locality for facilities designed to last for over one hundred years (in the case of stores) or longer (for facilities for reactor

decommissioning waste). The implications of climate change, including sea level rise, increased risk of periodic flooding and coastal erosion, will have to be taken into account. If it is not possible to protect sites against these potential hazards, then local solutions will have to be ruled out. This situation could arise for a number of reasons. For example, it may prove impossible to come up with accurate enough climate change models to enable engineers to design an effective system of protection without leaving an unacceptable risk of failure because conditions turn out to be more extreme than predicted. Even if accurate predictions can be made, the engineering requirements may be too technically challenging or too expensive to be practicable.

22. While, broadly speaking, stores could be built anywhere where the surface conditions are likely to be stable for a long enough period, the siting of a repository is constrained by the nature of the geology. The success of CoRWM's proposals for the implementation of its recommendations on geological disposal is dependent on there being one or more willing communities with a suitable geology. Even if those areas of the UK with unsuitable geology are eliminated before the search for a community begins, there will be no guarantee that the geology at any particular site will be suitable.

23. The major public concern expressed to CoRWM is that radioactivity will leak back to the surface when water gets into the repository. The site investigations are, in part, designed to address this issue by attempting to model the groundwater flow. This is a highly technical and specialised task that is difficult to explain to the lay person. The uncertainties over the geology could have implications for the implementation programme. Site investigations are expensive and it is unlikely that the implementing body will be able to carry out detailed work on the geology at more than one or two sites at a time. If these investigations show that the site or sites are not suitable, there will be a delay while another site is investigated (assuming there is a willing host community). The cynical view would be that the implementing body would seek to avoid having to do this and would make the best of the geology at the site or sites investigated. Because the nature of the investigations is complicated and covers a range of different topics, the potential for the public feeling that they have been deceived is high. It will be essential to provide a clear demonstration that this is not the case. The best way of doing this is to involve the host community partnership in the details of the site investigation from the start and take care to explain the implications of the results of the investigations as they go along. If it can be shown that the regulators are in agreement with the conclusions drawn from the investigations this would also go some way towards reassuring the public.

Uncertainties over Future Scientific Understanding and Technical Developments

24. Current assessments of the long term performance of the waste management facilities recommended by CoRWM are based on the assumption that the basic scientific premises will not change but that it will be possible for performance to be more tightly defined and assessed as a result of improvements in modelling as more data become available. However, it is also possible that scientific research may lead to changes in our understanding of the behaviour of radionuclides or on their impacts on human health and on the environment. Also, further research might lead to technological developments that could provide alternative, possibly better, options for management.

25. The system of radiation protection adopted internationally makes use of dose coefficients in assessing the health risks from radioactive emitters taken into the body. These dose coefficients relate intakes of radionuclides to radiation dose, which is intended to provide a measure of the potential for harm, taking into account the harmfulness of different radiations and the sensitivity of different body tissues and organs. Reference values are published by the International

Commission on Radiological Protection (ICRP).[7] There are differences of opinion, however, as to whether uncertainties have been adequately addressed in the current system of protection. In addition, it is not possible to know what levels of exposure to radiation future generations will regard as acceptable.

26. One issue of particular concern for some people, is the possibility that our current understanding of the impacts of low level radiation is incorrect and that, in particular, current standards are based on an under-estimate of the risks invo

27. lved.[8] On the other hand, standards have also been criticised for being over cautious.[9] It is probably unrealistic to think that these differences of opinion can be resolved to the satisfaction of all parties. However, it is generally acknowledged that scientific understanding of the biological effects of radiation is incomplete. Where there are uncertainties that could be reduced by further research, it is important that these should be addressed so that new data can be fed into the modelling of the performance of geological disposal concepts.

28. Some of the options on CoRWM's long list were rejected because they were not sufficiently well developed for CoRWM to have confidence in them (Chapter 10). Similarly, in its assessment of the short-listed options, CoRWM concluded that the use of boreholes as a form of geological disposal for some types of waste could not be recommended at this time but that improvements in technology might make it more attractive in the future (Chapter 11). CoRWM has made specific recommendations on the UK's involvement in research into the development of other options (chapter 14). The relatively long timeframe for the implementation of a repository provides the opportunity for such developments of other options to be taken into account before final decisions on disposal are made.

Uncertainties over institutional control

29. The uncertainties outlined above are mainly concerned with the lack of scientific knowledge and confidence in the models used to predict performance. There is a further set of uncertainties relating to the nature of human society in the future. CoRWM's work on intergenerational equity demonstrated how difficult it is to know what the right thing to do now is, given that we do not know the conditions under which future generations will live or what their needs and aspirations may be. Nevertheless, it is necessary to acknowledge that the future will not look like the present.

30. At the most basic level, it is important to note that both interim storage and the pre-closure phase of geological disposal are dependent on institutional control and any assessments of performance will have to consider the consequences of a break in that control.

31. The prospect, nature and societal implications of a loss of institutional control are unknowable and cannot be made more certain. However, it is possible to address the implications of a loss of institutional control on the performance of a facility. Most importantly, work is needed on the design of facilities with as little reliance on institutional control as possible; further research into enhancing passive safety and security of facilities would be a step towards addressing this need.

Conclusion

32. If the public are to have confidence in the proposals for the long-term management of radioactive waste, it is essential that the areas of uncertainty and the plans for addressing them are clearly identified from the outset. Wherever possible, uncertainties should be reduced through further research. Where this is not possible, the implications for the success of the programme should be

explained along with proposals for managing the programme in the face of these uncertainties.

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6 Committee on Radioactive Waste Management, "Moving forward: CoRWM's proposals for implementation", document 1703, July 2006

7 see ICRP website http://www.icrp.org

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9 Committee on Radioactive Waste Management, "Criteria Discussion Paper 1: Safety", IDM 21/1 Butler et al, June 2005

Chapter 19 Next steps

The publication of the CoRWM recommendations is a key point in the Government's 'Managing Radioactive Waste Safely' (MRWS) programme. There are a number of steps that should be taken as soon as practicable so that the momentum that has now been established in the MRWS programme is not lost.

1. As described in this report, attempts to implement policy for the long-term management of the UK's higher activity radioactive wastes have been protracted, inconclusive and unsuccessful. As part of the Managing Radioactive Waste Safely programme, CoRWM has spent over two and a half years conducting a wide-ranging study and assessment of options for dealing with these wastes. During the Committee's public and stakeholder engagement programme, CoRWM was told repeatedly that it was imperative for Government to respond to the recommendations quickly and begin the process of implementation as soon as possible.

2. There are a number of actions that need to be taken to ensure that momentum is not lost, and that there is a smooth transition from Stage 2 of the MRWS programme to Stage 3. This chapter does not list all the actions required, but provides a guide to the key initial ones.

Set out a Long Term Waste Management Policy

3. CoRWM urges Government, after considering these recommendations, to make a decision on its long term waste management policy as soon as is practicable.

Set up an Overseeing Body

4. In order to put policy into action, the Government needs to appoint an independent Overseeing Bbody. This body will help to drive the implementation programme forward in the early stages. The immediate actions needed are therefore to:

   i. Develop the terms of reference for the Overseeing Body

   ii. Appoint members

   iii. Review support requirements, including specialist staff

Establish an Implementing Body

5. Once the nature of the policy has been decided, Government will be in a position to decide what body, existing or new, should implement the proposals. This decision should be made as early as possible so that implementation planning can proceed.

Define the steps in a Staged Decision-Making Process

6. The implementation of CoRWM's recommendations will involve a complex series of steps and relationships with other agencies and programmes. It will be essential to set out the stages and to identify what decisions will be needed by when and by whom. While this process will, by its very nature, be iterative, clarity will be needed at an early stage about some of the anticipated major decisions.

Undertake a review of storage

7. Government and the NDA should ensure that current arrangements for storing waste are appropriate in the light of the recommendations and observations in this report. In addition, decisions must be taken about when and where new stores are to be constructed.

Identify areas that are unsuitable

8. CoRWM has recommended that areas that are not suitable for radioactive waste facilities should be identified before communities are invited to express a willingness to participate in implementation discussions. The process of developing and applying scientific and other screening criteria to identify those parts of the country that are not suitable for a geological repository and/or new centralised stores should be commenced as soon as practicable, with appropriate public and stakeholder engagement.

Develop the framework for Partnership Arrangements

9. The framework for partnerships between host communities, the implementing body, (and others as required) should be decided at national level, but with public and stakeholder input. This will involve, amongst other things:

    i. Clarifying by whom, under what circumstances and through which mechanisms, a community's 'willingness to participate' can be expressed.

    ii. Developing the broad framework of Involvement Packages and Community Packages.

    iii. Establishing the relationship between partners, with particular reference to how the 'equal and open' relationship that CoRWM recommends will work in practice.

    iv. Agreeing funding arrangements.

    v. Identifying the points in the programme, and the conditions under which, the right to withdraw could be exercised, including identification of the point beyond which no withdrawal will be possible.

Establish an R&D Programme

10. An R&D programme should be established as soon as practicable after Government has given its response to CoRWM's recommendations. This should focus on intensifying research into reducing the uncertainties surrounding the long-term safety of geological disposal; and examining the way in which the means of storing waste in the relatively long term (100-150 years) can be improved. Research into increasing the lifetime and robustness of waste packaging should be included. In addition, arrangements should be made to monitor national and international R&D in the field of radioactive waste management with a view to identifying any promising developments in alternative management options.

Bridging Activities

11. CoRWM will be undertaking some post-recommendation work until later in 2006 and will maintain relationships with public and stakeholders during this time. The Overseeing Body, once established, should then maintain these relationships, keeping the public and stakeholders informed of progress with the recommendations. This is important if public confidence is to be developed further.

12. Further work on those areas of the Implementation Report that require clarification could be undertaken during this period (see Chapter 17).

Conclusion

13. There are a number of actions that can be taken relatively quickly to get the implementation of CoRWM's recommendations off to a strong start. By taking action within a reasonable time of receiving CoRWM's report, Government will be able to maintain momentum and continue to build public confidence.

Annex 1 Terms of reference

Objectives

1. CoRWM is appointed jointly by Ministers of the UK Government and devolved administrations of Northern Ireland, Scotland and Wales, to oversee a review of options for managing solid radioactive waste in the UK and to recommend the option, or combination of options, that can provide a long term solution, providing protection for people and the environment. This follows the announcement by the Secretary of State for Environment, Food and Rural Affairs to the UK Parliament, and by devolved administrations, on 29 July 2002.

2. CoRWM must ensure that this review of options is carried out in an open, transparent and inclusive manner. The process of review must engage members of the UK public, and provide them with the opportunity to express their views. Other key stakeholder groups with interests in radioactive waste management, must also be provided with opportunity to participate. The objective of CoRWM's programme is to arrive at recommendations which can inspire public confidence and are practicable in securing the long term safety of the UK's radioactive wastes. It must therefore listen to what people say during the course of its work, and address the concerns that they raise.

3. CoRWM will have a corporate responsibility to deliver its recommendations to sponsoring Ministers in accordance with agreed work plans. It must aim to supply recommendations to them no later than the end of 2005[1], and sooner if possible. It will be for Ministers, with appropriate reference to their respective Parliaments and Assemblies to decide future policy for the long term management of the UK's solid radioactive waste and to make arrangements for its implementation.

Committee characteristics

4 **Size of the Committee**. CoRWM will consist of a Chair, and 12 Members which will include a Deputy Chair.

5. **Composition of the Committee**. CoRWM will include people with a range of expertise: people with a perspective of environmental, health, social or ethical issues, as well as people with technical experience and expertise in radioactive waste matters. Ministers hope to find these skills and perspectives: radioactive waste, nuclear materials and how they can be managed; regulation of UK processes that give rise to radioactive waste; public engagement, consensus-building and resolving conflict on contentious issues; applying ethical principles to scientific and technical decision-making; national and international environmental law; scientific and technical issues such as earth science, materials and their properties, and civil engineering; radiation protection principles and their implementation; radionuclides and how they affect the environment; environmental, health and safety issues and how they interact and conflict.

6. All members will need to be effective team workers, with good analytical skills and good judgment besides a strong interest in the process of decision-making on difficult issues. A number of them will need experience of managing complex projects, drawing on public and stakeholder group involvement and discussion, excellent drafting and communication skills, or business experience and knowledge of economics.

[1] CoRWM agreed with sponsors in the summer of 2004 that it would report by July 2006.

7. The Chair, in addition, will be capable of successfully and objectively leading committee-based projects, grasping complex technical issues, managing a diverse organisation effectively and delivering substantial results, presenting progress and outcomes in public, a person with appropriate stature and credibility.

8. **Access to other sources of expertise**. CoRWM itself will have to decide how best to secure access to other appropriate sources of expert input during the course of its work. Within this, it will have option of setting up expert sub-groups containing both Members of CoRWM itself and other appropriate co-opted persons. A member of CoRWM will chair any sub-group of this nature and ensure its effective operation, as well as provide a clear line of responsibility and accountability to the main Committee, and hence to Ministers. This approach will enable them to draw on a broad range of expertise in the UK and elsewhere.

9. The number of such sub-groups will be kept to the minimum necessary. Their role will be that of providing advice for the main Committee to consider and assess as it sees fit, and managing any activity which CoRWM delegates to them. It will be for the main Committee to assess and decide upon the advice it receives from such sub-groups. CoRWM may also utilise other appropriate means of securing expert input, such as sponsored meetings and seminars. The Chair will ensure that sub-group work and all other activities are closely integrated with the Committee and with one another.

10. **Length of appointment**. Initial appointments will be for three years. Sponsoring Ministers retain the right to terminate appointments at any time in light of individual members' performance appraisal, changes in CoRWM's work requirements, or completion of the work required of CoRWM.

Programme of work

11. CoRWM's objective is to recommend to Ministers the best option, or combination of options for managing the UK's solid radioactive waste that can provide a long-term solution, providing protection for people and the environment. The UK's waste inventory contains, or will contain, a wide range of high and low activity, short and long lived wastes. CoRWM's priority task is to recommend what should be done with the wastes for which no long-term management strategy currently exists - that is, high and ILW now in storage or likely to arise over the next century or two, and some low level waste unsuitable for disposal at Drigg. However, for some of these wastes, the Nirex "Letter of Comfort" system has provided a framework which has enabled helpful progress to be made on conditioning and packaging. (Ministers have other sources of advice on other wastes for which a long term management strategy already exists but where there may be long or shorter term issues needing attention. CoRWM may wish to offer advice on these issues but this should not divert it from its priority task set out above.)

12. CoRWM will take a strategic approach to the review and assessment of options for the long term management of radioactive waste. It will start by gathering information and familiarising itself with the issues, including meetings and presentations as appropriate. The outline framework within which CoRWM is then expected to complete its work is:

Setting the framework for the review through identification, on the basis of sounding public and stakeholder views, of:

- the inventory of materials to be covered (this will include not only the materials currently classified as waste liable to arise over the next century or so but also materials which may have to be managed as waste during that period, such as some plutonium and uranium as well as certain quantities of spent nuclear fuel);

- the options for the long-term management of the various waste materials; and

- the criteria against which each of the options being carried forward to the main assessment are to be assessed. (These criteria are likely to be wide-ranging, reflecting among other things, the potential risks involved, concerns been expressed by the public and stakeholders, and practicability of implementing each option.)

13. CoRWM should take the earliest possible opportunity to identify those options which have no realistic prospect of being implemented within the reasonably foreseeable future, so that the main effort during the assessment stage can be focussed on those which are practicable.

14. **Implementation of the review**. This will involve evaluation of each of the remaining options, for each of the wastes concerned, against the agreed set of criteria. The assessment will take account of existing information and any new research that CoRWM judges necessary. An initial assessment report will be produced by CoRWM and subjected to appropriate soundings of public and stakeholder group views. A final version will then be produced taking due account of the views expressed.

15. **Formulation of recommendations**. The final assessment report will be used to formulate Committee recommendations to its sponsoring Ministers. We also anticipate that, during the course of its work, CoRWM will have acquired views relevant to subsequent stages of the policy programme. For example, the assessment of options will not consider potential radioactive waste sites; but it will raise siting issues including whether local communities should have a veto or be encouraged to volunteer, and whether they should be offered incentives. CoRWM will need to consider these issues, and may want to make recommendations to Ministers on them.

Formulation and agreement of work programme

16. CoRWM will prepare a detailed draft work programme, within this outline framework, that will enable it to deliver its recommendation to Ministers within the required timescales. The programme will include any proposed sub-groups or other activities or events that are likely to involve significant time and effort by the Committee. CoRWM will send this draft work programme to its sponsoring Ministers for discussion and agreement at an appropriate early stage of its work. Such discussion may lead to appropriate adjustment and refinement. In considering this programme, CoRWM and sponsoring departments and Ministers will be able to take account of the parallel work with Government in this area.

17. In familiarising itself with the relevant background and issues, CoRWM will make itself aware of the UK Radioactive Waste Inventory and the nature of current and expected future UK holdings of plutonium, uranium and spent nuclear fuel. It will take account of existing technical assessments and research into radioactive waste management, and reports arising out of the Defra and devolved administrations' public consultation on radioactive waste. It will work closely with Nirex and other organisations with relevant experience and expertise. CoRWM is also recommended to meet and take presentations from appropriate key-player organisations and to visit a selection of key UK and, possibly, other European nuclear sites. It will also take account of other relevant policy developments, including the UK energy review. In particular, it is recognised that CoRWM will need to engage with the Nuclear Decommissioning Authority (NDA) and it's predecessor, the Liabilities Management Unit, given that the former's output will directly impinge on the long-term responsibilities of the NDA.

18. CoRWM is recommended to aim to complete its first phase (familiarisation work and proposals for the waste inventory, the waste management options, and the criteria to be used in their assessment) after about a year from the date of its

appointment. It is thereafter recommended to aim for completion and reporting of the assessment work itself (the second phase) after about a further year. Provision of recommendations to sponsoring Ministers would follow as soon as possible after that.

19. CoRWM should indicate the timing proposed for its work in the draft work programme sent for discussion with sponsoring Ministers. The intent is that CoRWM's recommendations should be delivered around the end of 2005. If the Chair anticipates that CoRWM will be late in completing any current phase or overall delivery of its work programme, he or she should inform the sponsoring Ministers as soon as possible, together with an indication of whether and how the Committee can catch up during any subsequent phases of its programme. CoRWM will agree with Ministers how to proceed so as to be able to carry its programme forward.

Public engagement

20. CoRWM must inspire public confidence in the way in which it works, in order to secure such confidence in its eventual recommendations. Hence, its work should be characterised by:

- a transparency policy;
- an active programme of public and relevant stakeholder group debate, using innovative and appropriate techniques to ensure public involvement and support;
- encouraging people to ask questions or make their views known, listening to their concerns, ensuring that they are addressed and that people get a response;
- public meetings and other consultative processes, well advertised in advance and involving a variety of interested stakeholders including members of the public;
- holding a significant number of its own meetings in public;
- clear communications including the use of plain English;
- making information accessible to as many people as possible, including use of the internet, as well as ways of reaching people who do not use the internet; and
- providing opportunities for people to challenge information, for example by giving them access to alternative sources of information and points of view.
- Chair

21. The Chair will be responsible for supervising the work of CoRWM and ensuring that its objectives are achieved. He or she will be the main point of contact with the public and the media, in presenting progress and answering questions. The Chair will meet Ministers on appointment, and then six-monthly to report progress. Notes of these meetings will be published. The Chair will provide an annual written report to Ministers, by 1 December, which he/she may be required to present to Parliament or Assembly representatives as appropriate. The report will set out, among other things, CoRWM's work programme, progress made, and costs incurred. Ministers will also appoint a Deputy Chair who can assist the Chair as the latter sees fit.

Members

22. Members will work, under the Chair's supervision, to the programme agreed with sponsoring Ministers so as to ensure its satisfactory delivery. Members will have a collective responsibility to ensure achievement of CoRWM's overall mission. It is

not envisaged that Committee Members themselves will be responsible for day-to-day work activities but rather in deciding what these should be, overseeing their delivery, and reviewing and being responsible for the reports and other output delivered under CoRWM's name. Individual Members may be appointed by the Chair to undertake specific, active roles, for example chairing sub-groups or in representing CoRWM in meetings with the public, organisations who are contributing to the work, or the media. All Members will be subject to individual performance appraisal as laid down by the Cabinet Office guide (see next paragraph).

Standards

23. CoRWM is set up by, and answerable to Ministers and is funded by the taxpayer. It must therefore comply with the Cabinet Office guide "Non-Departmental Public Bodies a Guide for Departments".

24. These and other relevant procedural requirements, including working to standards laid down by the Office of the Commissioner for Public Appointments, are set out in the Code of practice for members of the Committee on Radioactive Waste Management to which Members will agree prior to appointment.

Resources

25. Sponsoring Ministers will provide CoRWM with resources both staff and financial to enable it to carry out its agreed programme of work. These will include a secretariat which will help CoRWM carry out its programme including, at the outset, providing reading material and arranging for further briefings and visits. The Chair and Members will have a collective responsibility for delivering the work programme within the agreed budget, although the Chair may request sponsoring Ministers for adjustment to this budget should this be considered necessary.

Payments

26. The Chair and Members will be paid for their work for CoRWM. They will also be fully reimbursed for all reasonable travel and subsistence costs incurred during the course of their work.

Annex 2 CoRWM members and working groups

Chair

Professor Gordon MacKerron
Economist Director Sussex Energy Group, SPRU (Science & Technology Policy Research) University of Sussex.

Deputy Chair

Dr Wynne Davies
Former Vice President, Group Health, Safety and Environment, Amersham plc and former Lecturer in Physics and Radiation Biology, University of London

Mary Allan
Lecturer, The North Highland College.

Fred Barker
Consultant, specialising in nuclear policy analysis and stakeholder engagement.

Professor Andrew Blowers OBE
Professor of Social Sciences at the Open University, former county councillor, former Board Member of Nirex UK.

Professor Brian D Clark MBE
Professor of Environmental Management & Planning and Board Member, Scottish Environment Protection Agency.

Dr Mark Dutton
Physicist and radiological protection and radioactive waste management expert, independent consultant, formerly with NNC.

Jenny Watson
Chair, Equal Opportunities Commission and former Chair, Nirex Independent Transparency Review Panel.

Fiona Walthall OBE
Former Colonel, British Army and former Chief Executive, Sargent Cancer Care for Children.

Professor Lynda Warren
Zoologist and Emeritus Professor of Environmental Law at the University of Wales Aberystwyth, Board Member of the Environment Agency.

Pete Wilkinson
Director of Wilkinson Environmental Consultancy, former Chair of Greenpeace UK, Director of Greenpeace International and co-founder of Friends of the Earth.

Note: Dr Keith Baverstock was dismissed and Professor David Ball resigned from CoRWM in April and May 2005 respectively.

Working groups

CoRWM members often work individually and in small working groups. These develop specific issues and projects, and make recommendations for consideration and decision-making in the main plenary meetings. More details are on our website (www.corwm.org).

The main groups operating over CoRWM's programme have been:

Comparing Options Group
This group managed the initial work to identify the long list of options, and the process of producing a shortlist, including production of the technical briefing papers which supported the shortlisting process.

Implementation Working Group
This group ensured that CoRWM gave appropriate advice on how its recommendations could be implemented. This included advice on developing a siting process including partnership with local communities.

Information Working Group
This group managed the process of providing the technical input into the detailed assessment of CoRWM's short-listed options, including the scoring, by specialist panels of each option against CoRWM's criteria. Among other things, the group oversaw the collection of information requested by the specialists to enable them to carry out this work.

Integration Working Group
This group integrated CoRWM's work programme, including its MCDA, the holistic options assessment, work on implementation issues and the development of the final report to Government.

Inventory Working Group
This group managed the process by which CoRWM produced its inventory report, including the commissioning and review of technical work following discussions with the waste producers and other stakeholders.

Phase 3 Working Group
This group developed the detailed process for assessing the shortlisted options. This included developing the MCDA and the holistic assessment processes, and how these would be implemented.

Principles Working Group
This group formulated the key guiding principles under which CoRWM has worked, advised on decision-making processes that reflected these principles, and led the Committee's deliberations on ethical and environmental aspects of radioactive waste.

Public and Stakeholder Engagement Working Group
This group set the overall PSE strategy, and managed the implementation of each of the public and stakeholder engagement programmes.

Quality Assurance Group
This group ensured that CoRWM's work was of good quality and that it led to robust recommendations to Government.

Annex 3 Inventory

The following text is taken from CoRWM Document No. 1280 (CoRWM's Radioactive Waste and Materials Inventory – July 2005: A Summary)

Radioactive Wastes & Materials

Radioactive wastes have been produced in the UK since the 1940s, mainly from developing and using nuclear power to generate electricity, but also from the nuclear weapons and nuclear-powered submarine programmes, and from the use of radioactive materials in industry and medicine.

Radioactive wastes are hazardous to people and the environment, and many wastes will continue to be hazardous for thousands of years and some will remain hazardous for hundreds of thousands of years.

CoRWM has been asked to look at the higher activity wastes:

- High Level Waste
- ILW
- Low Level Waste (unsuitable for the UK disposal facility at Drigg in Cumbria).

High Level Wastes (HLW)

Wastes in which the temperature may rise significantly as a result of their radioactivity, so this factor has to be taken into account in the design of storage or disposal facilities.

HLW comprises the waste products from reprocessing spent nuclear fuels. These waste products arise in the form of highly radioactive nitric acid solutions, which are being converted into borosilicate glass within stainless steel canisters, using a process called vitrification.

Intermediate Level Wastes (ILW)

Wastes exceeding the upper boundaries for LLW, but which do not need heat to be taken into account in the design of storage or disposal facilities.

The major components of ILW are metal items such as nuclear fuel casing and nuclear reactor components, moderator graphite from reactor cores, and sludges from the treatment of radioactive effluents.

Non-heat generating waste is stored in tanks, vaults and drums. In time it will be retrieved, and packaged as ILW by immobilising the wastes in cement-based materials within stainless steel drums, or for large items in higher capacity steel or concrete boxes.

Low Level Wastes (LLW)

Wastes other than those suitable for disposal with ordinary refuse but not exceeding specified levels of radioactivity.

Most LLW can be sent for disposal at the Drigg facility. LLW unsuitable for disposal is mostly reflector and shield graphite from reactor cores, which contains concentrations of carbon-14 radioactivity above those acceptable at Drigg.

There are already over 80,000 cubic metres (over 100,000 tonnes) of higher activity radioactive wastes awaiting a decision on how they should be managed for the long-term. This quantity will increase substantially as the programme of decommissioning (dismantling and demolition) nuclear power reactors and other nuclear facilities develops over the coming decades.

Much larger volumes of lower activity wastes are forecast – this is the subject of a separate Government review.

CoRWM has also to consider the implications for waste management should some or all of UK accumulations of radioactive materials be declared surplus to requirements and so classified as wastes. These materials are:

- Plutonium
- Uranium
- Spent nuclear fuel.

Plutonium

A radioactive element created as a by-product in nuclear reactors. It can be separated from nuclear fuel by reprocessing. Separated plutonium can be used as a nuclear fuel and in nuclear weapons.

Separated plutonium is stored as an oxide powder.

Uranium

A radioactive element that occurs in nature. Uranium can be used for nuclear fuel and in nuclear weapons. It is also a by-product of spent fuel reprocessing. Less radioactive uranium (called depleted uranium) has more commonplace uses, such as counterweights in aircraft.

Most uranium is stored either as gaseous uranium hexafluoride or as an oxide powder.

Spent nuclear fuel

Nuclear fuel that has been irradiated in a nuclear reactor. It can be reprocessed (to separate out plutonium and “unburnt” uranium) or managed in some other way.

Like HLW, spent nuclear fuel is intensely radioactive and generates heat. It is usually comprised of uranium oxide, and contains the waste species (fission products) of irradiation.

July 2005 Inventory Update

We use the term "inventory" to describe the types and amounts of radioactive wastes and materials that the UK has to manage.

In October 2004 we issued our preliminary report on the inventory for consultation during the first stage of public and stakeholder engagement. We received much constructive feedback that identified a number of headline issues on the inventory where we have undertaken further investigations and analysis. In particular we have included:

- Data on radioactivity
- Data on the most important radionuclides in the context of long-term safety

- Data on the heat generation rates of alternative strategies and their potential impact on the short-list of options
- ILW that might be suitable for near surface disposal, either with or without treatment
- Spent sealed radioactive sources (SSRSs)
- Alternatives to our nuclear power reactor new build scenario.

Furthermore, we have taken the opportunity to update the inventory where more recent information is available. In particular we have made use of information in the draft 2004 UK Radioactive Waste Inventory (RWI) being prepared by Defra and Nirex that was not available when we prepared our preliminary report. This information is subject to change.

Baseline Inventory

We have established a baseline inventory of radioactive wastes and materials on which CoRWM will make its recommendations on the long-term waste management options.

The baseline inventory is based on the following principal assumptions:

Nuclear power reactors

- All operating Magnox reactors are shut down by 2010
- AGRs operate for up to 35 years, with the last shutdown in 2023
- Sizewell B PWR operates for 40 years and is shutdown in 2035
- No new nuclear power reactors are constructed.

Spent fuel reprocessed

- All Magnox fuel (55,000tU)
- AGR fuel covered by existing contracts (5,000tU)
- Overseas LWR fuel covered by existing contracts (4,500tU)
- Return of overseas Pu, U and HLW, with ILW & LLW substitution.

Radioactive materials to be managed as wastes

- All UK stockpile of separated plutonium (102 tonnes)
- All UK stockpile of uranium (153,000 tonnes)
- AGR fuel not covered by existing reprocessing contracts (3,500tU)
- Sizewell B PWR fuel (1,200tU).

All radioactive wastes, including spent fuel, are packaged so that they are in a form suitable for long-term management.

The volume and radioactivity of the wastes are:

Type	Packaged volume (cubic metres)	Radioactivity (terabecquerels)
HLW	1,290	39,000,000
ILW	353,000	2,400,000
LLW (non-Drigg)	37,200	<100
Plutonium	3,270	4,000,000
Uranium	74,950	3,000
Spent nuclear fuel	8,150	33,000,000
Total	**477,860**	**78,000,000**

Uncertainties in the Baseline Inventory

We have examined a number of factors in order to determine how changes in the assumptions used to construct the baseline inventory might affect the types and quantities of radioactive waste. These factors are:

- The building of new nuclear power reactors
- The quantity of spent fuel reprocessed
- ILW and LLW substitution (return additional HLW in place of ILW from reprocessing overseas spent fuel)
- Lifetimes of existing nuclear power reactors
- Decay storage and decontamination of ILW (for disposal as LLW)
- Early decommissioning of nuclear power reactors
- Waste segregation (of short-lived ILW; of mixed ILW/LLW streams)
- Quantity of unaccounted spent sealed radiation sources (SSRSs)

Their potential impact on the packaged volumes of radioactive waste and materials are given below.

In determining the impact of new nuclear power reactors we have assumed a programme of ten AP1000 reactors of Westinghouse design, which would be sufficient to maintain current nuclear generating capacity as today's reactors shut down. Our assumption is that the spent nuclear fuel would not be reprocessed. It is anticipated that other potential water-cooled reactor alternatives such as the European Pressurised Water Reactor (Framatome ANP design) or the Advanced Boiling Water Reactor (an evolution of the General Electric BWR design) would give rise to similar quantities of spent fuel and radioactive wastes. The Pebble Bed Modular Reactor is an alternative reactor concept that would give rise to different wastes, but given its development and licensing status, it is less likely to be the reactor selected for new UK nuclear power reactors.

Should there be a decision to close Magnox reprocessing earlier than forecast, we have assumed that the Magnox power reactors would be shut down and the remaining spent fuel would be reprocessed.

In addition the factors listed above, volume estimates are based on assumptions as to how waste will be packaged in the future for long-term management. For certain types of wastes there are uncertainties in the nature of the packaging process that will be adopted, the degree of volume change and the type of container used. All these can affect the packaged volume, although the quantity of radioactivity will remain unchanged.

High Level Waste (HLW) – 1,290 cubic metres

Potential for increase in volume (cubic metres)

+ 250	Reprocess remaining 3,500tU AGR spent fuel
+ 90	Reprocess 1,200tU Sizewell B PWR spent fuel
+ 60	No substitution for overseas wastes

Potential for decrease in volume (cubic metres)

Up to - 160	Early closure of Magnox reprocessing / Magnox reactors
Up to - 250	Early closure of Thermal Oxide Reprocessing Plant (THORP)

Should there be new nuclear power reactors built, we have taken the view that spent fuel is much more likely to be packaged directly than reprocessed.

Heat from the radioactive decay of HLW decreases significantly with time.

Intermediate Level Waste (ILW) – 353,000 cubic metres

Potential for increase in volume (cubic metres)

+ 7,000	Reprocess remaining 3,500tU AGR spent fuel
+ 2,000	Reprocess 1,200tU Sizewell B PWR spent fuel
+ 4,100	Extend AGR lifetimes by 5 years (fuel not reprocessed)
+ 170	Extend Sizewell B PWR lifetime by 10 years (fuel not reprocessed)
+ 17,580	Early decommissioning of nuclear power reactors
+ <10	Unaccounted SSRSs
+ 9,000	New build programme of 10 AP1000 reactors

Potential for decrease in volume (cubic metres)

Up to – 8,800	Early closure of Magnox reprocessing / Magnox reactors
- 5,000	Return of ILW from reprocessing overseas fuel (no substitution)
- 19,000	Decay storage / decontamination (waste producer plans)

- 4,500	Segregation of ILW and LLW in cases where they are mixed and disposal of LLW

Low Level Waste (ILW) – 37,200 cubic metres

The nature of the most of the waste - activated reactor core graphite – would make it difficult to treat in order that it would be acceptable for disposal to Drigg. There may be some uncertainty in the relative quantities of ILW and LLW reactor graphite, but this will not affect the inventory.

Plutonium – 3,270 cubic metres

Potential for increase in volume (cubic metres)

+ 580	Reprocess remaining 3,500tU AGR spent fuel (18 tonnes Pu)
+ 450	Reprocess 1,200tU Sizewell B PWR spent fuel (14 tonnes Pu)

Potential for decrease in volume (cubic metres)

Up to – 640	Early closure of Magnox reprocessing / Magnox reactors (up to 20 tonnes Pu)
Up to - 580	Early closure of THORP (up to 18 tonnes Pu)
Up to - 3,270	Use of UK separated plutonium in MOX fuel for new build programme of nuclear reactors (up to 105 tonnes Pu)

British Energy has advised us that separated plutonium could in principle be used in the manufacture of mixed oxide fuel (MOX) for Sizewell B and AGRs, although the commercial case (mainly in terms of the higher cost of the fuel, and the cost of plant modifications particularly in the case of the AGRs) makes it unattractive. New nuclear power reactors, depending on design, could also use MOX fuel, but at today's uranium prices, burning MOX fuel in light water reactors would be uneconomic. Thus existing stocks of separated plutonium would only be used if uranium prices rose, MOX fuel were used as a plutonium management tool, or the fast reactor programme was resumed.

About 5% of existing separated plutonium stocks are likely to require extensive chemical treatment to allow it to be used as fuel.

Uranium – 74,950 cubic metres

Potential for increase in volume (cubic metres)

+ 1,660	Reprocess remaining 3,500tU AGR spent fuel (3,390 tonnes U)
+ 550	Reprocess 1,200tU Sizewell B PWR spent fuel (1,120 tonnes U)

Potential for decrease in volume (cubic metres)

Up to – 3,390	Early closure of Magnox reprocessing / Magnox reactors (up to 6,940 tonnes U)
Up to - 1,660	Early closure of THORP (up to 3,390 tonnes U)

Up to – 6,840	Use of UK uranium in fuel for new build programme of nuclear reactors (up to 14,000 tonnes U)

Spent fuel – 8,150 cubic metres

Potential for increase in volume (cubic metres)

+ 840	Extend AGR lifetimes by 5 years (extra 1,320tU fuel not reprocessed)
+ 680	Extend Sizewell B PWR lifetime to 50 years (extra 300tU fuel not reprocessed)
+ 31,900	New build programme of 10 AP1000 reactors (14,000tHM)

Potential for decrease in volume (cubic metres)

- 5,410	Reprocess remaining 3,500tU AGR spent fuel
- 2,740	Reprocess 1,200tU Sizewell B PWR spent fuel

Heat from the radioactive decay of spent fuel decreases significantly with time.

CoRWM has developed four alternative scenarios to that which underpins the baseline inventory, in order to illustrate how the various uncertainties identified above could affect the total packaged volume.

Scenario	Packaged volume (cubic metres)
Baseline inventory	477,860
1: No substitution of ILW	472,920
2: Decontamination, decay storage and segregation of ILW	454,360
3: AGR and PWR life extensions plus programme of 10 new AP1000 PWRs	514,440
4: Early closure of reprocessing and early power reactor decommissioning	483,490

Conclusions

CoRWM has updated the inventory of radioactive wastes and materials on which it will make its recommendations on the long-term management options. The July 2005 inventory has taken into account the feedback we have received from the first stage of public and stakeholder engagement. It also includes the latest information from the 2004 UK Radioactive Waste Inventory (draft status).

We have determined the baseline inventory for the three categories of radioactive wastes - HLW, ILW and non-Drigg LLW – and three categories of radioactive materials - plutonium, uranium and spent nuclear fuel - that fall within our remit. The total packaged volume is 477,860 cubic metres and the total radioactivity is about 78,000,000 terabecquerels.

ILW makes up about 74% of the baseline inventory volume, uranium about 16% and the other categories in total about 10%. HLW makes up about 50% of the radioactivity, spent fuel about 42% and the other categories in total about 8%.

We have quantified uncertainties in the baseline inventory volume by examining how changes in our assumptions might affect the types and quantities of wastes and materials. To illustrate these uncertainties we have proposed four example scenarios.

These scenarios demonstrate that the extent to which the baseline inventory volume is likely to vary in the light of reasonably foreseeable developments in nuclear energy and waste practices is relatively small, of the order of less than 10%.

The only scenario that would change the baseline inventory radioactivity to any significant extent is that where there is a commitment to future nuclear energy with life extensions to existing AGR and PWR stations and a programme of new reactors. In this scenario the amount of radioactivity (and the quantity of spent fuel for long term management) could be up to a factor of five greater than the baseline.

Should ILW substitution not be implemented, the impact on the baseline inventory volume and radioactivity would be very minor.

Similarly early closure of spent fuel reprocessing with early reactor decommissioning would have a minor impact on the baseline inventory volume and radioactivity.

We have determined that only a small proportion of ILW (about 1%) can be categorised as short-lived and so potentially suitable for near surface disposal. Furthermore we have concluded that the impact of waste segregation in order that wastes can be routed for near surface disposal, further to that which is planned, would likely be very modest.

Further information on the inventory can be found in CoRWM Document No. 1279.

Annex 4 Additional detail on options assessment

The outcome of CoRWM's options assessment process, including the views of specialists on the options, is set out in the main body of this report. This annex provides greater detail on particular aspects of the process, including the way it was designed and constituted:

Section 1 The way in which CoRWM selected its options assessment method.
Section 2 The formulation of the "value tree".
Section 3 The selection of seven materials/wastes for assessment.
Section 4 The process of specialist scoring of options.
Section 5 Acquiring the inputs for sensitivity testing.
Section 6 Non-geological disposal of reactor decommissioning waste, in particular, CoRWM's definition of that waste stream.

Section 1 Assessing the method for assessing the options

1.1 During the initial information gathering and trialling period, CoRWM looked at "Deliberative Mapping", a "participatory, multi-criteria, option appraisal process developed by researchers working at University College London and the University of Sussex based on 10 years of experimentation"[1]. Deliberative Mapping is designed to bring citizens, stakeholders and specialists together in an analytical and deliberative process that supports the application of criteria in a systematic appraisal of options. It also provides opportunities for deliberation between citizens and specialists. CoRWM was attracted by the potential for involving these groups and ran a trial process[1] to assess the contribution this methodology could make to its appraisal of options.

1.2 The core appraisal process of Deliberative Mapping is based on two decision-support tools:

- *multi-criteria mapping*, a primarily quantitative methodology with its own dedicated software which allows specialists and stakeholders to undertake a facilitated option appraisal process in two to three hours.

- *stakeholder decision analysis*, a group-based methodology designed to frame problems, scope options, elicit criteria and make judgements through facilitated deliberation developed for environmental decision making with stakeholders and citizens.

1.3 Although the Committee decided not to adopt Deliberative Mapping in total, many lessons were learned about how to work with specialists, stakeholders and the public, and several techniques used in the Deliberative Mapping trial were later used in CoRWM's bespoke assessment process. A review of alternative methods for engaging with the public and stakeholders[2] was also used in the design of the process.

1.4 CoRWM formed the Phase 3 Working Group in October 2004 to make recommendations to the whole Committee on how option assessment should be carried out. Work was commissioned from IDM, a decision-making consultancy. The IDM review[3] examined methodologies including Multi-Criteria Decision Analysis (MCDA), Strategic Action Planning, Joint Fact Finding, and the part these have played in decision-making, especially in radioactive waste management. In response to the difficulties posed by decision-making in the area of radioactive waste management (complexity; disputed and uncertain evidence; multi-dimensionality) it concluded that MCDA was particularly suitable for encompassing and dealing with these issues.

1.5 This was on the basis that:

- it is open and explicit;
- the choice of objectives and criteria that any decision-making group may make are open to analysis and change if they are felt to be inappropriate;
- scores and weights, when used, are also explicit and are developed according to established techniques. They can be cross-referenced to other sources of information on relative values and amended if necessary;
- performance measurement can be sub-contracted to experts so need not necessarily be left in the hands of the decision-making body itself;
- it can provide an important means of communication within the decision-making body itself and between that body and the wider community;
- scores and weights can be used that provide an auditable trail and can be changed if new or updated information becomes available.

1.6 The IDM report was peer reviewed by Tim McDaniels, of the Eco-Risk Research Unit at the University of British Columbia[4]. In a supplementary note to this report Professor McDaniels indicated that "the only method I know of to address these features of such decision problems in a responsible manner is multiple objective (otherwise known as multi-criteria or multi-attribute) decision analysis".

1.7 CoRWM held an option assessment methodology workshop at its plenary meeting in Southampton on 15 December 2004 at which Professor Gregg Butler (Manchester University and IDM) and Professor Ortwin Renn (Stuttgart University and DIALOGIK gGmbH) gave presentations. For this meeting, advice was sought from Professor Renn on a suitable decision analysis methodology for CoRWM to use in option appraisal. Professor Renn's Cooperative Discourse Methodology was summarised in CoRWM document 844.[5] The resulting decision to adopt a version of MCDA is reported in the minutes of the December 2004 CoRWM plenary meeting.[6]

1.8 Professor Renn and Professor Larry Phillips (London School of Economics Decision Analysis Unit) were co-opted onto the Phase 3 working group, along with Richard Harris, a specialist in stakeholder engagement, to help design a bespoke assessment process. CoRWM document 898[7], presented to the January 2005 plenary meeting, contained outline proposals to be put out to consultation during CoRWM's second round of public engagement from 4 April to 27 June 2005.

1.9 Among other things, the proposals envisaged:

- researching the various scoring methods used in MCDA;
- use of specialists to score the options;
- review of scoring by stakeholders;
- weighting of criteria by stakeholders and members of the public to reflect their relative importance;
- a parallel "holistic" process of assessing the options (using intuitive judgment of the options as a whole).

1.10 Thus, the structure of a formal MCDA would be used "to provide an essential element of a wider assessment of the short-listed options. The process is based on key principles from Ortwin Renn's Cooperative Discourse Model, in which different groups complete appropriate parts of the process, and there is a balance between a MCDA type approach and a more holistic assessment of options"[8].

1.11 The methodology for the holistic assessment was developed later in the programme and was based on assessing the options as a whole rather than breaking them down into their specific attributes. CoRWM's Integration Group planned a series of plenary discussions and panels to discuss particular aspects in more depth. The topics chosen were those that would either self evidently play a critical role in assessing the options, such as the long term safety of geological disposal, or those that had been highlighted during PSE and/or the MCDA as being complex or disputed, and important discriminators, such as retrievability/flexibility.

1.12 The process for the holistic assessment was planned by a small group of members with the help of Richard Harris. The proposed method was discussed in plenary meetings and was modified to ensure that all members were satisfied that it would allow them to bring in to discussions all the aspects that were important to them. It included a combination of further in-depth discussions on critical issues, and a method of recording members' initial option preferences for each waste stream to stimulate debate on the areas of consensus and disagreement. This was the first moment that members declared their provisional option preferences, and was an important step in moving towards the formation of a draft strategy for all waste streams.

Section 2 The "value tree"

2.1 The options assessment criteria, together with their "implicit goals", and a set of factors whereby option performance can be assessed, are set out in a document known as the "CoRWM value tree". The value tree concept is used to elicit and represent the concerns and evaluative criteria used for judging different options on the part of all relevant stakeholder groups. According to Ortwin Renn, the process results in "a list of hierarchically structured values that represent the concerns of all affected parties"[8]. Thus, there are headline criteria which have associated sub-criteria at the next level of detail, but the headline criteria themselves are not arranged hierarchically.

2.2 The first draft of the value tree (December 2004) drew on a mix of published material including:

- existing published material: Radioactive Waste Management Advisory Committee[9], Nirex[10], COMPAS,[11] AkEND,[12] NEA;[13]
- work commissioned by CoRWM, e.g., on the Deliberative Mapping trial and ethical and environmental principles;[14;]
- the values incorporated in the screening criteria, as well as some outputs from the first round of PSE that had not been incorporated into them[15];
- member input.

2.3 An important stage of development occurred with preparation of the Consultation Document for the second round of public and stakeholder engagement and comments made during the engagement period itself.[16] The

responses were discussed at the July 2005 plenary meeting of CoRWM and the outcome recorded in the minutes of that meeting.[17]

2.4 Document 1202.2[18] indicated the process by which outputs from the second round of engagement would be taken account of in the further development of the value tree. This led to its deployment as a key tool in the MCDA specialist-led scoring in December 2005. Thus, both public and stakeholder engagement outputs and the views of the specialists influenced the composition of the value tree.

2.5 The final version of the value tree (November 2005) was developed by CoRWM drawing on the views of specialists (see below) and the concerns of the public and stakeholders. The views and concerns are arranged under an initial set of broad headings that, at lower levels, are broken down into more specific issues. There are 11 "headline criteria" and 27 sub-criteria; each of the sub-criteria is provided with a descriptor ("Extent to which the option is expected to .. ..") and with the factors relevant to assessing the performance of each option against it. The need for a manageable process meant that the options would be formerly assessed (scored) at the sub-criterion level. A "scoring scheme" (see Section 4) was formulated for each sub-criterion to reflect the terms of its descriptor and the associated factors.

Section 3 The materials and wastes for assessment

3.1 The assessment of the options was carried out for each waste stream. Seven types of materials and wastes were scored by the specialists, each of which had unique characteristics that meant it merited separate assessment. The seven materials and waste were:

- High level waste
- Spent nuclear fuel
- Plutonium
- Highly enriched uranium
- Intermediate level waste and low level waste not suitable for the LLWR
- Depleted, natural and low enriched uranium
- Reactor decommissioning waste.

3.2 The reasons for considering these waste streams separately were as follows:

- High level waste and spent fuel produce enough heat for them to require cooling during the initial years of storage and their heat production is a factor that has to be taken into account when designing a disposal facility.
- Plutonium and highly enriched uranium can be used to produce nuclear weapons as well as being potential reactor fuels and therefore have different security implications compared with high level waste and intermediate level waste.
- Spent nuclear fuel also contains plutonium and is potentially desirable to terrorists.

- Intermediate level waste is much more chemically complex than the other waste streams. This has implications for the disposal concept, for example, the type of backfill required to achieve the desired level of alkalinity in groundwater entering the repository and the potential for gas generation from the degradation of the waste.

- Depleted, natural and low-enriched uranium is a potential source of energy, but its radioactivity is similar to some naturally occurring rocks so that its potential hazard is less than that for the other streams.

- There are more options available for the disposal of reactor decommissioning waste than there are for the disposal of the other waste streams, which allows the transport of these wastes to be minimised.

3.3 The two types of uranium were treated as one during the latter stages of option assessment on the basis that if uranium came to be managed as waste, its highly enriched form would be physically brought within a matrix of less active uranium.

Section 4 The specialist scoring process

4.1 The way in which CoRWM selected specialists to participate in the scoring of options, and the organisation of them into workshops, has been described in Chapter 11. The objectives of the first stage of the workshops (June and July 2005) were to review the definition of the sub-criteria and to define the scoring schemes for each sub-criterion, identifying the information needed to allow scoring to be carried out.

4.2 In essence, the scoring schemes provide a means for converting a judgement on the extent to which an option meets the implied goals of each sub-criterion (how well it performs in each case) into a numeric score on a fixed scale of 1-9 (the former score representing the least preferred and the latter representing the most preferred). In order that CoRWM's recommendations are transparent and auditable, the reasons for the scores given by the specialists needed to be comprehensively and accurately recorded.

4.3 Seven workshops were held: safety; security; environment; implementability (including flexibility); social and economic (including amenity); burden on future generations; and cost. The output required from the workshops was a scoring scheme for each sub-criterion with its rationale, and the identification of further information required in order for scoring to be done later in 2005.

4.4 The workshops were facilitated by Catalyze Ltd by means of "Decision Conferencing" techniques supported by the MCDA approach and using the Catalyze software tools - Hiview and M-MACBETH (see the glossary for a description of these assessment tools.) Briefing information for specialists was provided in the form of a series of criteria-specific Background Papers. A total of 69 specialists were involved, most of whom also participated in later workshops.

4.5 The outcome of the June and July workshops was reported by Catalyze.[19] The majority of the scoring schemes were completed by the specialists but the Safety and Security workshops were reconvened in September 2005 to complete their work.[20]

4.6 As a result of the workshops it was agreed that:

- proximity would be dealt with through discussion on intra-generational equity outside the formal MCDA;
- the blight sub-criterion was dropped because it was considered to be too site specific to be scored.

4.7 A trial run was held in August 2006 to ensure that:

- each of the CoRWM short-listed management options could be scored against each of the sub-criteria;
- the criteria were preference independent (i.e., that scores on one criterion do not need to be consulted when scoring the options against any other criterion);
- “double counting” did not exist among the criteria (although some factors may appear under more than one sub-criterion);
- the criteria set was complete.

4.8 The trial involved a panel of CoRWM members and members of the Defra Chief Scientific Advisor's expert panel on CoRWM's work. The report of the trial[21] was a product of CoRWM consideration as well as that of Catalyze. As a result of the trial, the specialists were asked to score the interim storage options without any assumption about the management route that would follow. Any impact passed on into the post-300 year period would be captured under the "Burden on Future Generations" criterion.

4.9 The final version of the value tree was developed by CoRWM's Information working group, with regular report-back to the plenary Committee. This process can be traced by reading the minutes of the September and November 2005 plenary meetings, and the supporting documents for those meetings[22].

4.10 The 14 option variants were scored against the 27 sub-criteria at scoring workshops held in December.[23]

4.11 The environment workshop was reconvened on 11 January 2006 in order to score the radiological impact of the options on the environment over the short-term (0-300 years) and separately in the long term (over 300 years).

Section 5 Acquiring the inputs for sensitivity testing

5.1 CoRWM used the scores derived by the specialists as the baseline case in the MCDA but also invited comments on the scores from as wide a circle of interested parties as possible. These views were considered by CoRWM when deciding what sensitivity testing to do using the MCDA model. Sensitivity testing allows the impact of variations from baseline case scores to be explored, thereby increasing understanding of how the options perform from various perspectives.

5.2 Opportunities to comment on the scores derived from two sets of sources:

- the CoRWM National Stakeholder Forum and participants in the Nuclear Site Round Tables were given opportunity to make preliminary comments on the scores during the third round of public and stakeholder engagement in January and February 2006 and were encouraged to submit more detailed comments via the website;

- written and website comments on the report of the scoring workshops. Documents on which comments were invited were posted on the website with a series of questions developed and agreed by CoRWM. In addition, the CoRWM Chair and members of CoRWM's Quality Assurance group contacted several of the scientific learned societies to ask for their comments.

5.3 A paper summarising the impact of these comments on the scoring outcome[24] was submitted to the CoRWM MCDA decision-making meeting on 29-31 March 2006.[25]

5.4 CoRWM aspired to "frame its MCDA in the values and needs of society" and needed to be confident that these values were reflected in the weight (relative importance) attached to each criterion. The process of swing weighting ensured that judgements could be made on the basis of the relative importance of the criteria taking account of the difference (or "swing") between the top and bottom of the scoring scales. Thus safety, for example, was not judged purely on whether it was considered to be important per se, but posed the question of how important was the difference between a score of 1 and a score of 9. Swing weighting was carried out at the sub-criterion level.

5.5 Processes to inform criteria weighting were undertaken in five types of activity as part of the third phase of public and stakeholder engagement. These were:

Activity	Weighting process	Level of weighting	Participants
1.Discussion Guide	Groups asked to identify 4 most important criteria, and 2 least important criteria	Headline criteria	568 self-organising groups from across the UK, including community groups, environmental groups, older people and schools
2. Schools Project	Ranking of criteria following research and discussion	Headline criteria	1,305 students (age range 11-18) from 15 schools in Bedfordshire
3. Citizens' Panels	Judgements of (a) best and worst performing options against each criteria and (b) importance of that difference in performance against each criterion	Headline criteria	Four panels of 12-16 recruited citizens of mixed gender, age and social class, covering Scotland, Wales, North and South England
4. National Stakeholder Forum	Judgements of the importance of the difference in performance between best and worst options (based on specialist judgements of option performance)	Sub-criteria	One meeting of 20 stakeholders from national organisations and bodies. Weighting undertaken at 'sector' tables
5. Nuclear Site Stakeholder Round Tables	Judgements of the importance of the difference in performance between best and worst options (based on specialist judgements of option performance)	Sub-criteria	Eight Round Tables, with stakeholders from local organisations and bodies around nuclear sites, with between 17-26 participants at each event. Weighting undertaken at 'sector' tables at each event

5.6 A CoRWM report[26] collated the results from these activities for the purposes of helping CoRWM members carry out the swing weighting process at the Brighton plenary meeting in March 2006.

5.7 The meeting used sensitivity testing to test the robustness of the MCDA results by a process that employed different criteria weightings and scores to represent the views of various stakeholders and demographic sectors. The score and criteria weight variations from the processes described above were grouped into feedback from different sectors. Those sectors were NGOs, older and younger citizens, local government bodies and community organisations, non-departmental public bodies, the learned societies, and the environmental regulators. For each sector, all the feedback received on both scores and weights was analysed and the trends were identified. This enabled a sector 'position' to be articulated in terms of new suggested scores and weights. For example, the new scores and weights for the Green NGO perspective reflected their doubts about the efficacy of disposal to reduce burden and the flexibility offered by the Phased Geological Disposal option, and their belief that environment, amenity, implementability and flexibility should be more heavily weighted.

Section 6. Non-geological disposal of reactor decommissioning waste

6.1 The issues associated with this form of managing waste proved to be more complex than CoRWM anticipated and, for this reason, an outline of the thinking that led CoRWM to short-list the option is set out here.

6.2 As described in Chapter 10, feedback from public and stakeholder engagement suggested that there was support for local solutions for reactor decommissioning waste in order to avoid the transportation of these large volumes of waste. The Committee therefore expanded the option of the near-surface disposal of short-lived ILW to encompass suitable means of dealing with some longer-lived radio-elements contained in the waste from the decommissioning of nuclear reactors. A fuller explanation is contained in CoRWM document 1381[27] which, in turn, refers at length to the technical issues raised during the short-listing of options.

6.3 The options envisage, in different ways, the containment of wastes within man-made structures with additional barriers (such as sand, soil or clay) in place. They do not rely on the containment features provided by geological formations. It is extremely unlikely that safety cases could be made for the non-geological disposal of high-level waste, spent nuclear fuel, plutonium, uranium, or intermediate-level waste containing long-lived transuranic elements such as neptunium or americium.

6.4 The non-geological disposal variants are:

- Near surface engineered vaults excavated side-by-side and covered by earth/clay at or near current waste locations (option 10);
- Near surface engineered vaults similar to option 10 at a central location (option 11);
- Mounded over reactors; the reactor is defuelled and its high active components removed. All void spaces (including the pressure vessel and biological shield) would be filled with cement and the structure covered with sand, earth and clay (option 12);

- An engineered vault excavated at a depth of less than 100 metres at or near current waste locations and accessed by a tunnel (option 13);

- An engineered vault similar to option 13 at a central location (option 14).

6.5 The example for the design of options 10 and 11 is the LLWR and that for options 13 and 14 the facility at Forsmark in Sweden.

6.6 Document 1381 explains how CoRWM decided on the inventory of reactor decommissioning waste for assessment purposes. The inventory identified by CoRWM (with one member, Pete Wilkinson, expressing strong reservations) encompasses all reactor decommissioning waste (ILW and LLW unsuitable for the LLWR) of between 110,000 - 120,000 cubic metres, of which only about 2,000 cubic metres contains only radionuclides with a half-life of 30 years or less. Thus, the CoRWM reactor decommissioning waste inventory ("inventory c" in document 1381) contains very large volumes of graphite contaminated to varying degrees by Carbon-14 (half life of 5,730 years) depending on the location of the graphite in the reactor.

6.7 The reactor decommissioning waste can be physically segregated between "short-lived" and "long-lived", but, on the face of it, it would not be economic to dispose of the short-lived inventory of 2,000 cubic metres on a local basis, i.e., split between more than 20 local sites. The remainder has to be classified as "long-lived" although the presence of long-lived radionuclides varies.

6.8 Document 1381 said that CoRWM would not recommend any of the non-geological disposal options unless it was satisfied on the issue of the impact on public health and the environment of leaving long-lived wastes disposed of in situ for longer than 300 years.

6.9 The specialists were asked to score non-geological disposal on the basis of inventory c, but were unable to do so because, as the Catalyze report[23] pointed out:

"It was recognised that the non-geological disposal options would be implementable only if there was a measure of assurance that more active and (especially) longer-lived components of the reactor decommissioning waste had been segregated for management in the same way as other intermediate-level waste. For the purposes of the assessment, it would be assumed that such options had indeed been considered to be implementable on this basis."

6.10 Advice was also received from the Environment Agency that:

"... expressed concern about the possible disposal of significant quantities of long-lived radionuclides such as carbon-14 and chlorine-36 under non-geological disposal. Reactor graphite could be segregated and disposed of separately. For other dominantly short-lived wastes arising from reactor decommissioning, it might be possible to make a safety case for non-geological disposal, but this needs to be assessed quantitatively on the basis of the details of the proposed disposal inventory, including the component of long-lived activity that will be associated with such wastes. It was noted that the safety case for the disposal of long-lived radionuclides would vary from site to site, for example in relation to the potential for terrestrial versus marine discharge of radioactivity (with considerable differences in the extent of dilution that would be expected). It is also appropriate to highlight the issue of coastal erosion if disposal in the vicinity of a vulnerable coastline is under consideration. Thus, the Agency would not favour non-geological disposal for wastes with a significant long-lived component. Mounding was a particular

problem (viewed with "disfavour") as it does not involve a purpose-built engineered facility. It might be hard to claim that this concept is an optimised disposal concept." [28]

6.11 On the basis of the EA and specialist views, CoRWM revised its definition of reactor decommissioning waste to encompass short-lived ILW and only those elements or amounts of longer-lived radionuclides that would not produce a significant hazard after 300 years.

6.12 At the same time, it is clear that a number of overseas countries that are decommissioning their reactors are considering the non-geological disposal option. For example, the French waste management organisation, ANDRA, is investigating a long-term waste management system for graphite wastes in a sub-surface disposal facility at a depth of approximately 15 metres in low-permeability clay or marl.

6.13 The nature of safety cases is such (for example, they are site-specific) that it would always have been impossible for CoRWM to indicate whether or not a case could be made for localised (or centralised) non-geological disposal of reactor decommissioning waste. In the event, CoRWM is also unable to answer the question that it set itself in document 1381[27] on the question of the environmental and health impact from non-geological disposal after 300 years. This question will turn on each of the site-specific safety cases if and when the site operators decide to try to make them.

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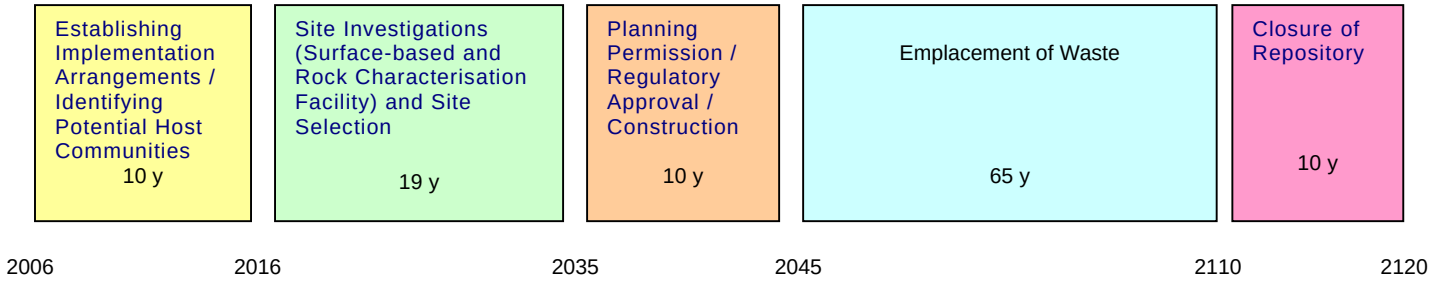
Annex 5 An indicative timeline

Introduction

1. A large proportion of the public and stakeholders that participated in CoRWM's engagement process asked the Committee to provide some indication of the timescale associated with implementing its recommendations.

2. CoRWM itself has not carried out any substantive work on timescales, except to consider what the implications might be of its recommendations to establish partnership arrangements with potential local host communities that might be willing to participate in the process. In the indicative timeline below, therefore, the first ten years represents CoRWM's initial view of the time it might take to get to the start of site investigations for a geological repository, mostly based on its interpretation of overseas experience where partnership arrangements have been attempted[1].

3. Beyond consideration of that first phase, CoRWM carried out no work of its own. However Nirex has provided guidance to Government and the NDA, although without assuming CoRWM's proposed early partnership arrangements. The timeline below combines the work done by CoRWM and Nirex to provide indicative timescales for the period from the time that Government accepts CoRWM's recommendations to the time that the repository would be closed.[2]



14. CoRWM's main assumptions in this timeline are as follows:

- Government accepts CoRWM's recommendations and begins the implementation process in late 2006
- No major new legislation is required
- Any changes in planning regimes do not necessarily shorten the process, because partnerships need time to reach decisions
- The electoral cycle will not result in withdrawal of support for the partnership approach
- There is no significantly accelerated decommissioning
- No new build waste is consigned to the repository

15. The timeline shows what might happen if the implementation process worked reasonably well. It is possible, for example if partnership negotiations were rapid

and site investigations were straightforward, that the time-scale might be shorter. It is also possible that delays at any stage of the process could cause the timescale to become longer.

16. The main stages before site investigations would start are as follows:

Stage 1 - Length: 2 years; Completion: 2008
Government accepts CoRWM's recommendations and establishes the Overseeing and Implementing Bodies.

Individual steps would include:

- Government accepts CoRWM's recommendations;
- determine the structure, nature and accountability of the overseeing and implementation bodies and establish them;
- draft and enact any necessary legislation, if required.

Stage 2 – Length: 2 years; Completion: 2010
Develop and apply scientific screening criteria. Develop framework for partnerships and Involvement Packages.

Individual steps would include:

- develop scientific screening criteria by engaging with interested parties;
- apply screening criteria and reject scientifically unsuitable areas of the UK;
- obtain best practical environmental design options for the disposal concept;
- develop broad framework of partnership arrangements and Involvement & Community Packages by national engagement process;
- issue invitations to local communities to participate in the implementation process.

Stage 3 – Length: 2 years; Completion: 2012
Local communities decide willingness to participate. Develop partnership and Involvement Packages.

Individual steps would include:

- local communities decide their willingness to participate;
- establish provisional partnerships and ensure they are sufficiently representative and workable;
- within the national framework, agree the Involvement Package for each partnership;
- the appropriate elected body for the local community decides whether or not to proceed.

Stage 4 – Length: 4 years; Completion: 2016
Develop Community Packages.

Individual steps would include:

- each partnership develops a Community Package that is acceptable to the local community, which could include the extent and period of flexibility to be incorporated into the design;
- the appropriate elected body decides whether or not to proceed;
- if no partnership decides to proceed, develop a different partnership/package arrangement.

Summary Table 1

Stage	Time	Period (years)	Main Activities
1 – 4	2006-2016	10	Establish organisations and screening criteria, partnerships and packages.
5	2016-2035	19	Site investigation and selection
6	2035-2045	10	Planning permission for repository and construction
7	2045-2110	65	Emplacement (assumes co-disposal)
8	2110-2120	10	Closure

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Annex 6 Acronyms and glossary of technical terms

Acronyms

AGR	Advanced Gas-cooled Reactor
AWE	Atomic Weapons Establishment
BE	British Energy
BNFL	British Nuclear Fuels plc
BNG	British Nuclear Group
CORE	Cumbrians Against a Radioactive Environment
CoWRM	Committee on Radioactive Waste Management
Defra	Department for the Environment, Food and Rural Affairs
DTI	Department of Trade and Industry
HAL	High active liquor
HEU	Highly enriched uranium
HLW	High level waste
IAEA	International Atomic Energy Agency
ILW	Intermediate Level Waste
LLW	Low level waste
LLWR	Low Level Waste Repository
LMU	Liabilities Management Unit
LWR	Light water reactor
MOX	Mixed oxide fuel
NDA	Nuclear Decommissioning Authority
NEA/OECD	The Nuclear Energy Agency of the Organisation of Economic Cooperation and Development
NGO	Non-Governmental Organisation
NII	Nuclear Installations Inspectorate
NORM	Naturally occurring radioactive materials
OCNS	Office for Civil Nuclear Security
OSPAR	OSPAR Convention: The Convention for the Protection of Marine Environment of the North-east Atlantic.
PSE	Public and stakeholder engagement
PWR	Pressurised water reactor
QA	Quality assurance
R&D	Research and Development
RCF	Rock characterisation facility
RDW	Reactor decommissioning waste
RSA93	Radioactive Substances Act 1993
RWI	Radioactive waste inventory
RWMAC	Radioactive Waste Management Advisory Committee
THORP	Thermal oxide reprocessing plant
UKAEA	United Kingdom Atomic Energy Authority
VLLW	Very low level waste
WIPP	Waste Isolation Pilot Plant

Glossary of technical terms

Activity - The number of disintegrations per second which occur in a radioactive source. The unit of activity is the Becquerel.

Advanced Gas-cooled Reactor - The reactor type used in the UK's second generation nuclear power plants.

Alpha decay - Spontaneous emission of an alpha particle from a nucleus.

Alpha particle - Nucleus of a helium atom comprising two protons and two neutrons.

Backfill - The material used to fill in and close off the void areas of an underground repository, such as vaults, silos, and drift tunnels, which usually occurs after the radioactive waste has been emplaced; thus "backfilling the waste".

Becquerel (Bq) - S. I. unit of measurement of radioactivity, equivalent to one disintegration per second. A Gigabecquerel is a thousand million Bq; a Terabecquerel is a million million Bq.

Beta decay - Spontaneous emission of a beta particle from a nucleus.

Beta particle - An electron or a positron emitted from the nucleus of an atom during radioactive decay.

Borehole - A cylindrical excavation, made by a drilling device. Boreholes are drilled during site investigation and testing and can also be used for waste emplacement in repositories and monitoring.

CARL - A self-supporting social sciences research project into the effect of stakeholder involvement in decision-making on radioactive waste management. The term comes from the four types of partners in the project: Citizens, Agencies responsible for radioactive waste management, Research social scientists, and Licensing and regulatory authorities.

Ceramic matrix - In this context, use of high performance ceramics, heat and corrosion resistant materials, which are mixed with, and thus immobilise, radioactive waste.

CLAB - The Swedish near surface interim store for spent nuclear fuel.

Cm 2919 - The Command White Paper "Review of Radioactive Waste Policy - Final Conclusions" (1995); although to an extent overtaken by events, this remains an important statement of the UK Government's position on radioactive waste.

Compas - "Comparison of alternative waste management strategies for long-lived radioactive wastes", a project undertaken within the 5th Framework Programme of the European Commission by individuals representing waste management organisations in 15 countries.

Conditioned waste - Radioactive waste that has been treated or processed in preparation for packaging.

COWAM2 - A project involving 12 European countries plus Japan and South Africa aimed at developing decision making processes to be used in radioactive waste management implementation programmes that are thought of as fair and equitable by the stakeholders involved.

Criticality - The point at which a nuclear chain reaction occurs as a result of the concentration of certain types of radioactive materials.

Decommissioning - Generic term to cover all the procedures undertaken once a nuclear installation has ceased operating. Decommissioning covers processes such as defuelling reactors, cleaning out and making safe an installation, dismantling and removal of structures, and waste conditioning prior to storage or disposal.

Decontamination - The complete or partial removal of contamination by a deliberate physical, chemical or biological process.

Defra - One of CoRWM's sponsor departments, along with the Scottish Executive, the Welsh Assembly Government, and the Department of the Environment of Northern Ireland.

Depleted uranium - Uranium containing a lesser mass percentage of Uranium-235 than in natural uranium.

Dilute and disperse - A term normally describing a form of management for radioactive waste where radioactivity is released from a facility as a gas or liquid and is diluted in the air or marine environment.

Encapsulation - Immobilisation of solid waste by mixing it with a matrix material within a container in order to produce a more stable waste form.

EURATOM - The legislative basis for the activities of European Union countries in the nuclear energy field.

Fissile materials - Materials which are capable of undergoing nuclear fission i.e., the spontaneous or impact-induced splitting of a heavy atomic nucleus accompanied by a release of energy. Fissile materials include Uranium-233, Uranium-235, Plutonium-239, Plutonium-241 or any combination of these radionuclides.

Fission products - Radioactive elements produced by nuclear fission through the spontaneous or impact-induced splitting of a heavy atomic nucleus accompanied by a release of energy.

Gamma emission - Emission of high energy, very short wavelength, photons from a nucleus.

Geological disposal - Disposal refers to long-term management options where future access or future changes in management are not intended. Geological disposal usually refers to a long-term management option involving the emplacement of radioactive waste in an engineered repository at between 200 metres and one kilometre underground where the geology (rock structure) provides a barrier against the escape of radioactivity.

Groundwater pathway - When water flows underground, it finds a route through the rock via cracks and fissures to flow to its destination. This is termed the groundwater pathway; drinking water is frequently obtained by drilling into underground reservoirs on the groundwater pathway. This is one route through which radioactivity from a geological repository could be brought back to the surface.

Grouting - A means of encapsulating radioactive waste by mixing it with, for example, cementatious material.

Half-life - The time required for half the number of nuclei of a specific radionuclide to undergo radioactive decay.

Heat-generating waste - Waste that generates heat as it decays, a specific attribute of HLW. The heat generated decreases with time.

High active waste - A term applying to the highly radioactive waste product of the reprocessing of some spent nuclear fuels; sometimes also called "high active liquor" (HAL).

Highly enriched uranium - Uranium in which the proportion of the isotope Uranium 235 has been increased above that at which it occurs naturally.

Hi-View - a computer programme often used in MCDA processes.

Immobilisation - Conversion of waste into a less mobile or non-mobile form by, for example, grouting or encapsulation.

HLW - High level waste; classified in Cm 2919 as wastes in which the temperature may rise significantly as a result of their radioactivity, so that this factor has to be taken account in the design of storage or disposal facilities.

ILW - Intermediate level waste; classified in Cm 2919 as wastes with radioactivity levels exceeding the upper boundaries for LLW but which do not require heating to be taken into account in the design of storage or disposal facilities.

Incineration - A waste treatment process of burning combustible waste which reduces its volume although also produces radioactive residues.

Ionising radiation - Radiation that produces ionisation in matter, for example, alpha particles, gamma rays, x-rays and neutrons. When radiations such as these pass through the tissues of the body, they have sufficient energy to damage DNA.

LLW - Low level waste; classified in Cm 2919 as wastes containing radioactive materials other than those acceptable for disposal with ordinary refuse, but not exceeding 4 GBq per tonne of alpha or 12 GBq per tonne of beta/gamma activity.

LLWR - Low level waste repository: a term sometimes used for the facility sited near the village of Drigg in west Cumbria at which some forms of LLW are accepted for burial. Not all the UK's LLW can be disposed of at the LLWR because of its unsuitability in terms of radioactivity, or its physical or chemical properties, such as liquid content or flammability.

London Dumping Convention - The London Convention of 1972 is an international treaty that limits the wastes that can be disposed of at sea.

Long-lived waste - Radioactive waste that contains radionuclides that have a half-life of more than 30 years.

M-MACBETH - a tool to convert a verbal descriptive scale into a numerical one for the MCDA process.

Magnox - Gas cooled fission reactor using un-enriched uranium as fuel, with magnesium alloy as cladding, the reactor type used in the UK's first generation nuclear power plants.

Mixed oxide fuel - Nuclear fuel composed of a blend of uranium and plutonium.

Multi-barrier concept - Two or more natural or engineered barriers used to isolate radioactive waste in, and prevent radionuclide migration from, a repository.

Nirex - UK Nirex Ltd; a company jointly owned by Defra and the DTI that advises nuclear site operators on the preparation of safety case submissions to the regulators for the conditioning and packaging of radioactive waste.

Nirex Phased Geological Concept - A form of phased geological disposal developed by UK Nirex Ltd.

Neutrons - Electrically neutral sub-atomic particles.

Nuclear fuel cycle - All nuclear fuel related operations associated with the production of nuclear energy, including: the mining and milling of ores, enrichment, manufacture of fuel, operation of nuclear reactors, spent fuel reprocessing, and all related radioactive waste management activities.

Nuclide - An atom specified by its atomic number, atomic mass and energy state.

Overpacking - A secondary (or additional) outer container for one or more waste packages, used for handling, transport, storage and/or disposal.

Packaged radioactive waste - The product of conditioning that includes the waste form and any container(s) and internal barriers, prepared in accordance with the requirements for handling, transport, storage and/or disposal.

Partitioning - The separating out, by physical and chemical methods, of radioactive elements contained in a waste stream to permit their further treatment.

Passive safety - Passive safety describes a situation where no intervention is required to keep the waste in a condition where it poses no threat to health or safety. The waste does not require additional work or processes to be carried out to keep it in a safe condition.

Phased approach - In its report of 1999, the Science and Technology Select Committee of the House of Lords suggested that a ‘phased approach’ is one in which wastes are stored on the surface while a site is found and a repository is constructed; and the wastes are then emplaced in a repository in such a way that they can be monitored and retrieved. The repository would be kept open while data are accumulated from the monitoring and additional research carried out. When there is sufficient confidence to do so, the repository would be backfilled and sealed. Monitoring would then continue and it would still be possible (but difficult) to recover the wastes.

Phased geological disposal - Generic term covering the phased approach to disposal. One concept has been developed by UK Nirex Ltd - the Nirex "Phased Geological Repository Concept".

Plutonium - A radioactive element, occurring in small quantities in uranium ores but mainly produced artificially by neutron bombardment of uranium for use in nuclear fuel and in nuclear weapons.

Radioactivity - The phenomenon whereby atoms undergo spontaneous random disintegration, usually accompanied by the emission of radiation. Radioactive decay describes the way in which a radioactive material loses activity naturally as a result of this process. The rate at which atoms disintegrate is measured in becquerels.

Pressurised Water Reactor - reactor type used in the UK's third generation nuclear power plants, the only example being Sizewell B.

Radioactive materials - Material designated in national law or by a regulatory body as being subject to regulatory control because of its radioactivity.

Radioactive waste - For legal and regulatory purposes, waste that contains or is contaminated with radionuclides at concentrations or activities greater than clearance levels as established by the regulatory body.

Radionuclide - A nucleus (of an atom) that possesses properties of spontaneous disintegration. Nuclei are distinguished by their mass and atomic number.

RCF - Rock Characterisation Facility; term for an in-situ underground laboratory used for experiments to acquire knowledge about the geological and hydrogeological conditions of the surrounding rock.

Reprocessing - In this context, a physical and chemical operation, the purpose of which is to extract Uranium or Plutonium for reuse from spent nuclear fuel.

Retrievability - Used by CoRWM in a generic sense to mean the ability to withdraw waste from a management facility. Since withdrawal could be effected by a number of different methods, the withdrawal mechanisms can be described in the following ways:

- reversibility: designed into the option to facilitate the recovery of material by reversing the original emplacement process;

- retrievability: designed into the option to facilitate the physical retrieval of waste through means other than reversing the process, such as ensuring access to the waste and having (or being able to have) the retrieval mechanism in place;

- recoverability: addressing the retrievability issue by demonstrating that the waste is technically recoverable through mining or other means.

Separated plutonium - Plutonium that has been separated from spent nuclear fuel by reprocessing.

Short-lived fission product - A short-lived radionuclide, with a half-life of less than 30 years that is produced by nuclear fission.

Short-lived nuclides - Radioactive nuclides with a half-life less than 30 years. Thus, radioactive waste described as short-lived would reduce in activity by a factor of 1000 within 300 years.

Sievert - The S. I. unit of radiation dose; one millisievert (mSv) is a thousandth of a sievert and one microsievert (uSv) is one millionth of a sievert.

Sizewell B - A nuclear power plant in Suffolk operated by British Energy.

Specific activity - Of a radionuclide, the activity per unit mass of that nuclide; of a material, the activity per unit mass or volume of the material in which the radionuclides are essentially uniformly distributed.

Spent nuclear fuel - Irradiated (used) nuclear fuel that cannot any longer be used in a nuclear power reactor.

Stakeholder - Any individual or group which has an interest in the mechanism for, or the outcome of, a process.

Streams - As "material/waste stream", a term used to make a broad distinction between one type of radioactive material or waste and another. The decommissioning of a large nuclear facility could be said, for example, to result in the creation of "a large number of waste streams".

Subduction - In this context, radioactive waste is placed in a subduction zone - an area where one denser section of the earth's crust is moving towards and underneath another lighter section, the result being that the waste will eventually subduct beneath the continental plate and gradually be drawn down into the earth's mantle.

Substitution - The contractual arrangement by which wastes resulting from reprocessing carried out in the UK for overseas customers can be retained and other wastes - equivalent in radiological terms - can be returned. If implemented, substitution would mean that the UK would retain some overseas-owned ILW and LLW and return an additional amount of HLW together with the overseas-owned HLW due, in any case, to be returned.

Surface investigations - Work carried out from the land surface to test the suitability of geology for the possible disposal of radioactive waste. For example, Nirex drilled 28 boreholes around the Longlands Farm site near Sellafield to test its suitability for the proposed RCF.

Tonnes (Te) - Unit of mass (10^6 or 1,000,000 grammes).

Transmutation - The conversion of one element into another. Transmutation is under study as a means of converting longer-lived radionuclides into shorter lived or more manageable radionuclides.

Transuranic waste - Radioactive waste containing elements that have a higher number than Uranium in the periodic table, such as Plutonium, Neptunium, Americium, Curium, etc.

Uranium - A heavy metallic element, radioactive and toxic, easily oxidized, and having 14 known isotopes of which Uranium-238 is the most abundant in nature.

Vitrification - Process of incorporating materials into molten glass. Vitrification is commonly applied to the solidification of liquid high level waste from the reprocessing of spent fuel.

VLLW - Very low level waste; classified in Cm 2919 as wastes which can safely be disposed of with ordinary refuse.

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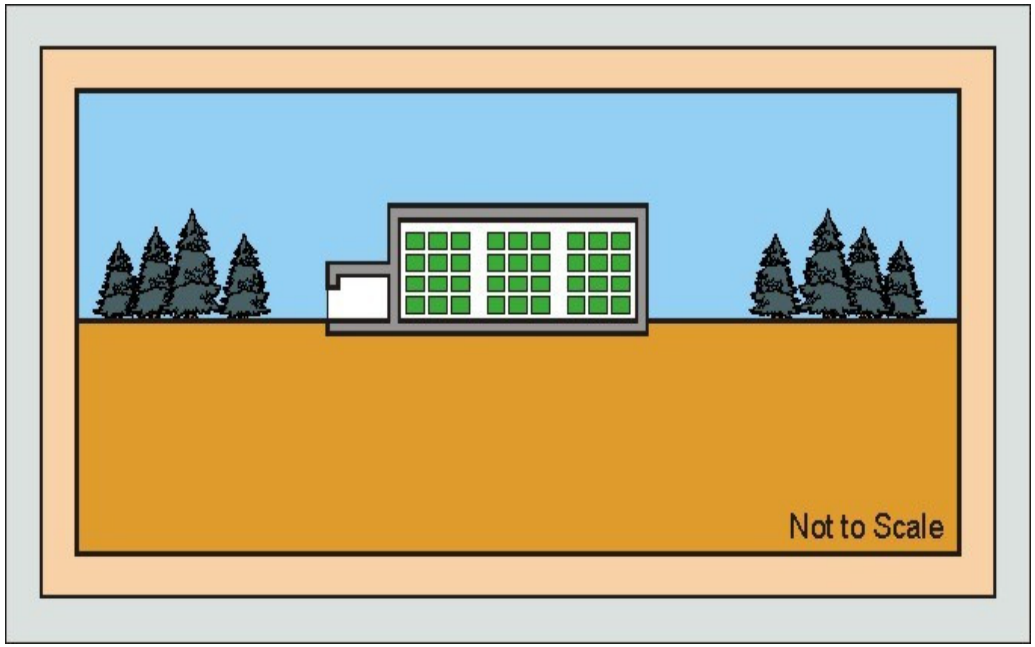
CoRWM Options

M Dutton

2 November 2004

Interim Storage

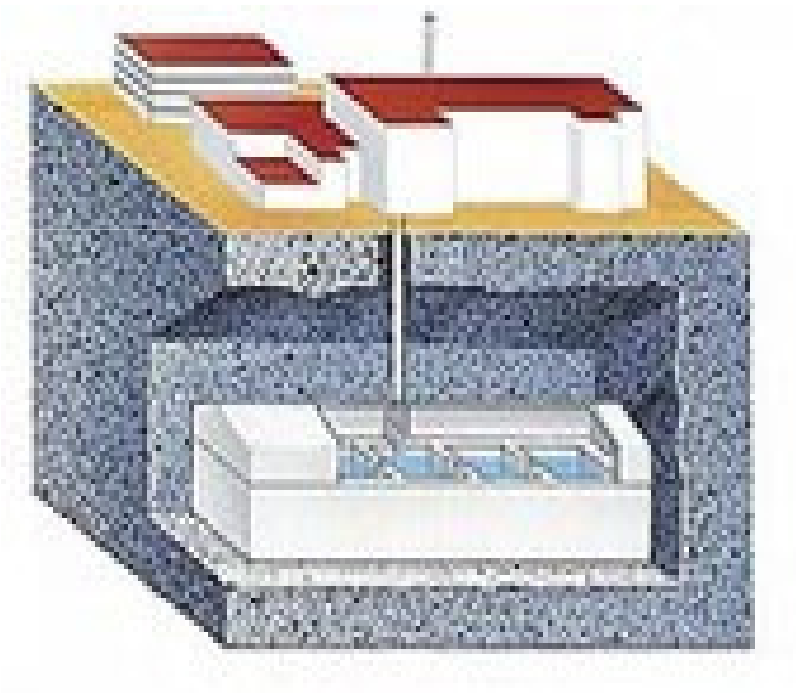


Schematic of surface storage

Interim Storage

- BNFL Sellafield experience
  - Magnox Encapsulation Plant (1990)
  - Waste Encapsulation Plant (1994)
  - Waste Packaging and Encapsulation plant (1994)
  - Waste Treatment Complex (1998)
  - Six Operational ILW Stores

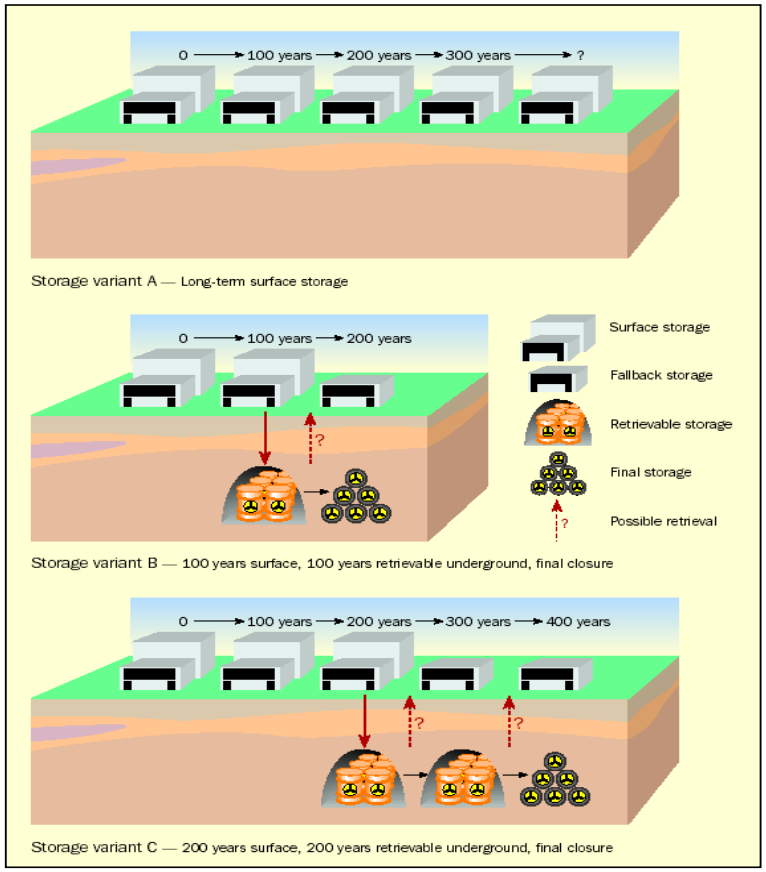
CLAB, Fuel Store



- CLAB is located in Oskarshamn, Sweden, near the Oskarshamn nuclear power station.
- Spent nuclear fuel disposal in ponds 30m underground

CLAB Fuel Store

Long-term Storage and Disposal

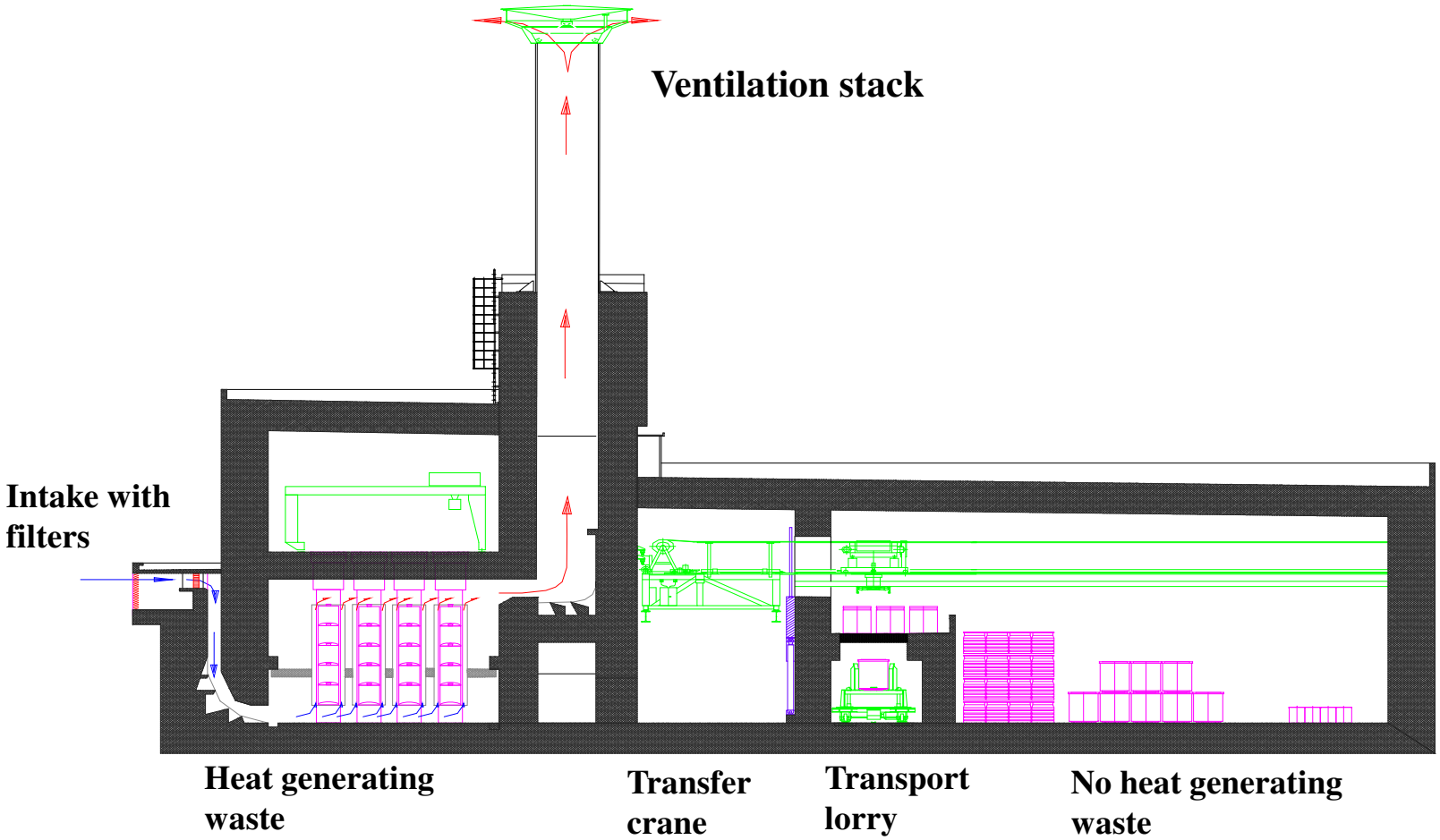


- 3 variants involving surface storage and then long term storage and disposal

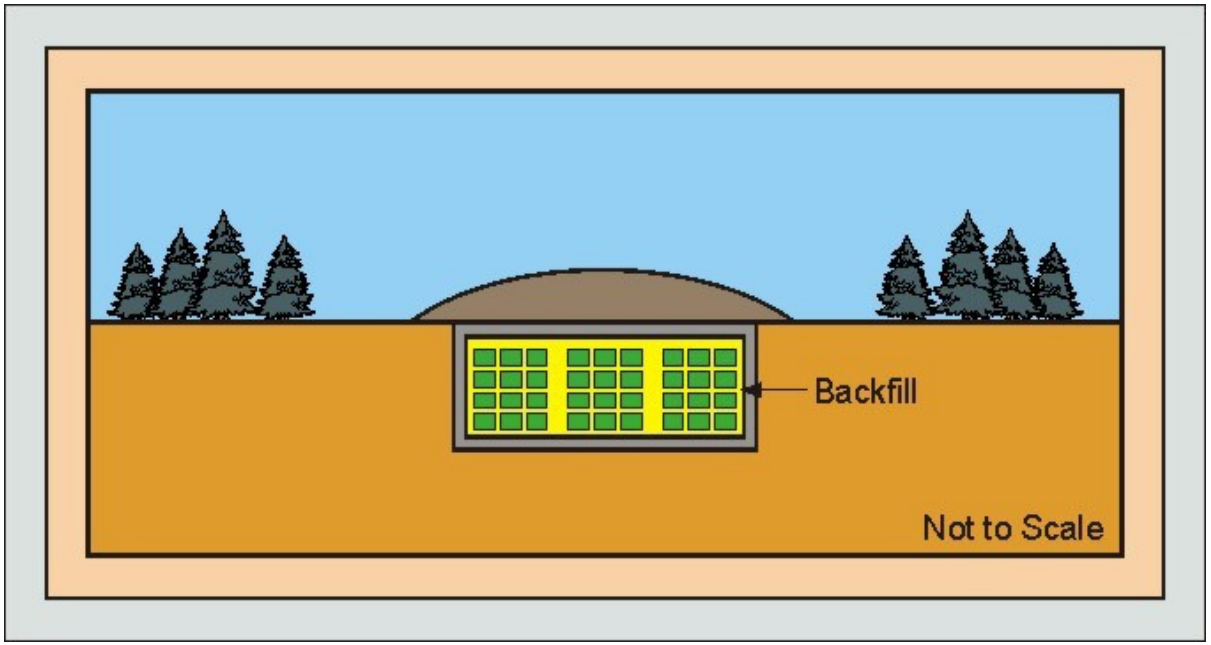
Long-term Storage

- Habog, Holland
- Consists of
  - 3 vaults
  - 38 storage wells per vault
  - 4 different dimensions of storage wells

Habog Schematic

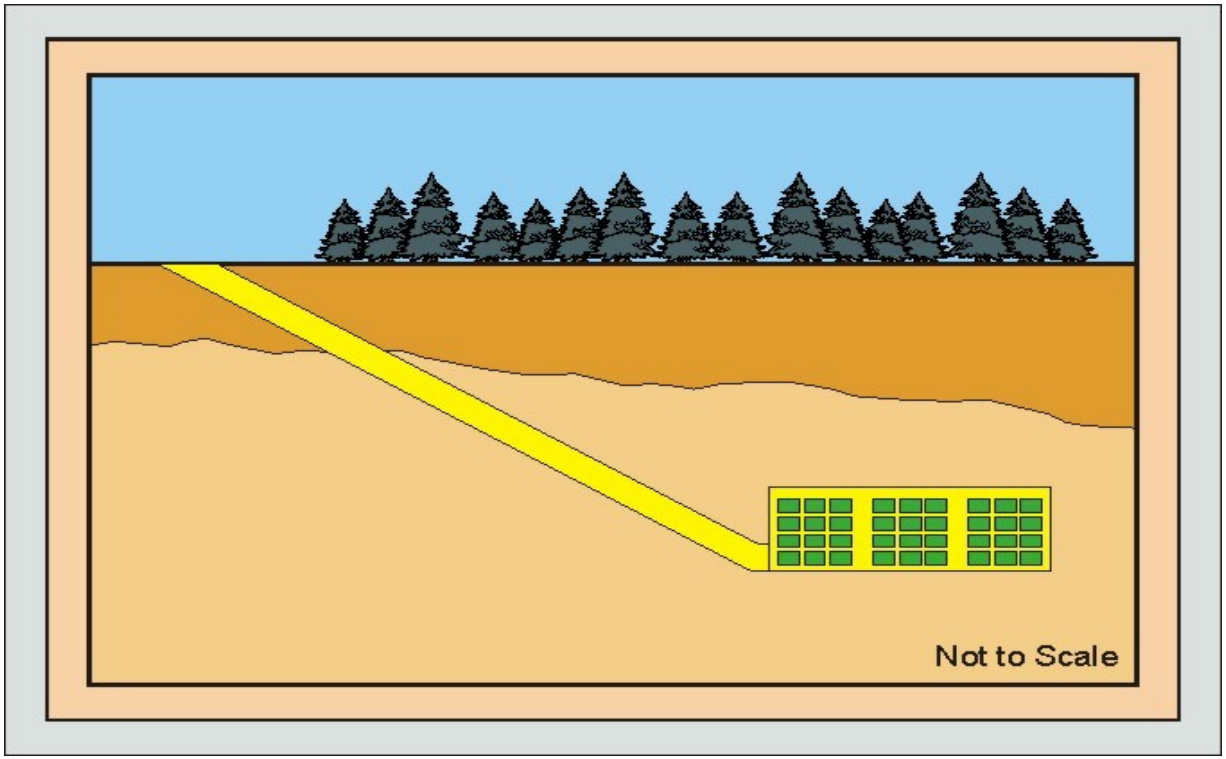


Near Surface Disposal



Below surface

Near Surface Disposal

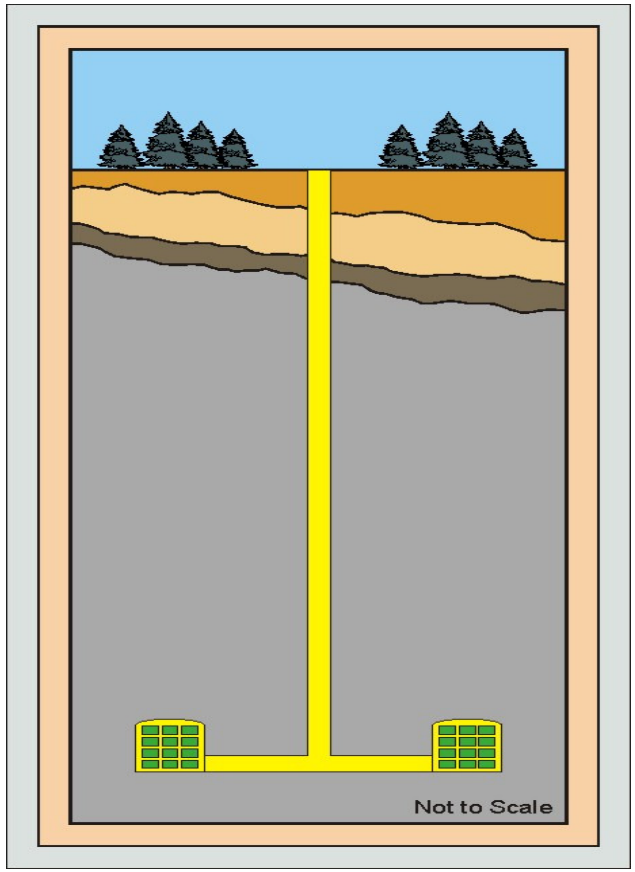


Storage in underground caverns

Near Surface Disposal

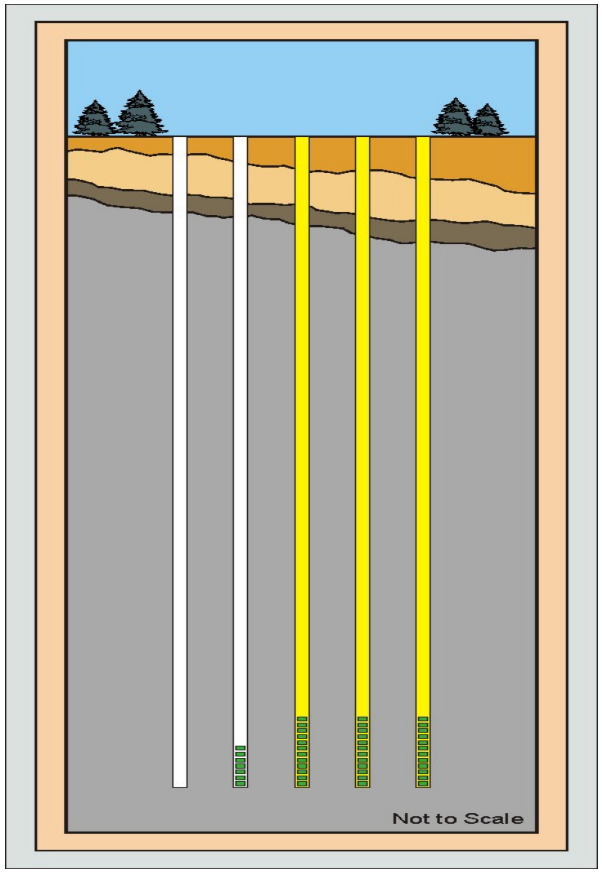
- Drigg, Cumbria,
- Current UK LLW disposal facility

Deep Disposal



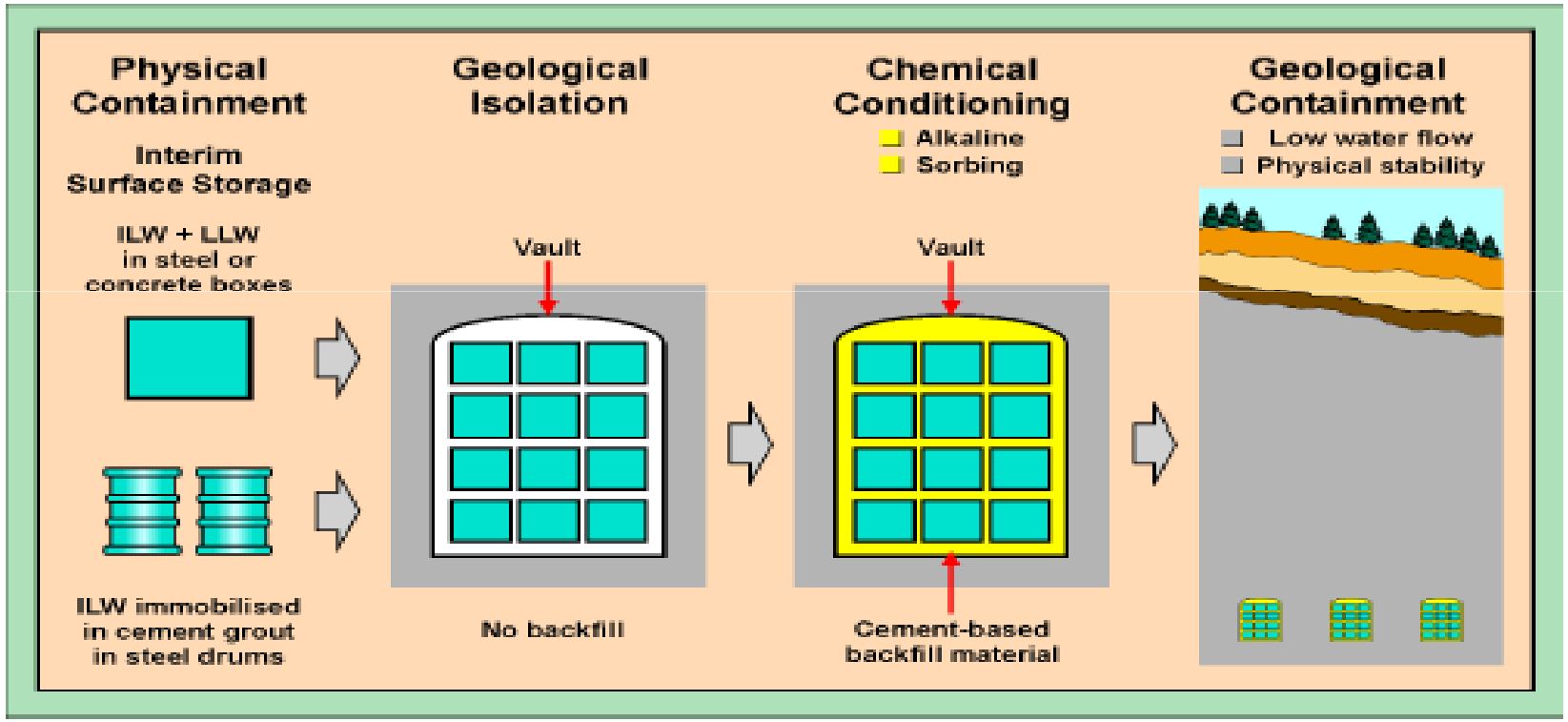
- Deep geological disposal

Deep Disposal



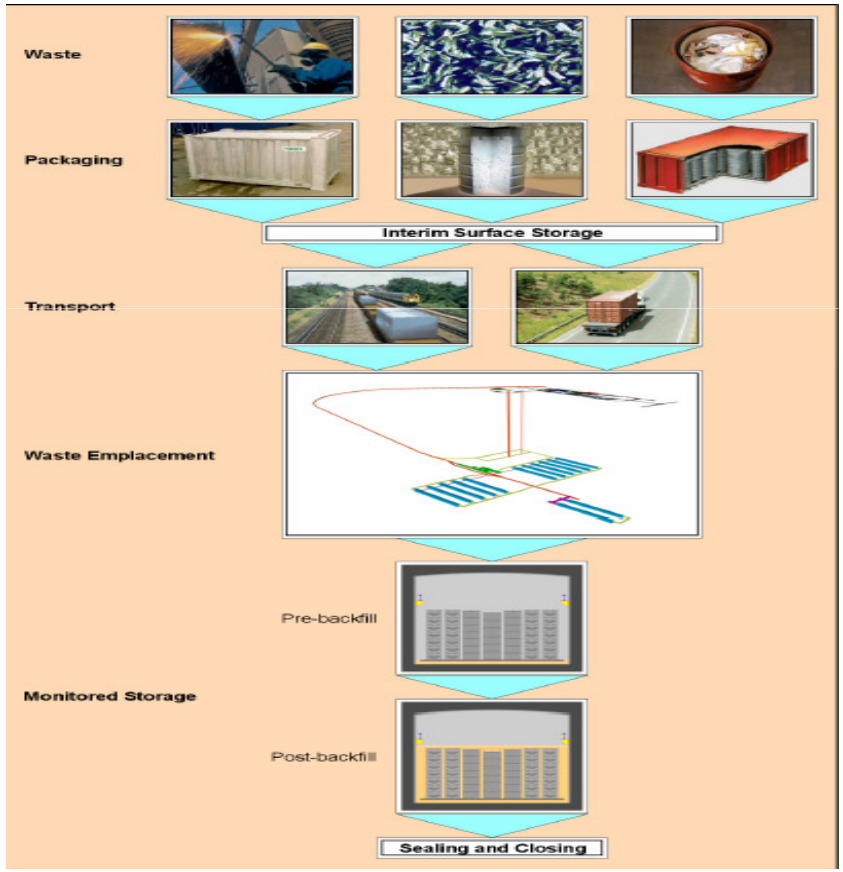
- Direct injection of waste into deep boreholes

Deep Disposal



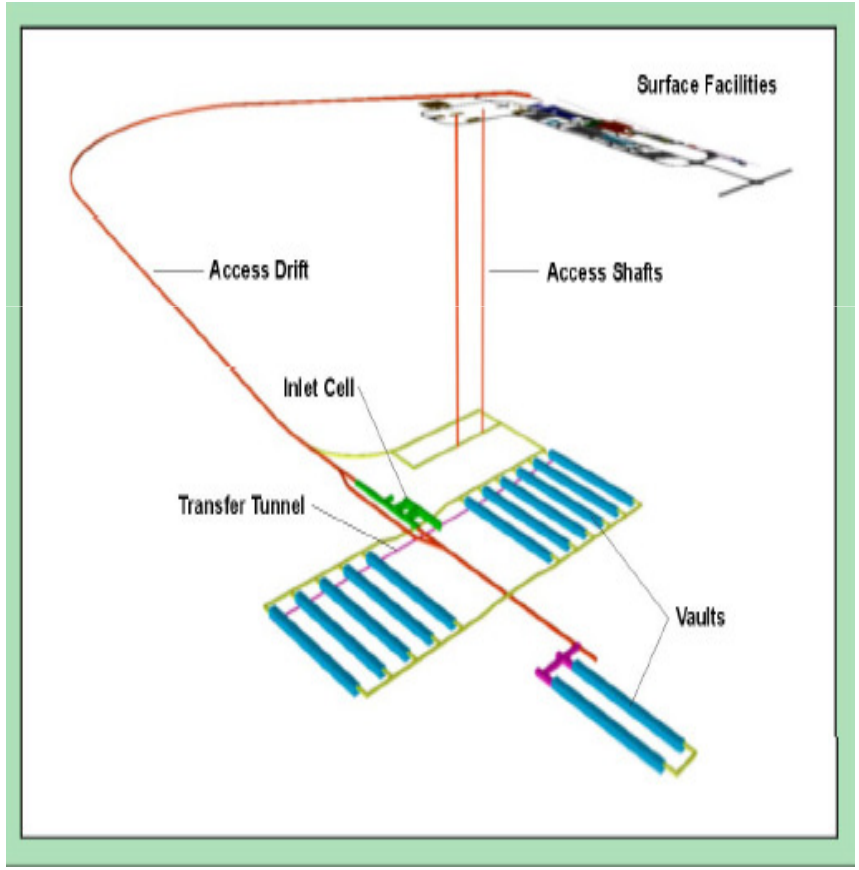
Nirex Phased Multi Barrier Disposal Concept

Phased Deep Disposal



- Nirex phased disposal concept

Phased Deep Disposal



- Nirex repository concept

iDesign & construction of repository and completion of first vault20 years

iiWaste emplacement and completion of other vaultsnominal 50 years

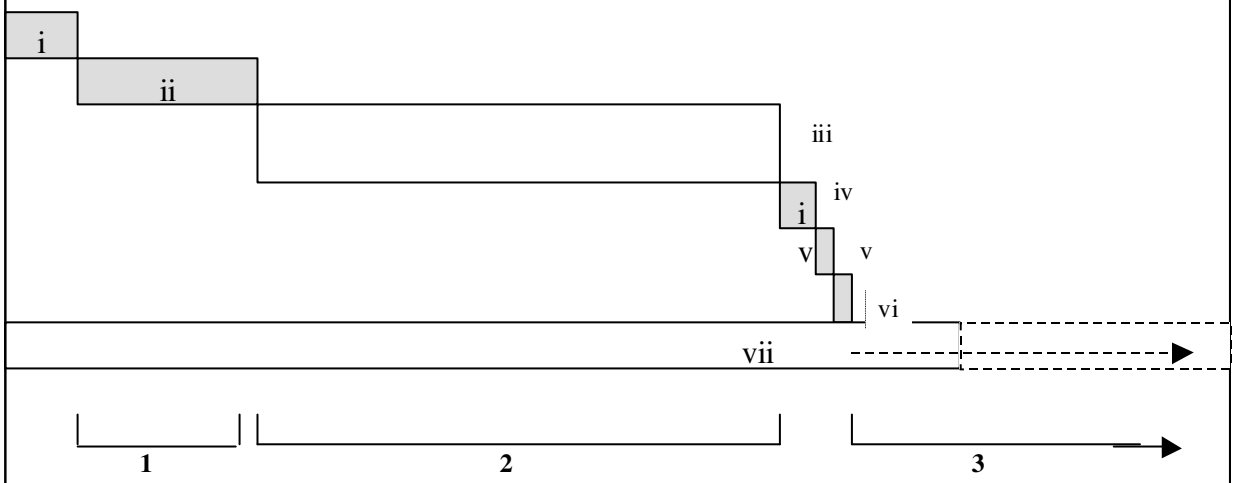
iiiPost-emplacement, pre-backfilling, ‘open period’ for reversibility0 to 100’s years

ivBackfill & seal vaults5 to 10 years

vBackfill transfer areas and access ways3 to 5 years

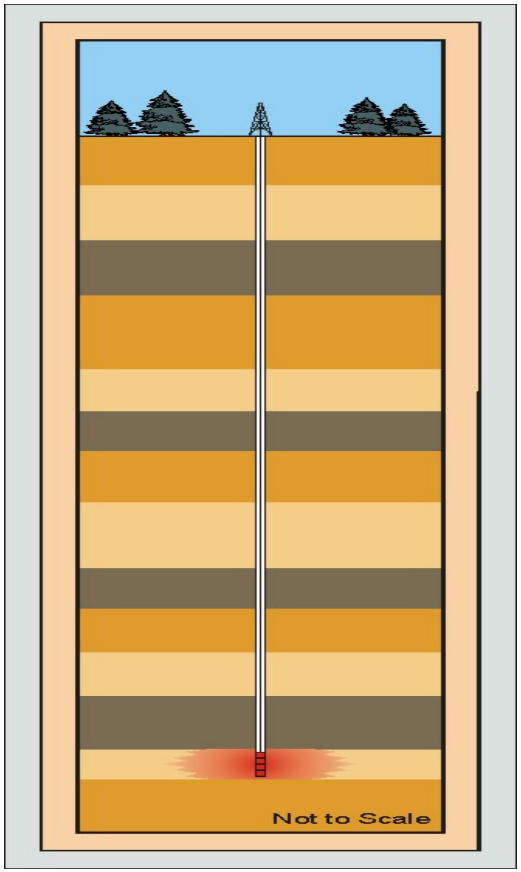
viBackfill & seal shafts/drifts1 to 2 years

viiInstitutional control periodseveral 100’s years?



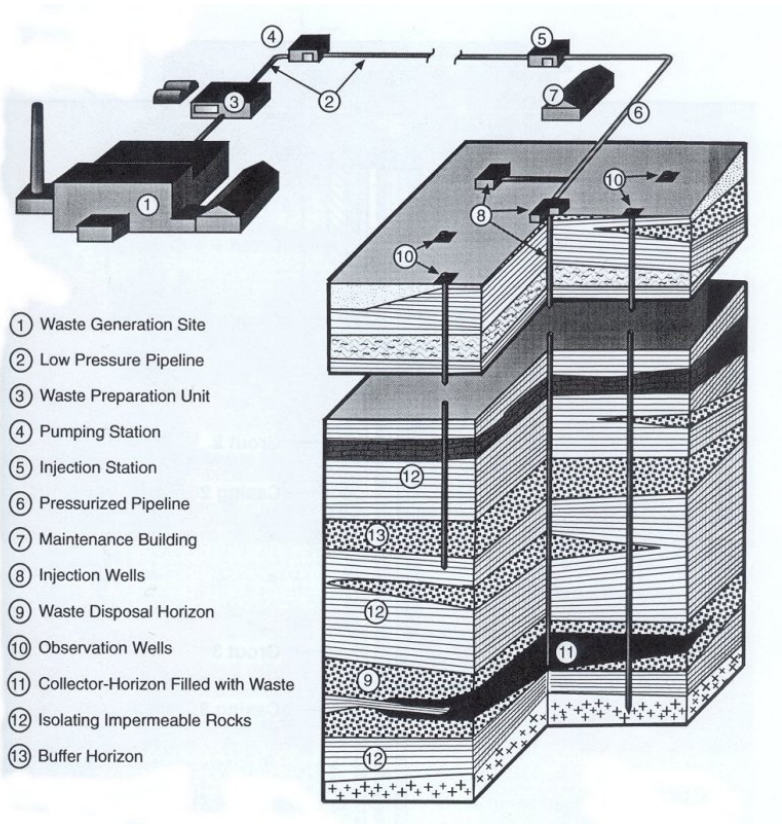
Periods in which to consider waste retrieval

Direct Injection



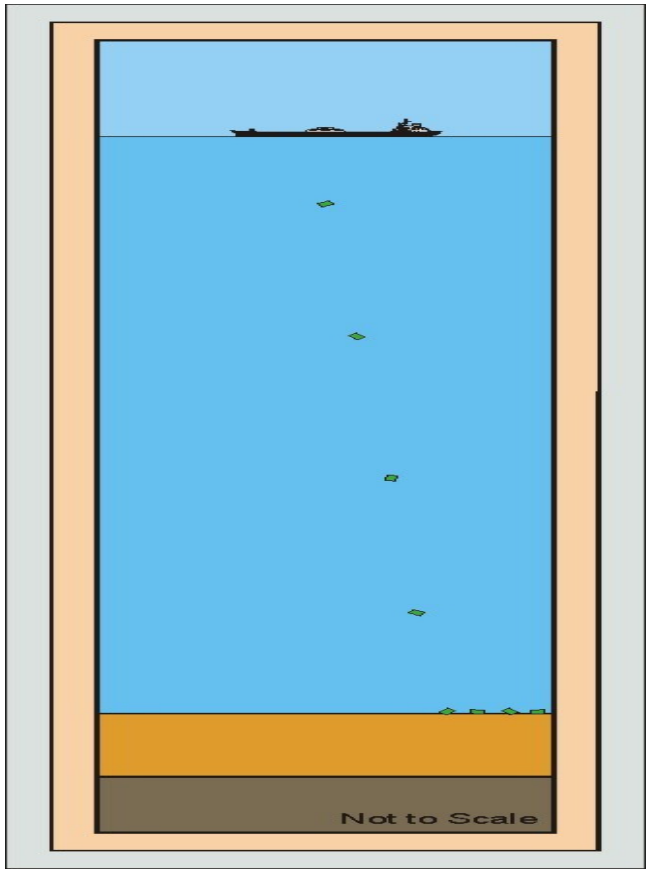
- Direct injection of liquid waste into the rock deep underground

Deep Injection

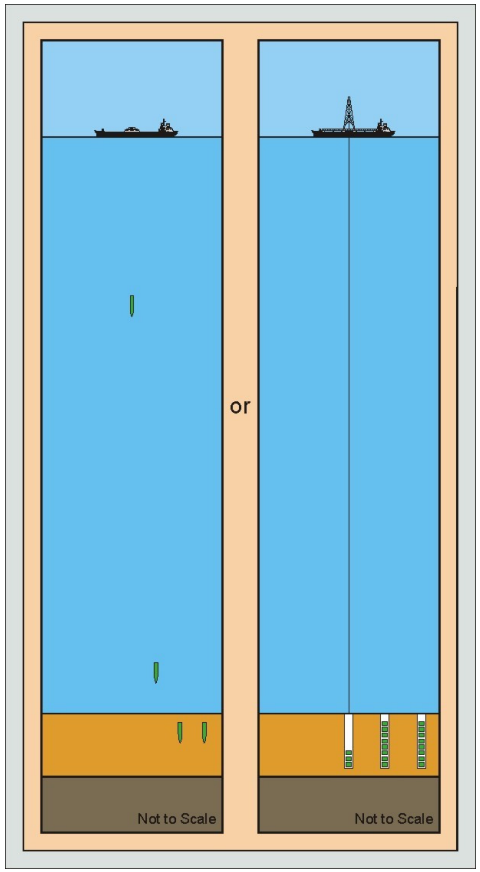


- Russian sites utilise a system of wells, through which the waste is pumped into the ground, and the system of pipelines that connect the wells to the surface facilities, treatment plants and pumping stations.
- The pipeline operates at low pressure and the active wastes are pumped through stainless steel pipes laid in concrete trays, which is located 5 m below the ground surface

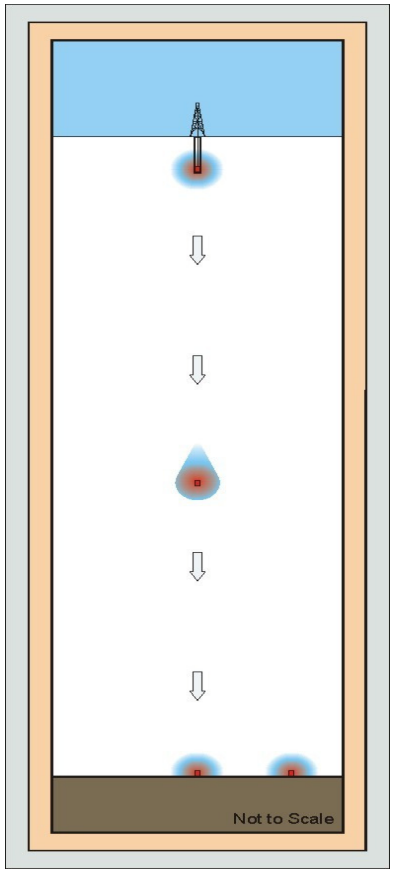
Disposal at Sea



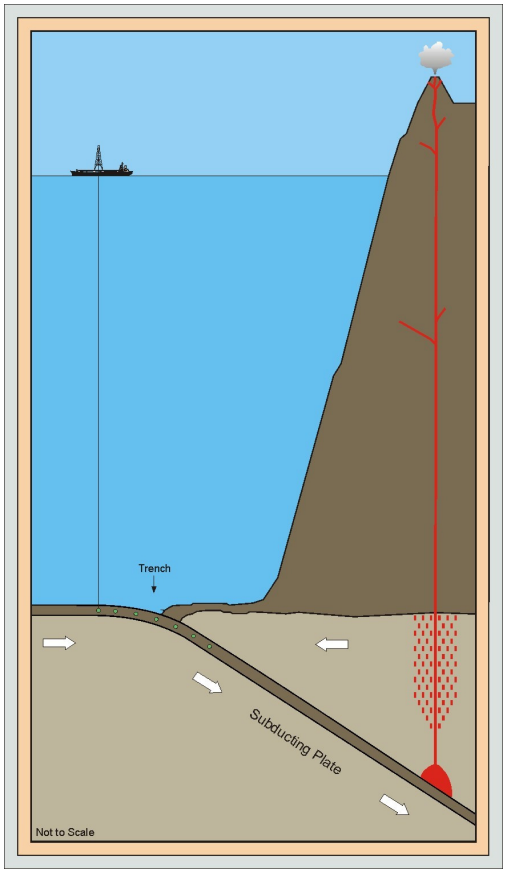
Sub-Seabed Disposal



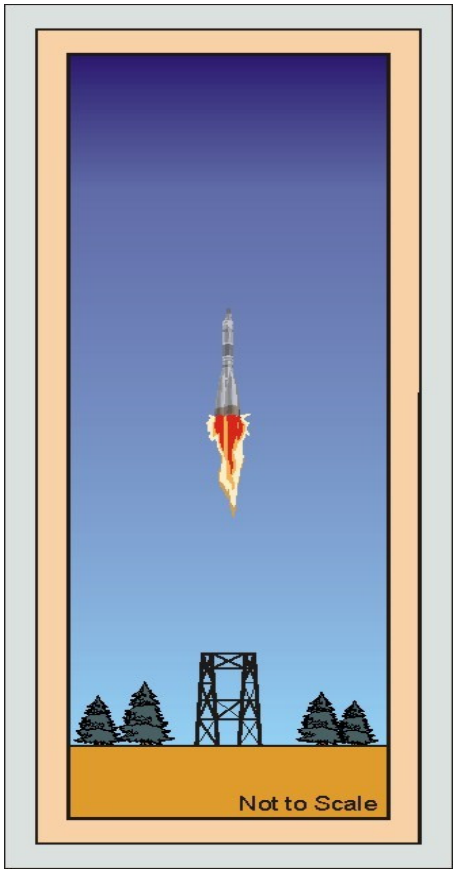
Disposal in Ice Sheets



Disposal in Subduction Zones



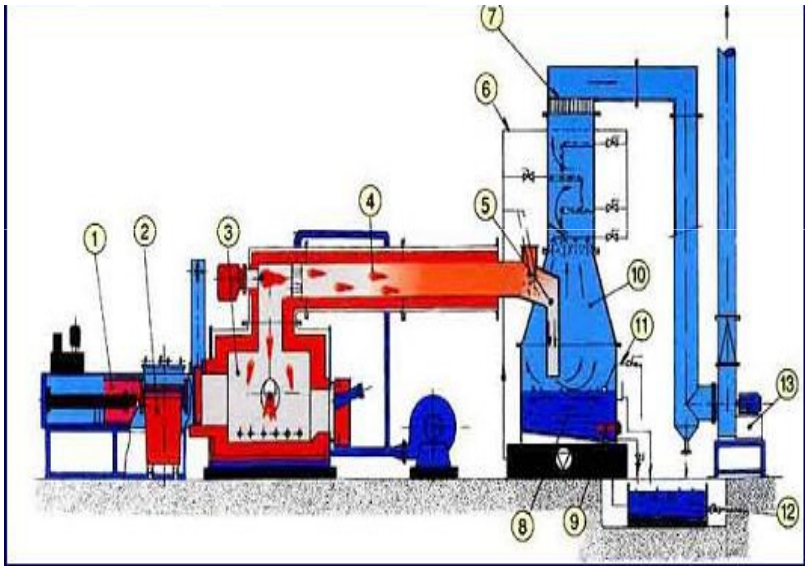
Disposal in Space



Options

- Dilute and Disperse
- Partitioning and Transmutation
- Burning in Reactors

Incineration



- Schematic of an incinerator

Incineration

- Commercially available incinerator

Incineration

- Between 1999 and Dec 2003 Socodei, France have Incinerated the following quantities of waste:
  - Solid waste 7125 tons
  - Ion Exchange Resins 543 tons
  - Aqueous Liquids 1270 tons
  - Organic Liquids 1493 tons
  - Total 10431 tons

Melting of Metals

- BNFL Capenhurst experience of melting
  - Aluminium components melted for free release
  - Volume reductions achieved

Melting of Metals

- Between 1999 and Dec 2003 Socodei, France have Melted the following quantities of waste:
  - Carbon steel 5630 tons
  - Stainless Steel 2415 tons
  - Non Ferrous 54 tons
  - Scrap recycled 76 tons
  - Total 8099 tons

Committee on Radioactive Waste Management

1. **Author** **Adam Scott**
2. **Date** **17/1/05**
3. **Title / subject** **House of Lords report on Radioactive Waste Management**
4. **Status** **Final**
5. **Who is receiving a copy** All Members
6. **When did CoRWM commission this paper?**
7. **Confidentiality**

   Reasons (if any) why the document should not be published: none
8. **Document number: 904**

Conclusion	Comment
1. Both Mr MacKerron and Mr Morley assured us that CoRWM will be able to deliver its recommendation to Ministers by July 2006. This timetable must not be allowed to slip, nor must CoRWM's report be followed by further procrastination.	We are working to that programme. What the Government does next is not a matter for CoRWM, but our recommendations must be robust and inspire broad support if they are to be acted on.
2. We are astonished that CoRWM was asked to start from a "blank sheet of paper" when several of the options being considered had already in effect been ruled out by the Government and numerous authoritative bodies. CoRWM must waste no more time considering infeasible strategies.	CoRWM will work to the programme agreed by Ministers and has agreed a specific timetable for short-listing culminating in a final decision this summer.
3. The inadequacies in CoRWM that we have found might well have been recognised at an early stage in its conception if Ministers had involved the Chief Scientific Advisor from the outset.	Defra will consider and respond. We welcome the involvement of its Chief Scientific Advisor.
4. There is a danger that, without technical expertise relating to waste management options, CoRWM will be unable to evaluate evidence critically. Total reliance on contractors is unwise.	CoRWM does not rely totally on contractors. It relies on its own Members, contractors (who will include a very wide range of expert consultants including independent academics), peer reviewers, citizens and stakeholders (including the Select Committee itself). We need to get peer review and quality assurance arrangements up and running and this is currently a high priority.
5. We welcome the involvement of the learned societies, including the Royal Society and the Royal Academy of Engineering, in the technical assessment of CoRWM's work, and in identifying data gaps.	See comment on point 4.
6. We urge the Government to consider, without delay, either the appointment of additional members to CoRWM with expertise in earth science, materials or civil engineering, or the establishment of a technical sub-committee to CoRWM comprising several members of the main committee along with a number of experts with experience of relevant technologies. It is not too late for such experts to play an important role in	A matter for Government. But CoRWM currently has a full complement of Members and we do not believe Ministers have plans to change this. We are adding various kinds of expertise directly to parts of the CoRWM process e.g. our QA procedures

the decision-making process.

7. The amount of time and money CoRWM gives to discussing its methodology of engagement and ways of working is disproportionate to the public engagement that is likely to be generated by its work.	It is for CoRWM~~the CoRWMommittee~~ to agree, with any amendments it judges appropriate, the specific public-engagement proposals put to it, so that these can be implemented. We shall then see how effective our public engagement is.
8. Documents submitted to CoRWM should be made available to the public, well in advance of meetings. At the meeting itself, some indexing of papers is essential to enable the public to follow proceedings. The meeting, its room and proceedings, should be accessible to all members of the public as far as is practicable.	The secretariat works to the direction of Members and will continue to improve arrangements where it can. For example, we cannot circulate papers that are not produced by working groups &c - generally for very good reasons - until shortly before the meeting. These are CoRWM not public meetings though we aim for an open and transparent process.
9. The Government must be clear as to what they expect from CoRWM so that the next stage can follow on promptly. Planning and preparation by Government will be needed regardless of CoRWM's recommendation. They must not wait until 2006.	A matter for Government, but it seems to us that the Government is doing what the Committee suggests, so - while it cannot predict CoRWM's recommendations - it will be ready to consider and act on them.
10. The Government must no longer allow delays in developing a long-term radioactive waste management strategy to be used as a pretext for deferring decisions on the future of nuclear power.	A matter for Government. CoRWM's task is to advise what to do with radioactive waste regardless of what decisions are taken on nuclear power.

Summary

In some cases the report points to things which CoRWM is already doing (1, 9); things it has agreed with Government to do even if the Committee does not support that course (2); or matters for Government not CoRWM (3, 6, 10).

In other cases it points to things which CoRWM is already doing (4, 5, 7, 8) and where we have already identified the need to maintain momentum or improve quality.

In all cases, we (the Chair and Secretary) consider that the proposals already before CoRWM, especially those presented to the January plenary meeting and those that will go to the February and March meetings, should be the focus for substantive discussion, and that the views of the Select Committee - along with the views of other stakeholders and commentators - help to inform that discussion. They do not require separate discussion.

We anticipate that the Government will comment on the Committee's report in due course, consulting the Chair. We welcome Parliamentary interest; we hope to keep both Houses directly informed of developments; and we are discussing with Government how this might be achieved.

House of Lords report on radioactive waste management (2004) Extract

ABSTRACT

Almost 30 years after the Royal Commission on Environmental Pollution first drew attention to the urgent need to find a long-term solution to the problem of storing radioactive waste, there is still no strategy for dealing with the United Kingdom's high and intermediate level radioactive waste. Surface stores of such waste are already considerable, and continue to increase in volume. In the current climate of uncertainty over global security, there are now serious concerns over their vulnerability to terrorist attack.

In 1997 planning permission for an underground test laboratory near Sellafield was refused. This was regarded as an essential first step before the building of an underground repository for radioactive materials. Since 1997 the Government have procrastinated until earlier this year when the Committee on Radioactive Waste Management (CoRWM) was established.

CoRWM is charged both with finding the best technical solution to the problems of radioactive waste management and with inspiring public confidence in it.

In the light of the numerous authoritative and exhaustive reports that have been published in the United Kingdom and abroad, of current international agreements, and of European Union guidance, we are astonished that the Committee should have been told to set about this task "with a blank sheet of paper". CoRWM could more fruitfully have been instructed to concentrate on the various alternatives for underground repositories that United Kingdom and international opinion have identified as the best options.

We regard it as most unlikely that meaningful public acceptance can be secured for any particular method of managing nuclear waste in the abstract. As the Department's own survey shows the wider public becomes exercised with this topic only when particular sites are up for discussion.

We commend CoRWM for its objectives of openness, transparency and inclusivity. We are, however, concerned at the actual opacity of its open meetings, and the undue emphasis given to investigating methodologies of decision-making and public and stakeholder engagement at the expense of identifying the right scientific and technical solution.

Overall, we find that CoRWM's terms of reference are dauntingly broad and in some respects astonishingly vague. We judge the composition of CoRWM to be inappropriate for offering advice to the Government on the technical aspects of their remit. We were unconvinced by CoRWM's response that they could rely on the peer-reviewed advice of consultants to arrive at the appropriate technical solution. We therefore regard it as essential that CoRWM should have more internal technical expertise and we make suggestions as to how this might be done.

We note that the delay in developing a strategy for handling nuclear waste is seen by the Government as an impediment to considering the role of nuclear power in meeting its objectives of planned reductions in carbon emissions and a secure energy supply. We deplore this and urge the Government to reconsider.

CHAPTER 1: INTRODUCTION

1.1. This Report examines recent developments in the United Kingdom Government's radioactive waste management policy. It follows up two earlier Reports by the Committee, on *Management of Nuclear Waste* and on *Managing Radioactive Waste: the Government's consultation*. On this occasion we have focused on the role of the Committee on Radioactive Waste Management (CoRWM), which was appointed by the Government in November 2003. CoRWM has been asked "to oversee a review of options for managing solid radioactive waste in the United Kingdom and to recommend to Ministers the option, or combination of options, that can provide a long-term solution, providing protection for people and the environment."

1.2. On 17 September 2004 the Select Committee attended the second day of CoRWM's open meeting in Ipswich. Following the meeting, Mr Gordon MacKerron, Chairman of CoRWM, gave the Select Committee a brief presentation on the work of CoRWM, and answered questions. A note of this meeting is at Appendix 3. On 18 October the Select Committee took formal evidence from Mr MacKerron, along with two colleagues, and separately heard from the Minister of State for the Environment, Mr Elliot Morley MP. The transcripts of these meetings are reprinted in this volume.

1.3. The body of this report examines the process by which CoRWM was established and the manner in which it is operating, before putting these matters in the context of wider radioactive waste policy.

Summary of conclusions

1.4. The Select Committee remains deeply concerned at the slow progress towards developing policy in this area. From the evidence we have heard in the course of this short inquiry, and drawing on our previous work, we have reached the following conclusions:

Timing

1. Since 1997 progress towards finding a long-term solution to the problem of radioactive waste management has been bedevilled by delay. Both Mr MacKerron (Q 3) and Mr Morley (Q 36) assured us that CoRWM will be able to deliver its recommendation to Ministers by July 2006. This timetable must not be allowed to slip, nor must CoRWM's report be followed by further procrastination. (Paragraph 3.4)

A "blank sheet of paper"

2. We are astonished that CoRWM was asked to start from a "blank sheet of paper" when several of the options being considered had already in effect been ruled out by the Government and numerous authoritative bodies. CoRWM must waste no more time considering infeasible strategies. (Paragraph 3.15)

Scientific expertise and commissioning scientific work

3. We cannot understand why Defra's Chief Scientific Advisor was not directly involved in the formation of a committee that will be providing advice to Ministers on crucial scientific and technical matters. The inadequacies in CoRWM that we have found might well have been recognised at an early stage in its conception if Ministers had involved the Chief Scientific Advisor from the outset. (Paragraph 3.11)

4. There is a danger that, without technical expertise relating to waste management options, CoRWM will be unable to evaluate evidence critically. Total reliance on contractors is unwise. (Paragraph 4.9)

5. We welcome the involvement of the learned societies, including the Royal Society and the Royal Academy of Engineering, in the technical assessment of CoRWM's work, and in identifying data gaps. (Paragraph 4.4)

6. We urge the Government to consider, without delay, either the appointment of additional members to CoRWM with expertise in earth science, materials or civil engineering, or the establishment of a technical sub-committee to CoRWM comprising several members of the main committee along with a number of experts with experience of relevant technologies. It is not too late for such experts to play an important role in the decision-making process. (Paragraph 4.8)

Public and stakeholder engagement

7. The amount of time and money CoRWM gives to discussing its methodology of engagement and ways of working is disproportionate to the public engagement that is likely to be generated by its work. (Paragraph 4.14)

Meetings of CoRWM

8. Documents submitted to CoRWM should be made available to the public, well in advance of meetings. At the meeting itself, some indexing of papers is essential to enable the public to follow proceedings. The meeting, its room and proceedings, should be accessible to all members of the public as far as is practicable. (Paragraph 4.17)

After CoRWM reports

9. The Government must be clear as to what they expect from CoRWM so that the next stage can follow on promptly. Planning and preparation by Government will be needed regardless of CoRWM's recommendation. They must not wait until 2006. (Paragraph 5.2)

The future of nuclear power

10. The Government must no longer allow delays in developing a long-term radioactive waste management strategy to be used as a pretext for deferring decisions on the future of nuclear power. To do so would seriously narrow the range of options open to the Government in meeting their longer term energy and environmental goals. The small uncertainties associated with radioactive waste disposal that still exist must be balanced against the spectre of global warming: the consequences of not doing enough to limit greenhouse gas emissions may be catastrophic. (Paragraph 5.10)

CHAPTER 2: BACKGROUND

2.1. The scale of the problem may be quantified by reference to CoRWM's own preliminary inventory of the United Kingdom's radioactive waste materials: there are currently 764 m^3 of "high level" waste, with a similar amount expected to arise in the future from the current nuclear programme. This waste is stored above ground, mostly at Sellafield. The total amount of current "intermediate level" waste is 74,500 m^3, with 162,700 m^3 unavoidably arising in the future from the current nuclear programme. This is also held in surface stores, at various nuclear sites around the United Kingdom. All this waste poses a potential health risk and will continue to do so for many thousands of years. The volume of "low level" waste is much higher, but this is mostly disposed of at a dedicated site at Drigg in Cumbria, and therefore falls outside the remit of CoRWM and this inquiry.

2.2. The waste is a legacy of decades of military and civil nuclear programmes. The need to develop a policy on long-term storage or disposal of such waste was identified as long ago as 1976 when the Royal Commission on Environmental Pollution published its seminal report. However, the defining moment of recent years came in 1997 when the outgoing Government decided to accept the recommendation of the planning inspector and to uphold Cumbria County Council's refusal to grant Nirex planning permission for a Rock Characterisation Facility at Sellafield. This decision effectively "stopped dead in its tracks the search for a long-term disposal route for intermediate level radioactive waste". In 1999, in the wake of this debacle, this Select Committee published a comprehensive report, *Management of Nuclear Waste*, which analysed the disposal and storage options for radioactive waste, and discussed ways to ensure that any solution was publicly acceptable.

2.3. The Government accepted two principal recommendations of the report: first, that there was an urgent need to develop a policy for the permanent storage of the growing amounts of radioactive waste, and second, given public interests and concerns, that the policy should be developed with wide consultation. The report also recommended disposal of radioactive waste in an underground repository as the best long-term solution.

2.4. Since 1997, various authoritative reports have been published on this subject, including the report of the Consensus Conference on radioactive waste management in 1999; the report of the House of Commons Environment, Food and Rural Affairs Committee in February 2002; and the report of the Royal Society in May 2002. They broadly support this Committee's conclusion that underground storage or disposal represents the best long-term solution.

2.5. We also commend a recent interdisciplinary study from the Massachusetts Institute of Technology (MIT), *The Future of Nuclear Power*, published in July 2003, which contains a chapter and appendix on radioactive waste management. It points out "that there is today a high level of confidence within the scientific and technical community that the geologic repository approach is capable of safely isolating the waste from the biosphere for as long as it poses significant risks. This view has been stated and supported in several recent national and international assessments", the references to which we take the opportunity to reproduce here. This is also the view of the European Commission in its proposed Council Directive on the safe management of spent nuclear fuel and radioactive

waste, which would require Member States to study the possibility of giving priority to deep geological disposal for high-level and long-lived waste.

2.6. In 2001 the Government launched a consultation paper, *Managing Radioactive Waste Safely*, which asked how the public could be involved in decision taking. It failed to address any of the substantive issues, betraying a preoccupation with process at the expense of content. Our report on the consultation paper argued that it was flawed "by providing insufficient background to enable meaningful responses". The Government's response to this consultation was to set up a new independent body, CoRWM, announced in July 2002. The timetable for its programme of work should culminate in a recommendation to ministers in July 2006.

CHAPTER 3: ESTABLISHMENT OF CORWM

Timing

3.1. It is clear from the reports listed above that the science and technology of radioactive waste management have changed little since 1997. The desire of the Government to embark on repeated consultation exercises looks increasingly like an attempt to put off taking a decision.

3.2. Much of the Government's *Managing Radioactive Waste Safely* "consultation on a consultation" was unnecessary. Much thought has been given to public and stakeholder engagement (PSE) on high profile technical and scientific matters (including our own *Science and Society* report in 2000). Indeed, several relevant examples of such PSE already exist, including Defra's own Chemicals Stakeholder Forum, on which we comment below. We agree with the Royal Society that "the processes of public consultation are more or less well known and could be readily designed by experienced social scientists working with relevant technical and policy experts."

3.3. In 1999 an independent body with strong technical expertise would have been well placed swiftly to review the management options. Government would then have been in a position to set up a body to take forward public and stakeholder engagement in the process of looking at possible sites.

3.4. **Since 1997 progress towards finding a long-term solution to the problem of radioactive waste management has been bedevilled by delay. Both Mr MacKerron (Q 3) and Mr Morley (Q 36) assured us that CoRWM will be able to deliver its recommendation to Ministers by July 2006. This timetable must not be allowed to slip, nor must CoRWM's report be followed by further procrastination.**

CoRWM's terms of reference

3.5. CoRWM's terms of reference require it to undertake two distinct but related tasks:

- to propose a technical solution;
- to inspire public confidence in that solution.

3.6. The terms of reference also require CoRWM to review the options "in an open, transparent and inclusive manner." This emphasis is welcome. However, we are sceptical that the public will in reality be interested or engaged by the current

process, which will be perceived to be largely theoretical. Indeed, this is backed up by the findings of the Government's own consultation, that most people "will not be interested in the issue of radioactive waste until it affects them directly."

3.7. CoRWM is required to arrive at a recommendation which can "inspire public confidence". However, public confidence will largely be won or lost by the process of site selection which follows CoRWM's work. In the meantime, the requirement that the right scientific and technical solution is found seems to have been given a lower priority than it deserves. Future generations will not forgive a wrong choice made because it was deemed to inspire public confidence.

Scientific expertise

3.8. We note that CoRWM's terms of reference specify its composition. Paragraph five states that it will include people with a range of expertise, then lists the skills that Ministers will hope to find included. One of these is "scientific and technical issues such as earth science, materials and their properties, and civil engineering". With the greatest respect to the members of CoRWM, who possess expertise in many areas, we do not feel that these essential skills are adequately represented within CoRWM.

3.9. As a result, we have no confidence in the technical ability within CoRWM itself sufficiently to understand the science of some of the disposal options. Whilst CoRWM will receive advice from a number of sources, we do not believe it can even be considered an "intelligent customer" for technical advice without additional expertise. It appears to have been formed with a view to inspiring public confidence in a solution at the expense of finding the best solution.

3.10. We asked the Minister in writing whether Defra's Chief Scientific Advisor, or other senior scientific advisors within the Department, were involved in setting up CoRWM, deciding its composition and terms of reference; and if so, how. The Minister replied that the Defra Chief Scientific Advisor "was not directly involved in the setting up of CoRWM, although [he] has been kept informed of its establishment and development of its work."

3.11. **We cannot understand why Defra's Chief Scientific Advisor was not directly involved in the formation of a committee that will be providing advice to Ministers on crucial scientific and technical matters. The inadequacies in CoRWM that we have found may well have been recognised at an early stage in its conception if Ministers had involved the Chief Scientific Advisor from the outset.**

A "blank sheet of paper"

3.12. We are also concerned that CoRWM's terms of reference require it in effect to start from a "blank sheet of paper", as Mr MacKerron put it (Q 5).

3.13. The Government's consultation paper summarised the main options (which numbered nine) for long-term management of radioactive wastes. Five of these (disposal at sea, sub-seabed disposal, outer space, subduction zones and ice sheets) were classified as "unacceptable" or having been "ruled out", and the Minister confirmed to us that "disposal at sea is clearly out" (Q 44). One option, partitioning and transmutation, was described as only a partial solution. The remaining three were above ground storage, which must now—given heightened

security concerns—be seen as unsatisfactory, underground storage and underground disposal.

3.14. Starting from underground disposal and storage as the likeliest options, the Government should by now have begun the process of investigating possible sites which could accommodate either. This process, conducted in the open, transparent and inclusive way that CoRWM has been asked to operate, would have brought real public interest and engagement. Instead this vital next stage is being still further delayed.

3.15. We are astonished that CoRWM was asked to start from a "blank sheet of paper" when several of the options being considered had already in effect been ruled out by the Government and numerous authoritative bodies. CoRWM must waste no more time considering infeasible strategies.

CHAPTER 4: WORK OF CORWM

Commissioning scientific work

4.1. We are pleased to see that CoRWM is well supported by Defra, with a six-strong secretariat and external programme management (Q 3). We are concerned, though, that programme managers were not selected by Defra until over six months after CoRWM had begun work.

4.2. Mr MacKerron told us that CoRWM had requested an increase in budget from Defra to support further technical and specialist work (Q 9). He felt that the initial budget of £0.5 million was not adequate, but was optimistic that an additional £0.25 million would be forthcoming. In addition, Mr MacKerron told us that CoRWM would draw on the learned societies to review the technical work it is proposing to commission, and as part of its own technical assessment of options (QQ 9, 11).

4.3. Mr MacKerron also pointed out that it did not fall within CoRWM's had remit or scope to commission fundamental new scientific work (Q 11). Sufficient scientific understanding of physical processes already exists to allow a decision on radioactive waste management to be made in principle. However, in this context we draw attention to the MIT study *The Future of Nuclear Power*, which recommends that further research be commissioned on potential improvements or alternatives to the current mainstream mined repositories approach to geological disposal.

4.4. **We welcome the involvement of the learned societies, including the Royal Society and the Royal Academy of Engineering, in the technical assessment of CoRWM's work, and in identifying data gaps.**

4.5. The complex methodology employed by CoRWM, and the lack of sufficient in-house technical expertise, has necessitated the appointment, as noted above, of an external consultant (NNC) as the programme manager. NNC describes itself on its website as the United Kingdom's "premier dedicated nuclear services company and is committed to delivering cost-effective engineering solutions and safety consultancy services throughout the life cycle of nuclear plants." Amongst many other activities, NNC operates a laboratory measuring radioactivity in low-level waste on behalf of the Environment Agency.

4.6. NNC, as the programme manager, is outside the formal decision-making line of responsibility, yet as we witnessed, it is on hand at meetings to advise the

Committee on technical issues (Q 13). We pressed Mr MacKerron on this matter. He assured us that his Committee would make full use of a range of consultants both to commission work and to help evaluate the results. He told us of his eagerness to ensure that technical work was commissioned from sources other than NNC. CoRWM would also use independent review by the learned societies as indicated above. But given the limited capability within the United Kingdom on these matters, we suspect that in practice NNC may be in a very strong position to bid for the work CoRWM commissions, as well as for that which will arise subsequently as a result of CoRWM's recommendations. We do not question the integrity of either CoRWM or NNC, but there is clearly the potential for a conflict of interests, and a lack of clarity in lines of responsibility.

4.7. As Mr MacKerron stated, CoRWM will take full ownership of its recommendations (Q 6), and it is therefore essential that it should possess its own technical expertise so as to be able to evaluate critically any advice received, whether from the programme manager or from other sources. Do the Government really intend to make important national decisions on a technical matter with far reaching consequences, on the advice of a committee that has such heavy dependence on commercially provided external advice?

4.8. **We urge the Government to consider, without delay, either the appointment of additional members to CoRWM with expertise in earth science, materials or civil engineering, or the establishment of a technical sub-committee to CoRWM comprising several members of the main committee along with a number of experts with experience of relevant technologies. It is not too late for such experts to play an important role in the decision-making process.**

4.9. **There is a danger that, without technical expertise relating to waste management options, CoRWM will be unable to evaluate evidence critically. Total reliance on contractors is unwise.**

Public and stakeholder engagement

4.10. When members of the Select Committee visited the second day of CoRWM's open meeting in Ipswich, we were dismayed at the length of time given over to discussion of methodology. At times it felt as though CoRWM was engaged in a philosophical exercise in theoretical decision making. In particular, much effort is being devoted to a Principles Working Group, whose aim is "to define the principles—such as transparency and fairness—to which CoRWM should work", discussing "roles, responsibilities and values in decision making." The discussion of a hypothetical situation "where a majority hold a view that a minority cannot subscribe to, and where they are also unable to agree to disagree" could be taken as a satire on bureaucratic processes in general.

4.11. Whilst we recognise that thought must be given as to how CoRWM will engage with the public and take decisions, the amount of discussion given over to these issues seems disproportionate. As Mr MacKerron (Q 21) and Mr Morley (Q 60) admitted, there are similarities between what CoRWM is undertaking, and the work of others, yet, in methodology as in substance, once again CoRWM seems to be starting from a blank sheet of paper.

4.12. Defra's own Chemicals Stakeholder Forum and Agricultural Environment and Biotechnology Commission (Q 60) are well established models for public engagement in decision making. We can also point to the work of the Human Genetics Commission, which has in its remit to advise ministers and gain public confidence, and which has a Public Involvement Strategy.

4.13. We await CoRWM's plans for continued PSE with interest. As we noted in our report *Science and Society*, public dialogue techniques fall into two kinds:

- Market research exercises, designed to improve policy-makers' understanding of the attitudes and values of the public by engaging with a more or less representative sample;
- Public consultation exercises, designed to engage directly with as many as possible of the public at large.

These two possible purposes are not mutually exclusive. However, while CoRWM's objective is to engage the public as a whole, the techniques that are currently being employed appear to consist more of market research, using representative samples. There is a danger that the two kinds of dialogue are being confused.

4.14. **The amount of time and money CoRWM gives to discussing its methodology of engagement and ways of working is disproportionate to the public engagement that is likely to be generated by its work.**

Meetings of CoRWM

4.15. When members of the Select Committee attended CoRWM's meeting in Ipswich, we were also astonished at the volume of impenetrable paperwork that was on offer to members of the public. We understand that the open meetings are not part of the public or stakeholder engagement process (Q 19), but if meetings are to be open they should at least be intelligible. Furthermore, Ipswich Town Hall had no wheelchair access, and had acoustics such that even members of CoRWM found it hard to hear each other. There is no point holding a meeting in public if the public cannot hear or understand what is going on.

4.16. In contrast the Food Standards Agency Board, which also embraces openness by meeting in public, makes all relevant papers comprehensible and available on its website well in advance.

4.17. Documents submitted to CoRWM should be made available to the public, well in advance of meetings. At the meeting itself, some indexing of papers is essential to enable the public to follow proceedings. The meeting, its room and proceedings, should be accessible to all members of the public as far as is practicable.

CHAPTER 5: WIDER POLICY ISSUES

After CoRWM reports

5.1. As we have noted, public interest will become much more intense when potential locations for the chosen storage or disposal method are investigated. However, CoRWM's terms of reference are somewhat vague as to its role at this critical stage: "the assessment of options will not consider potential radioactive waste sites; but it will raise siting issues … CoRWM will need to consider these issues, and *may want to make recommendations* to Ministers on them" (our emphasis). We are dismayed by this vagueness which seems a recipe for yet further delay. CoRWM must not be left to decide whether to produce a second report on implementation issues (Q 67). When asked about post-CoRWM timescales, the Minister answered simply "I think you will have to wait for the report in July 2006" (Q 66). This is unacceptable. There is no reason to wait until

2006: scenarios for post-CoRWM work and processes should be explored now and over the coming two years.

5.2. **The Government must be clear as to what they expect from CoRWM so that the next stage can follow on promptly. Planning and preparation by Government will be needed regardless of CoRWM's recommendation. They must not wait until 2006.**

5.3. Looking at the longer term, it is clear from the work done by MIT that the United Kingdom is dragging its feet compared to other countries, though we were pleased that the Minister was able to correct their report that a decision on disposal plans in the United Kingdom would be delayed until 2040 (Q 52).

The future of nuclear power

5.4. In recent years, the threat of climate change has become more quantifiable. The best available scientific evidence finds that the observed global warming over the last 50 years is due to increases in greenhouse gas concentrations as a result of human activities.

5.5. The Government have set a target of reducing carbon dioxide emissions in the United Kingdom by 60 per cent by 2050. The role that nuclear power can play in this respect is widely recognised, and is becoming a matter of increasingly urgent public debate. With the proportion of electricity generated by nuclear projected to drop from 24 per cent to 7 per cent over the next 15 years, the United Kingdom will become more and more reliant on imported gas, which raises serious questions regarding the security of supply. As we stated in our recent report *Renewable Energy: Practicalities*, we do not believe that renewables will contribute as much as the Government expect to the United Kingdom's electricity needs.

5.6. The RCEP concluded in 1976: "There should be no commitment to a large programme of nuclear fission power until it has been demonstrated beyond reasonable doubt that a method exists to ensure the safe containment of long-lived highly radioactive waste for the indefinite future."

5.7. For retrievable storage we believe that this condition has now been substantially satisfied. In the decades since RCEP reported, technology has progressed and there has been much research into disposal techniques. New methods of handling high-level waste by vitrification (locking waste into a glass-like substance) have been developed, and as noted earlier, there is overwhelming scientific consensus that underground disposal is "capable of safely isolating the waste from the biosphere for as long as it poses significant risks".

5.8. The lead time for constructing new nuclear power stations could be more than a decade. It is therefore alarming, particularly given the lack of urgency shown by the Government, that resolving the long-term issue of nuclear waste is still being presented, in Mr Morley's words as "a prerequisite in terms of deciding whether or not future nuclear power is viable" (Q 80). We disagree, although it is clearly desirable that there should at least be a plan for the long-term management of waste as a preliminary to new build.

5.9. We neither endorse nor reject the concept of new nuclear build, but it should be recognised that modern reactors produce significantly lower waste volumes than the present generation of United Kingdom installations. A new nuclear programme would therefore add relatively low amounts of radioactive waste to that which already exists or will exist with the decommissioning of current

nuclear plant. Whether or not there is a new nuclear programme, a long-term strategy for dealing with radioactive waste is essential and will have to be implemented.

5.10. **The Government must no longer allow delays in developing a long-term radioactive waste management strategy to be used as a pretext for deferring decisions on the future of nuclear power. To do so would seriously narrow the range of options open to the Government in meeting their longer term energy and environmental goals. The small uncertainties associated with radioactive waste disposal that still exist must be balanced against the spectre of global warming: the consequences of not doing enough to limit greenhouse gas emissions may be catastrophic.**

A cautionary note

April 2006

Pete Wilkinson

Introduction

This note is designed to be constructive and positive. It is not intended as an attempt to defend my position but more to highlight areas in which I believe we must ensure consistency and attention to detail in our majority position if it remains as it was a few days ago. We all have an obligation to make recommendations which are robust to challenge and which can be supported by views which we have solicited over the years. This note identifies a few areas which concern me which I bring to your attention so that we can reassure ourselves that we are addressing them and dealing with them effectively.

Justifying disposal

At the end of the Edinburgh plenary in April 2006, it became evident that the majority of CoRWM members favoured some form of disposal as they were apparently confident in the long-term safety of this method of radioactive waste management. I respect and acknowledge the right of members to hold such a view: it happens to be one with which I disagree, but that is largely beside the point of this note. Whatever CoRWM recommends to the government by way of long-term management methods, the recommendations must be credible and it is important that CoRWM feels able to justify a recommendation for deep geological disposal – should that be its ultimate view - which is fundamentally based on confidence in long term safety while at the same time recommending a programme of research and development designed to increase that confidence. Critics will inevitably say that if the level of confidence is such that CoRWM would recommend deep geological disposal, further R and D should be redundant. I appreciate there is an answer to that criticism but we should be ready to provide it.

In addition, it is vital that we can demonstrate an interpretation of PSE outputs which supports disposal and that such support is not confused with a desire to see retrievability through the phased option (which I appreciate is an unavoidable and welcome consequence of a 'staged' process anyway as long as we assume that once emplaced, it will ever be seen as cost effective to remove it, although I believe that the advantages of the 'stages' during implementation have potential down-sides.)

At the Warwick meeting, I somewhat flippantly made reference to Fred's 'evidentially based criticism of deep disposal' remark he made some weeks ago, saying that, quite apart from the fact that opposition to disposal is often ethically rather than evidentially based and therefore is beyond 'evidence', positions *in favour* of disposal should be evidentially based. I am aware that this is difficult and that confidence can only be 'sufficient', 'adequate' and comparative. However, I believe it is imperative that the confidence CoRWM expresses is based on a sound set of arguments and is articulated in a way which demonstrates confidence as robustly but as sensitively as possible.

Paper 1691

I am concerned that, despite airing the issue several times, we have never quite agreed what the public and some stakeholders had in mind when opting for 'phased'. Perhaps we can never know but I feel we must, in our statement(s), recognise that the high performance of phased has two interpretations. This is the case in Andy's draft statement and I hope we can agree to retain the comment about the potential 'lack of societal consensus'.

The question put to the public in PSE3 was essentially, 'act now and remove the burden or allow flexibility so as to leave future generations to decide.' Faced with such a dilemma, it is not surprising that, as the document 1691 suggests, the most frequent response was 'act now but keep it flexible/retrievable'. It may be beyond CoRWM to arrive at an unambiguous view as to what citizens really wanted when they voted for phased.

If the high performance of 'phased' is interpreted as a plea for retrievability, a clear majority for retrievability/reversibility emerges which CoRWM should at least recognise and acknowledge.

I've taken the liberty of pulling some figures from paper 1691 to illustrate the point:

39% of citizens who took part in the third round of citizens' panels voted in favour of an option which catered for retrievability (i.e. the 'upto 300 years' in which a phased geological repository is assumed to remain open which thereby satisfies the retrievability criteria). The scores were 37 votes in favour of phased out of 94 votes overall. If the 20 votes for direct interim storage are added to this, we see that the percentage of votes seeking retrievability goes up to 61%.

Discussion guide responses were even more starkly in favour of retrievability. Of the 568 consultees, 401 were schools and colleges. 72% (289) expressed a preference for disposal but of these, 69% (199) expressed a wish for retrievability through the phased option. Add to this the 12% (48) expressing a direct preference for storage and there is a 247 to 154 (61%) in favour of retrievability.

Of the 167 non-schools and colleges which took part in the discussion guide project, 41.5% (69) expressed a desire for disposal, of which 66% (45) expressed a preference for retrievability through phased. Add the 24% (40) expressing a preference for direct storage and there is an 85 to 82 (51%) majority in favour of retrievability.

The school's conference results also demonstrate through the wording of document 1691 and the reports upon which it draws the fact that, despite a strong and understandable desire on behalf of the younger generations to 'act now', the caveats speak volumes: dispose 'only if it is safe to do so': 'the need to leave to future generations the ability to make their own decisions…was also a prominent factor'. Of the 38 votes cast, 22 (58%) favoured retrievability through phased.

The recent bilateral meeting reports

Trades Unions and BNG: Amicus, GMB, British Nuclear Group

*Preference for phased to '**ensure monitoring and retrievability'** for as long as possible seen as '**essential'.***

Cumbrian Strategic Partnership:

Preference for phased. If CoRWM recommended a different solution, both councils (Cumbria County and Copeland Borough) would judge the recommendation on the basis of the arguments that were made to support it. In short, if the element of retrievability (as associated only with phased or storage) is not incorporated into the proposed CoRWM recommendation, support for it would be judged on the arguments for deep disposal.

The NDA Group of Cumberland County Council (Eleven members of the NDA Group of Cumbria County Council, plus Head of Environment, economy and Environment, CCC, plus Director of Clean Up, BNG and Head of Public Affairs, BNG):

*'Among members, there were many who did not accept that the stability of any geology or hydrology could be predicted for timescales of 100,000 years. **In their view, this 'precluded geological disposal'.** There was strong support for the view that 'scientific knowledge will increase considerably over the next few hundred years and that this supports reversibility for at least this period of time……..there was strong support for underground storage…'*

Conclusions

1. CoRWM should ensure that its recommendations – particularly those in respect of disposal – are clearly articulated and supported by as much data and comparison as possible as well as by robust ethical justification where possible.

2. CoRWM should recognise that, if it recommends deep disposal, it may be articulating a view which has less support than it can currently impugn from the PSE outputs. 'Phased' was doubtless seen by many consultees as being equally accommodating of 'monitoring and retrievability' as a store and that is simply not the case.

3. CoRWM should recognise that a 'staged' disposal as opposed to a 'phased' disposal, while inevitably sharing a procedure which is unavoidably 'staged', is nonetheless a different animal entirely to the Nirex concept put to stakeholders in literature and upon which they expressed a view: the period in which a deep disposal facility is likely to be open for is much shorter than in the phased option and this should be acknowledged and addressed in any statement CoRWM makes.

4. CoRWM has to attend carefully and with equal weight to the storage element of its recommendations acknowledging the need for new designs in packaging and store construction as well as expressing a desire for passivity and longevity of stores to be pursued. Storage issues – a preference for them as well as the practical impact

within communities over the short and possibly medium term - impinge on the views of many local and national NGOs as well as local authorities, trades unions, SSG and communities up and down the country and must receive the sort of attention from CoRWM that they deserve. Such attention will pay significant dividends in achieving broad buy-in to the recommendations.

Others issues:

Issues relating to the uncertainty of the impact of radioactivity on future generations should be acknowledged and dealt with in a credible manner (the upcoming HPA meeting notwithstanding). *(NB The LLRC sensitivity testing has yet to be carried out and we should mention this as an issue of conditionality when considering the purpose and importance of the PSE4 consultation period).*

Implementation: we will deal with this at the appropriate time, but I've only been able to go through a third of the paper thus far and I have some comments. However, what has begun to concern me most is the fact that encouraging site specific equality of decision making with a series of 'break points' in an agreement can be interpreted as uncertainty and hesitancy on behalf of the implementing authority. The process beyond the waiving of the 'veto' must be carefully thought out to avoid giving the impression of a lack of confidence.

ANNEX 1 Conflicts of Interest via NNC and AMEC

The government's choice of NNC to run the process was a clear mistake due to their longstanding nuclear industry pedigree and involvement. NNC were the UK's leading private sector supplier of nuclear engineering, technical and safety services, when they were awarded the contract for managing CoRWM's programme in 2004. CoRWM's Chair admitted to discomfort over this closeness to the nuclear industry (meeting with NGOers, Bristol, 20 January 2006; Annex 6) but said that NNC were forced on them by Defra. This left CoRWM in no position to withstand the influence of vested interests. One example occurred in the presentation of NNC's own GeoMelt® technology for rad-waste at CoRWM's 22 Feb. 2005 meeting, on which ex-NNC's Mark Dutton prepared CoRWM's Notes (Doc.985).

When welcoming NNC at the July 2004 meeting, the Chair stated (not minuted) that Dutton would "sever" his connections with NNC; then, at the Sept. 2004 meeting (Doc. 720), Dutton declared an interest via his "employment with NNC up to 2002, since when he was only undertaking NNC consultancy work outside the UK" (see Dutton's letter*). Being outside the UK does not, of course make the interest innocuous, especially when the work was used for a dubious paper on ethics (Doc. 334.1) and setting narrow terms for the Grimston ethics study (Doc.514). Dutton wrote a CoRWM paper explaining the concept of long-term interim storage and variants, which relies largely on Hillis's paper for CoRWM (Doc. 615) while Hillis works for NNC. Moreover, Dutton and Hillis jointly wrote a paper for the European Commission covering similar and overlapping ground (EUR 21021, 2004), referred to in Ref. 1 of Doc. 615.

In July 2005 AMEC acquired NNC, creating the division of AMEC-NNC. With AMEC's overt agenda for new-build nuclear power, NNC's position as programme managers became untenable under conflict of interest criteria, yet nothing changed. Indeed, NNC's Sam Usher who manages the CoRWM contract was bold enough to write an article for the company's in-house magazine entitled *Waste management strategy critical for nuclear new build* saying "This is a high profile contract that puts AMEC at the leading edge of developing nuclear strategy – not only in the waste management industry, but to have an influence on new build." He explained: "There is an argument that you shouldn't build new nuclear power stations if you can't manage the waste from existing ones". An internet article in July 2006, *Exposed: CoRWM's Close Ties to the Nuclear Industry* (Spinwatch 2006) used documents disclosed under Freedom of Information to detail the close influence that Sam Usher had in CoRWM's processes.

In January 2006, AMEC joined UKAEA and CH2M HILL to form a new alliance to "target opportunities in the UK's £56 billion nuclear clean-up market" (http://www.ukaea.org.uk/news/2006/16_01_06.html). Sir Peter Mason, chief executive of AMEC, said at the time: "This team has the right blend of nuclear and

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* Dutton's letter to Mackerron, 7 Oct. 2004
http://www.corwm.org.uk/pdf/m%20dutton%20_nnc%20links.pdf
Doc.334.1 is 'A Note on Ethics in the Context of Long-term Radioactive Waste Management.', Mark Dutton, April 2004
Doc. 514 is 'Principles - Scope of ethics task', Mark Dutton 15 June 2004

commercial skills to win a sizeable slice of the £2 billion a year market." Thus AMEC were tendering for government contracts on nuclear decommissioning and waste at the same time as running the programme for the supposedly independent CoRWM.

ANNEX 2 Problematic CoRWM Process

Faulkland Associates were engaged to assess the Public and Stakeholder Engagement (PSE) processes from January 2005 and help CoRWM to improve them. They noted that in the early stage of framing criteria and options, it was unclear what working groups existed, what their membership was, or the minutes of their meetings (Faulkland 2005a). One has to plough through the document list, or work back from references at the plenary meetings to find them. CoRWM's claims to a 'transparent' process were compromised in Phases 1 and 2 by this unclear structure and delays in posting documents on a second-rate website.

Neither Faulkland's evaluation of the consultations, nor that of the NNC for PSE1 (NNC 2005) say what standards they used to guide their analyses, an unprofessional omission; neither refers to the central guidance on Consultation (*Code of Practice on Consultation*, Better Regulation Exec. 2005) that government departments and agencies are required to use. As neither picked it up, this basic flaw persisted in all consultation exercises. NNC's (2005) evaluation dissected responses into component points, yet as Faulkland (2005a) comments, stakeholders "expect to have their arguments considered, not just component points which may be less meaningful when taken out of context".

Consultation events were over-focussed on nuclear site communities; no effort was made to hard-to-reach groups. Faulkland warned that the problems due to time pressures in PSE1 would be repeated in PSE2. This proved true (section 3.4). Because of the time schedule, the short-listing was reviewed and finalised (Cardiff plenary, July 2005) when there was no report/summary of the PSE2 responses. Just one member (Barker) had read through them.

In PSE1, *Discussion Groups* were supposed to elicit basic views and concerns (*Report* Table 7.1), then CoRWM formed four Citizens' Panels to achieve intensive engagement in shortlisting, options assessment, etc. to fulfil Renn's CDM. The *Report's* Ch.7:20 implies the Panels did this successfully, yet the facilitators (Lancaster Univ.) report patchy results and also a diversity of views which go unreflected in CoRWM's *Report*. The Panels were formed too late to validate the short-listing process (Doc.1750), and found themselves pressed to choose options in advance of even basic information. At specialist briefing and questioning sessions, there was complaint at the exclusion of counter-specialists from NGOs. There was disaffection and hostility over 'swing weightings' for the MCDA (Doc.1532, 4.3.1) described as subjective judgement piled on subjective judgements. They had the task to develop ethical perspectives and address "more difficult ethical issues in the context of technical solutions" (*Report* Ch.7:20) where the "quality of the discussions and output was high". The facilitators' summary (Doc. 1532, 5.2.1) showed on the contrary an amateur, human-centred ethic, uninformed by sustainable development legal concepts,

and largely limited to a 300yr timescale. One Panel did go deeper, expressing ideas of genetic continuity and stewardship of the biosphere, but these didn't get through to CoRWM's discussions.

We found some reporting of public and stakeholder meetings to be inadequate (even biased). In particular, the argument for a specific (~ million years) timescale for 'disposal' was suppressed in the Minutes of the Bristol stakeholder meeting (Doc. 1161; May 2005) and again in the record of public comments at the Cardiff plenary meeting** of July 2005. The Bristol record was both mistaken and false in reporting that the Stakeholders there agreed to a "national meeting", when they actually decided against pressure from the falicilators to seek a further round of regional Round-Tables.

The 'stakeholder' meetings were loaded in favour of nuclear industry membership and expertise. Because they were linked to existing nuclear sites, numbers attending from the 'public' were employed or relatives of employees on these sites. Though the Renn MCA divides the scoring process into a technical appraisal by expert specialist and value judgements by non-expert stakeholders, both the regulators and nuclear industry were nevertheless well-represented at the 'non-expert' Round-Tables as well as in the Specialist Groups. Nuclear critics were inevitably far out-numbered at the specialist workshops, but even NGO specialists from LLRC (www.llrc.org) were squeezed out. The consequence, naturally, was perceived bias in scoring and lack of confidence in outcomes.

ANNEX 3 CoRWM's Adoption of Volunteerism

CoRWM's ToR invited the Committee to consider such issues as 'whether local communities should have a veto or be encouraged to volunteer, and whether they should be offered incentives' (*Report* Annex1:1). CoRWM made 'volunteerism' into a principle in their Recommendations (No.10), and the government has elevated it further into a 'key principle'.

In March 2004, Mackerron as chair stated after a presentation from NIREX that for "areas such as potential host communities and veto and volunteerism... CoRWM (is) in the lead" (Doc 236.1). Then NIREX who were advocating this idea handed over five reports written by and for them:

E. Atherton, A. Hooper and J. Mathieson, *Concepts That Could Aid a Site Selection Process*, A NIREX Technical Note, 2000. (document 226)

P. Robinson, *Legal Issues Relating to Veto, Volunteerism and Community Benefits*, A Report for NIREX by Burges Salmon, 2002 (document 229)

K. Rawles, *Compensation in Radioactive Waste Management: Ethical Issues in the Treatment of Host Communities*, A Report to NIREX, May 2002 (document 230)

** The comment (Doc. 1131 Annex A) was mis-recorded as "The need for CoRWM to establish clear timescales, for example for the period during which regulatory controls could be relied on", when the comment actually covered the geological timescales and not the social or regulatory timescale that was NNC's and CoRWM's agenda.

United Kingdom NIREX Limited, *NIREX Response to the Defra and Devolved Administrations' Consultation Paper 'Managing Radioactive Waste Safely'*, March 2002 (document 231)

K. Rawles, *Ethical Issues in the Disposal of Radioactive Waste*, A Report to NIREX, 2000 (document 235)

A search on CoRWM's document library shows just three passing references to the concept by end of 2005

April 2004 "concepts, policies and principles such as *volunteerism*, compensation, community veto, retrievability, intergenerational equity, environmental risk, sustainable development... useful to identify those issues which the Committee really does need to discuss in some depth". The Complementary Programme - ideas and proposals, Andy Blowers (Doc. 349)

January 2005 "implementation issues might involve the role of representative democracy and site-related issues such as vetoes, *volunteerism* &c." Summary of phase 3 Working Group Meeting (Doc. 944)

June 2005 Topic 92 Volunteerism - should involve democratic institutions not individuals / companies.

PSE 2 Outputs Reporting, from *National Stakeholder Forum* (Doc. 1186, Sec 7B, p12)

The appropriate place for discussion 'in some depth' would have been the Sept. 2005 Ethics Workshop. The report on that in March 2006 (Blowers 2006) shows from the external experts:

- Kate Rawles mentions 'volunteerism' in passing, as an issue, in the introductions
- Barbara Adam would rule it out as taking a short-term anthropocentric view of the planet
- Anna Vari, in reflections after the workshop, describes the difficulties found in practice in various countries (abandoned in Sweden), but gives no analysis of the ethical back-up.

Volunteerism gets no mention in the body of the *Report* (Ch.7, citizens and stakeholders involvement), nor is it explicit in reports of the Citizens' Panels (who saw little burden or unfairness to a host community). Thus it was never an issue for consultation and was not given the in-depth consideration required of a new "principle" with significant ethical implications. Contrary to any intent for CoRWM to take a lead role, it appears they took over NIREX-sponsored studies and added CoRWM gloss with a few references.

ANNEX 4 Gas Generation from long-term Repositories

The Secretariat's *Note of NIREX meeting* of 20th February 2006 (Doc 1608) mentioned gases but only as a geochemical issue:

> "Gas generation was a recognised problem caused by the corrosion of waste packages in water. The objective was to manage the balance of

> containment/release of gas in groundwater. The ideal was to ensure that gas left the repository and dissolved in the external groundwater before it caused disruption through pressure build-up. This would require site-specific investigation."

Gases from corrosion are not in fact restricted to watery environments – water vapour is important and its diffusion through seals and rocks suffices for microbiological processes generating gases. The Secretariat's summary of April 2006 (Doc.1693, *Uncertainties Associated with Geological Disposal*) did not cover miocrobiology or biogenic gases. Para.24 referred just to earth sciences, chemistry and geo-chemistry, posing the issue as "how long it will take for radioactivity to reach the surface in groundwater".

NIREX in their *Viability Report* (NIREX 2005a) admitted the radioactive carbon problem as a "major uncertainty" that could give up to 1000 times excessive dose via the "gas pathway":

Carbon – *14 in the Gas Pathway*

> "The one major uncertainty that we are still tackling at the generic stage is the possible generation and migration of methane containing carbon-14 (C-14). There are three potential sources of C-14 containing gases that are typically identified. These are irradiated graphite, irradiated metals and organic wastes.
>
> The possibility of the release of gaseous C-14 from irradiated graphite and irradiated metals has not previously been included in gas pathway calculations in the generic documents. Models have now been developed to allow these possible sources to be included in the calculations.
>
> Since it is uncertain how any release of C -14 in wastes will occur, scoping calculations have been carried out to bound the consequences if all the carbon in these materials reacts to form C-14 bearing methane and that this migrates as a free gas to the biosphere. These assumptions have a significant impact on the calculated risk from the gas pathway with peak annual individual risks up to of order 10^{-3} per year being calculated. However, groundwater has the capacity to dissolve methane and work is underway to see if this capacity can be scoped in the absence of site-specific information."

Two of the EA's key technical challenges (Section 5.2) involved C-14, namely the release rates of C-14 gases, "particularly where these estimates depend on models of microbiological processes" and the assumption that all C-14 in carbon dioxide does not escape from the repository, but reacts with backfill via a carbonation reaction.

The NGO (2006) critique reminded CoRWM of the gas issue in March 2006, referring to the Sellafield Inquiry. At the same time, New Scientist carried an article (Nielsen 2006) on the Swedish studies for deep disposal that said

> "in recent years it has become clear that microbes could pose a threat to any repository".

CoRWM, however, remained uniformed about this issue – due, presumably, to their NNC managers and the UK nuclear industry as a whole having ignored it. Evidently NIREX had not been following the work in Sweden and had failed to follow modern research on the microbiology of rock-living microbes, so were still (in Sept. 2005) making crude chemical assumptions.

ANNEX 5 Mistaken Choice of Multi-Criteria Decision Analysis (MCDA)

Following the explicit Minute of the chairman's statement (July 2004 plenary – see Section 6.1) CoRWM selected the MCDA process on the basis of a review commissioned from Prof. Gregg Butler (of 'IDM'; *Report* Annex 5:1.4), which was considered by a "Phase 3 group" but not by the full committee. It failed to incorporate any substantial critique or identification of the shortcomings of MCDA (only claimed positives are listed in Annex 5:1.5). It's a matter of concern that Gregg Butler (2006) has a nuclear industry background, with on-going connections and funding, and is well-known to several members of the committee (Barker, Blowers, Davies, and Warren) through his membership of RWMAC where he served as *'consultant specialising in nuclear fuel cycle and nuclear industry matters'*. The paper's reviewer Prof McDaniels is quoted in CoRWM's Annex 5:1.6 as declaring MCDA is *"the only method that I know of to address these features of such decision problems in a responsible manner"*. Such an explicit and unqualified endorsement - in the context of general critiques and acknowledged limitations of MCDA - implies a deficit in the balance and impartiality needed of a reviewer.

An MCDA, by its structure, separates dimensions (aspects or factors) which are actually interrelated and often co-constitutive. Yet, eg. ethical aspects are intrinsic to technical and economic assessments. Section 6.3 of the text describes why an inclusive democratic approach is essential in the strongly contested arena, characterised by disparate knowledge bases and disparity in power. As this is accepted policy in the health field, it was a clear mistake for CoRWM to choose an MCDA, especially one with a strong technocratic basis derived from the nuclear industry.

The facilitators gave no consideration of how trust might (or might not) be established. No consideration was given as to the information base or option setting that has to go into a decision-making process. There was too little time allocated for a real deliberative process. Instead the "Phase 3 group" influenced by Gregg Butler's review decided "an intuitive assessment might be woven together... to encourage deliberation" (Walthall 2005) by letting the holistic assessment be made by CoRWM members rather than by citizens as in Renn's model.

The MCA process shaped much of CoRWM's further work - for instance, a lot of discussion went on about how to define the options and criteria so that an MCDA would 'work'. These had to be decided at the July 2005 meeting, before stakeholder responses on the "short list" had been assembled and analysed.

CoRWM should have sought a 'robust' way forward in July 2005 from PSE2 responses, by seeing if they could meet the most critical comments, through redefining the options (Section 3.3). But with no analysis of responses, there was little re-examination of the 'broad' options to look at variations and how options might be amalgamated or differentially used (e.g. storage and research, or a realistic timescale for stores).

adapted from NGO critique (NGO 2006)

ANNEX 6 NGO Objections at Bristol, 20 January 2006

Following prolonged argument over the programme and facilitation at the Round-Table that was intended to confine particpants to setting scores on pre-defined option-criteria (MCDA), a special session was agreed where objectors could present criticisms for recording by a CoRWM Member (Lynda Warren). These were transcribed as Appendix 5 to the report of *CoRWM PSE3 Roundtable - Bristol, 20 January 2006* (no Doc. number) and are cryptic because written large on a wall-chart and with Warren's phrasing. In late afternoon, Gordon Mackerron arrived for a pre-arranged discussion with some six NGOers, joined by Lynda Warren and Fiona Walthall. The record from our side is below.

Anti-nukes criticise CoRWM at Stakeholder Round-Table, Bristol, 20 Jan.'06

The CoRWM secretariat wrote to us that the invitees had an "emphasis on engaging stakeholders from communities local to the (nuclear) sites". Yet ours had 8 "community" reps, compared with 8 from the nuclear industry out of 25. The exercise was intended to assess "your inherent values" said the Corwm rep (Fiona Walthall) so why involve (so many) nuclear industry staff and employees (or regulator and local authority people) ?

They eventually stopped our complaints about the process, allowing us to record a number of points in direct discussion with the CoRWM rep and afterwards in a 'bilateral' session:

1. the Corwm process makes us feel hostage to a warped decision-process, that's not open but tightly constrained in outcomes.
2. Corwm claims to record all stakeholder inputs, but the reality of the shortlisting process was that it was completed (Cardiff in July) when there was no report/summary of the PSE2 responses and just one member said he'd read through them.
3. We are concerned about the NNC-AMEC running the process, because of their nuclear industry involvement with perceived bias.
4. The bias in specialists appointed to the first stage of the MCDA leads to perceived bias in scoring and lack of confidence in outcomes
5. concern that the "Netherlands strategy" of storing for up to 100 years while pursuing studies of alternative long-term options was not in CoRWM's short-list
6. concern that sub-seabed disposal was dismissed in the artificial short-listing process
7. concern over the 300 year timescale in the "interim" store option, being overlong and unsound for assuming institutional control (the US specifies 100yr max)
8. concern over CoRWM's failure in their stakeholder and public information to link the "interim store" option with the package of potential options that may become feasible within decades (CoRWM shelved them for a "watching brief")
9. concern we were given selected knowledge, insufficient to base stakeholder decisions

10. concern that geology is highly important, but deferred by CoRWM till late in the process – which has meant failure to specify timescales that deep disposal has to meet in eg. the USA (1 million years for the Yucca Mtn store, as decided in Court with science advice)
11. concern that "ethics" was addressed too late, with the workshop output still not available and a tendency to reduce it to polling people's views
12. concern that the Quality Assurance group has been slow in getting going, is meeting rarely and is perceived as an inadequate check on NNC.
13. concern over reporting of public and stakeholder meetings; in particular the argument for a specific (~ million years) timescale for 'disposal' was suppressed in the Minutes of the Bristol stakeholder meeting (May) and again in the record of public comments at the Cardiff plenary meeting (July 2005). Also the Bristol record falsely says the Stakeholders agreed to a "national meeting", when they actually wanted a further round of regional round-tables.

We talked of walking out, but didn't in the end. The whole set-up is biased and intimidating, but we were strong enough to persist – others might prefer to walk out, demonstratively. We were allowed no opportunity for discussing the Specialist group 'scoring' as the draft agenda had promised. We were critical of the "option preferences" exercise, which facilitates choice according to prejudices with limited testing and scrutiny.

20 January 2006

EDITORIAL

Keith Baverstock and David Ball

The Importance of Nuclear Waste as an Issue for E&E

We should declare a personal interest in the issue of radioactive waste management at the outset; our interest in the subject, as assessors and managers of risk, was stimulated in 2003 on learning of the intention of the British government to create an advisory group known as the Committee on Radioactive Waste Management (CoRWM). We applied to become members, drawn by the challenge of the problem, social as well as technical, and its obvious importance in a small country which had for decades failed to come up with a 'solution' to its burgeoning stockpile of waste. Both of us had extensive experience of advising on risk assessment and management in relation to a diversity of hazards. We were both appointed but, as it transpired, spent less than one and a half years as members of CoRWM. We will return to this experience later, because it reflects on the present-day tendency of governments and regulators (and also CoRWM) to lay claim to attributes of transparency, openness and inclusivity. First though, we welcome the invitation to be guest editors of E&E and to look back with the benefit of hindsight on how the issue of high level radioactive waste management in particular has developed more globally.

It is worth noting why radioactive waste is a fitting topic for this journal. The short answer has to be that the unresolved issue of nuclear waste is regarded by many as the Achilles' heal of the nuclear fuel cycle, while at the same time nuclear power is gaining favour as, at the least, an interim measure in the global challenge to ensure continuing security of electricity supply during the C21st while also reducing greenhouse gas emissions. What might be unusual for E&E, however, is that in this issue we have invited a highly multidisciplinary group of authors to contribute. This is because, as mentioned above, the process of reaching a decision about what to do with nuclear waste entails both highly technical and complex socio-political issues.

The Papers in this Volume

The opening paper, by Gordon Thompson, sets the scene by providing an historical account of the US effort, so far unsuccessful, to dispose of high-level radioactive waste. As the author says, it is important to understand the reasons for this disappointing outcome, for on the one hand the process of deciding is consuming large amounts of human capital, and, of greater importance, the unresolved situation poses a continuing risk of a large release of radioactive material to the atmosphere. Because of the failure to find a more lasting solution, most high level waste is currently stored at reactor sites in high-density configurations in water-cooled pools. Loss of cooling water could result from accident or attack, leading to a pool fire and, potentially, a

release of radioactivity large even by comparison with Chernobyl. Nonetheless, Thompson suspects that the Yucca Mountain project, to provide a deep underground repository, will lose momentum and eventually be cancelled, leading to continuing wet storage at commercial reactor sites along with dry storage in ISFIs (independent spent fuel storage installations). He concludes by noting the complex ethical issues to which this gives rise. For some, the storage and passing on of spent fuel to future generations would be burdensome and therefore immoral and counter to any notion of sustainability. For others, the fact that the stored waste contains plutonium could permit it to be seen as a valuable energy resource for future generations.

Thompson's final comment is that there is no systematic debate in the USA about the respective merits of opposing ethical perspectives on nuclear waste. The second paper, by Bill Leiss, describes what might be seen as Canada's path to providing just this platform. As Leiss describes it, 1998 was a pivotal point in the history of Canada's approach to dealing with its nuclear waste. In that year the Seaborn report was published amid great controversy. The conclusion which caused the furore was that whereas, from a technical perspective, the concept of geologic disposal had on balance been adequately demonstrated, *it had not been shown to have broad public support*. At the time the report was denounced by industry partisans e.g. 'a social perspective is not relevant to safety as normally defined,' but the genie of social acceptability was unleashed. In 2002 the Canadian government required reactor owners and operators to establish an arm's-length entity, the NWMO (Nuclear Waste Management Organization), to re-examine the disposal issue and recommend a preferred solution within three years. A crucial and controversial aspect of NWMO's remit was to examine the "acceptability" of disposal options, not just from the experts' perspective of the technical demonstration of compliance with safety criteria, but from the viewpoints of the wider public, a move which opened the door to far wider considerations of social legitimacy. Thus, NWMO sought to start afresh by considering and comparing all feasible disposal options, by blending technical and social dimensions into a unified evaluation, by subjecting decisions to ethical evaluation, and by inclusion of an exhaustive program of public and stakeholder consultation.[1] The Leiss paper describes perhaps the most difficult part of that process – the attempt to integrate social, ethical and technical issues within the same evaluation framework with equal priority.

The third paper, by Tapio Litmanen, provides a Finnish perspective on the entrainment of socio-political considerations in what previously had been regarded as a technical decision making process. Finland's experience is central because of the year 2000 decision by Eurajoki Municipal Council to accept the island of Olkiluoto as the site of a final disposal facility for spent nuclear fuel. Key in Litmanen's analysis is the issue of independence. Independence is vital from the perspective of trust and trust is vital because where such highly technical issues are being addressed the lay audience (stakeholders and the public) cannot be expected to acquire sufficient expertise to make valid judgments on what they are being told. The role of social science is to ensure that the processes of decision making respect the needs of the

[1] NWMO, Assessing the options: future management of used nuclear fuel in Canada, June 2004.

stakeholders and lay public. In Finland the regulator, STUK, took on the role of protector of the public interest and it does command trust. In spite of this and the undoubted success of the Finnish process, Litmanen is not entirely satisfied. He attributes what short-comings there were in part to the changing way social science is practiced and the potentially conflicting demands of the commissioners of the social science which could, in some cases, be seen as compromising the independence of the social scientists. Essentially he asks the question: if the overseers are not independent how can the process be judged independent?

Another important matter in understanding how decisions are made is how the various participants perceive the risks, and what motivates those perceptions. Since decisions also involve a complex interplay of actors, it is also pertinent to ask how the various actors perceive other people's perceptions, and whether these alternative perceptions in turn affect their own. Lennart Sjöberg and Britt-Marie Drotz-Sjöberg investigate these matters in the Swedish context[2] by addressing the issue of how politicians, who have to make and sell decisions to the public, view the risks of radioactive waste management compared to the public and experts. Of the many interesting strands to this paper, several stand out. For example, it is often presumed that politicians react to public demands rather than their own assessments of the risk or that of experts, resulting in irrational decision making. But is this true? Their paper suggests not, and that politicians in fact are guided by their own risk beliefs and not by the opportunistic gambit of merely accommodating themselves to what they think the public wants. Questions are also raised about the role of stakeholders in participatory decision making, the views of whom tend, one way or the other, to be more extreme than of others, and which could lead to a serious distortion of decision processes. The paper also explores the nature of 'trust,' finding that trust in science is a more important determinant of perceived risk than social trust, where social trust entails perceived honesty, objectivity, consistency, competence, and fairness. This finding is consistent with a Eurobarometer poll[3] in 2005 which found that two out of three European citizens believe that decisions of a scientific and technical nature should be based primarily on the opinion of experts.

The fifth paper, by Deborah Oughton, examines from an ethical and philosophical perspective the modern trend to participatory decision making involving public and stakeholder inputs, as for example required by the Aarhus Convention. Often it is presumed that participation is of itself such an obviously good thing that even to question it is an act of heresy. Oughton's paper provides a clear signal that, like everything else contributing to complex decisions, the mode and conduct of participatory processes also requires careful scrutiny. She addresses the issue of how stakeholders and the public should be involved in such processes, starting by examining and confirming the validity of the view that they should, and then addressing how. She finds legitimacy to be the over-riding criterion for successful stakeholder and public participation rather than efficiency, that is, acceptability of the outcome. Here there is a common cause with Litmanen's concerns.

[2] As in Finland, there has been preliminary acceptance by some Swedish communities of a repository siting decision.

[3] See http://ec.europa.eu/public_opinion/archives/ebs/ebs_225_report_en.pdf

The next paper, by Keith Baverstock, is about our understanding of the health effects of exposure to ionising radiation. It should not be overlooked that in parallel with the revolution in the approach to societal decision making, scientific knowledge also advances. As health risks are possibly the foremost concern of the wider public in considering nuclear waste, it is curious that health gets no special attention in the deliberative processes we have seen, especially that run in the UK by CoRWM which sacked and did not replace its only health expert. Baverstock's paper sets out those new developments in understanding of the health consequences of ionising radiation, particularly in relation to low doses of the kind which might arise from far-future leakages from nuclear waste repositories. The issue is that there is new radiobiological evidence of harmful cellular processes, known as genomic instability and the bystander effect, which are induced by radiation, but which are not factored in to current risk estimates used by industry and regulators. At the least, this evidence widens the bounds of uncertainty.

The final paper presented here is a viewpoint by Max Wallis, describing his experience of the work of the UK's CoRWM which, like the Canadian NWMO, sought to reach a decision on the future of the UK's nuclear waste legacy which was anchored both in science and social acceptability. Max Wallace had a strong interest in the UK process, attending a fair number of the public meetings and, where permitted, contributing. By coincidence, both Canada's NWMO and the UK's CoRWM started their processes in the same year, with a similar time frame, and reasonably similar objectives, but by very different routes. Also, judging by events and including the perspective related in this paper, with very different outcomes in terms of procedural validity. Thus, Wallace finds, as have others including eminent bodies such as the House of Lords Science and Technology Committee,[4] the CoRWM process to have been marked by a panoply of shortcomings, several of which alone would have holed the enterprise below the waterline had not the sponsoring departments sought repeatedly to casually dismiss and deny the deficiencies. Thus, Wallace identifies major shortcomings in the quality and use of science, the deliberative procedure employed, the means of short-listing options and procedural matters relating to the independence of the Committee from its lead sponsor (DEFRA) as well as commercial nuclear interests.

Personal Reminiscences on CoRWM and its Legacy

We intend to take this opportunity, with the benefit of our personal experience, to evaluate what went wrong with the CoRWM process. That it did go wrong is incontrovertible, given the severity of criticism heaped upon CoRWM by the House of Lords S&T Committee and others, including the media. Nor was this attributable to lack of funding, which was generous. The management of HLRW is not a trivial issue for the UK; the present "management strategy" both creates unnecessary risk (e.g. Thompson, ibid) and costs to the tax payer. Radioactive waste management is equally an issue in many other countries. The urgent need for a solution was identified in the

[4] House of Lords Science and Technology Committee (2004) 5th Report of Session 2003-4, Radioactive waste management. HL Paper 200: TSO: London.

UK in 1976[5]. The UK has a distinguished record of technical expertise in nuclear issues and in our experience all the necessary tools to make decisions on how to manage this hazardous material safely. It is thus a matter of national importance to understand why the CoRWM process was so inferior to the Canadian and Finnish processes described in this volume. One way of deciphering this is to take a step back, and to consider the nature of knowledge itself.

Radioactive waste management is first and foremost a complex technical issue involving many aspects of natural and applied science, health and engineering, that is, one involving considerable technical expertise. 2007 saw the publication of a very relevant and timely book by Harry Collins and his co-worker Hugh Evans, from Cardiff University, entitled "*Rethinking Expertise.*"[6] They identify five levels of expertise from what they term "beer mat"[7] expertise (at the lowest level) to contributory expertise (highest level), i.e., the expertise developed by those skilled in a subject, including for example gravitational wave physics. Their thesis is that this high level of expertise is only acquired by being part of the community that practices that expertise and "speaks the language." Thus, for there to be effective communication between different expert communities an intermediate fourth level of expertise, "interactional expertise," is required. This level of expertise allows its holders to communicate effectively with the contributory expertise community. It follows that a committee that has to provide advice on a multidisciplinary subject must devote a significant proportion of its effort to sharing expertise at the interactional level and this is precisely what the Canadian project, under NWMO, did with an extensive series of papers prepared by international experts and made widely available on the INTERNET. In contrast CoRWM, which arguably produced a much greater volume of paper, relied on papers prepared largely by its own membership, very few of which would survive external peer review. Even in the case of externally commissioned work, some of the briefs provided on behalf of CoRWM were described by experts as being like something out of 'Toy Town.'

In December 2004, when the House of Lords Science and Technology Committee (HofL) reviewed CoRWM's progress one year into their process it remarked as follows[8]: *"We judge the composition of CoRWM to be inappropriate for offering advice to the Government on the technical aspects of their remit"* and *"we have no confidence in the technical ability within CoRWM itself sufficiently to understand the science of some of the disposal options. Whilst CoRWM will receive advice from a number of sources, we do not believe it can even be considered an "intelligent customer" for technical advice without additional expertise."* and *"We urge the Government to consider, without delay, either the appointment of additional members to CoRWM with expertise in earth science, materials or civil engineering, or the establishment of a technical sub-committee to CoRWM....."*.

[5] Royal Commission on Environmental Pollution Sixth Report, *Nuclear Power and the Environment*, HMSO 1976.

[6] H. Collins and R. Evans (2007) Rethinking expertise, University of Chicago Press: Chicago and London.

[7] From a brewery which produced beer mats with very basic explanations such as how lasers, radars, x-ray generators etc., work.

[8] house of Lords Science and Technology Committee, 5th Report, See: http://www.publications.parliament.uk/pa/ld200304/ldselect/ldsctech/200/20003.htm

Publicly the sponsors of CoRWM, DEFRA and the devolved administrations, either ignored or dismissed this advice and indeed a senior DEFRA civil servant, when asked under oath[9] if he was concerned about the HofL criticism, claimed he was not. In his paper, Wallace, from the perspective of a stakeholder, identifies important failures in the CoRWM process in aspects of its public consultation, accusing it of concealing information relevant to the public discussion and essentially of being economical with the truth.

Our disenchantment with the CoRWM process started at the earliest meetings in January 2004 when it seemed that some members (hereinafter the "caucus"), nearly half the committee, were well-acquainted with one another and already had a clear idea of the direction in which they were determined to go; weak chairmanship allowed them their way. By the time of our departures in April and May 2005 the committee still had no strategy to address the technical aspects of the problem. Indeed, it appeared that an atmosphere of antagonism to expertise of any kind, whether natural or engineering, health or social science, prevailed. By this time the caucus had fully taken over the direction of the committee which displayed all the attributes of "groupthink"[10].

Whereas Canada now has a clear audit trail from the deliberations of the NWMO and a clearly marked path ahead, CoRWM started experimenting with volunteerism, as noted by Wallace, an approach rejected by Sweden and not part of the successful Finnish process. CoRWM's own audit trail is a second-rate web site with a dysfunctional search facility[11] and some 2,250 documents, many of the most important of which are not accessible over the web and the most important one (the scientific evaluation of the CoRWM process carried out in 2006) 'unavailable' even after a freedom of information application (Wallace, ibid).

Committees such as CoRWM are but a part of a much larger system, some elements of which the committee is designed to serve, others designed to serve the committee, and still others to exercise oversight. As Litmanen's paper has described, Finnish law on environmental impact assessment requires the involvement of social sciences in the making of technical decisions such as those pertaining to radioactive waste. This is a relatively recent development and Litmanen's account provides a valuable and detailed evaluation of the role of social scientists in the successful Finnish process of selecting the municipality of Eurojoki as the repository site for Finland's spent fuel, with special emphasis on how this served the public interest. What this analysis most clearly reveals is the complexity that is entailed in such a process when properly followed. From the perspective of most European countries, what is most impressive is the political continuity that has supported the process from the decision in principle to use geological disposal taken by parliament in 1983, to site selection on schedule in 2000, and projected opening of the repository in 2012. One might contrast this with the UK's performance, essentially acknowledging that the issue was urgent in 1976, followed by the rejection on scientific grounds of a planning application by NIREX in

[9] Dr Robert Jackson in February 2006

[10] See: http://en.wikipedia.org/wiki/Groupthink

[11] For example, a document, No 2248, randomly selected from the document list, was "not found" on 22 February 2008.

1997, and barely perceptible progress represented by CoRWM's final report in 2006, and the anticipated availability of a high level waste repository in 2075.[12]

Litmanen emphasizes the importance of "independence". CoRWM presented itself as an "independent" committee but that seems to be a claim based on a novel definition of the word independent. The OED defines independent as: *"Not depending upon the authority of another, not in a position of subordination or subjection; not subject to external control or rule; self-governing, autonomous, free"*. We would, particularly in the context of nuclear issues, add to that the phrase *"free of vested interests."* DEFRA seems to have tried to meet the definition of independent by appointing both sides of a highly polarised dispute (over the role of nuclear power) to the Committee, the caucus and chairman anti-nuclear and other members and the project manager (who had a degree of autonomy) from the pro-nuclear camp. That left only four of the 12 initially appointed members, including ourselves, as neutral, or as we would claim, "independent."

The first and most important problem with the whole CoRWM enterprise was that there was a strong constituency for whom no solution was a good outcome. For example, the strongest card in the anti-nuclear lobby's opposition to new build is the unsolved waste problem. So long as there is no solution they would maintain, correctly in our view, that it would be unethical to generate more waste. The Secretary of State who initiated CoRWM (Meacher) and the incumbent at the time of appointment of members (Beckett) and the responsible Minister (Morley) in DEFRA have all expressed their opposition to nuclear power. Appointments to CoRWM were delayed several weeks due apparently to getting approval from the then Secretary of State (Beckett). From the HofL report it is clear that the Chief Scientific Advisor to DEFRA, the late Professor Sir Howard Dalton, was not consulted on the membership before appointment. It seems plausible then that the "appointments process" was politicised from the outset.

We speculate that this might well have been the reason why the originally appointed Chair of CoRWM, Kathryn Bryan, who was involved in the interview process for the membership, resigned in January 2004, barely a month after the first meeting of the Committee. She was replaced "on the spot" by an existing member, Gordon MacKerron, an economist, also with a track record of opposition to nuclear power. The National Academy of Sciences in the USA, which prides itself on offering independent advice to government for more than 140 years,[13] identifies among many other factors that ensure independence and objectivity, the pivotal role of the Chair. MacKerron would have been well advised to read the briefing that the NAS provides to the Chairs of its committees.

Thus we have to conclude that the very foundations of CoRWM were deeply problematic from the outset and it is interesting that as far as we are aware NWMO, in spite of being a commercial enterprise, managed to maintain its independence and integrity.

[12] http://royalsociety.org/displaypagedoc.asp?id=27169

13 http://www.nationalacademies.org/studycommitteprocess.pdf

When it comes to the role of expertise there is a very basic issue which is addressed by Collins and Evans. It is interesting to consider their account of the history of social science's involvement in technical decision making. Up to around 1970 and a bit beyond, technical decisions were largely the province of experts in the appropriate disciplines. From then onwards until 2002/3 this supremacy was increasingly questioned to the point that anyone's opinion was as good as anyone else's; folk knowledge was in the ascendant and technical expertise was no more and no less important. More recently there has been a developing consensus that expertise may after all be important and that it has a different role to play compared to stakeholder and public input.

In our view all the most sophisticated deliberative process can do is inform about the opinion of a very small sample of the population and it is a very legitimate question what the meaning of that result is. If a sample of say 60 individuals were brought together to assess whether public funding of opera was appropriate because it is a minority interest, the consensus might well be that it is not. In terms of the Collins and Evans model those with the contributory expertise to judge what public good derives from opera performances would be such a small proportion of the sample that their weight would be swamped by those with only beer mat knowledge of the benefits of opera.

In Finland never more than 40% of the general population have been in favour of geological disposal, but the Eurajoki decision at the local level was strongly in favour. One might argue that because of the potential close involvement with radioactive waste management policy the Eurajoki inhabitants had acquired more expertise than the average member of the public and were better informed to make the judgements necessary; their opinions carried greater legitimacy. As Oughton (ibid) says, *"superficial public participation efforts usually serve the decision makers much more than they serve the stakeholders."* We conclude and have always maintained that education of the public and stakeholders is the key to robust decision making that serves the public interest; to CoRWM, which produced no independent documentation of any worth aimed at educating the public and stakeholders, education was an irrelevance, indeed counter to their philosophy which saw the public as already having the necessary wisdom.

CoRWM's public and stakeholder engagement (PSE) process, particularly in the early stages, was both superficial and ill thought through. It seemed to us, from the comments made by members attending PSE events, that the criterion of success was that *"a good time was had by all."* Certainly as observers of that part of the process we were not aware of any thinking in depth about how the results from these events reflected public opinion in general and most of our questions were brushed aside. We have observed this behavioural pattern, which goes starry-eyed at the mere thought of public engagement and pays no heed to issues of validity and legitimacy, in other contemporary settings.

The issue of how to manage the highly toxic waste products of nuclear power generation affects almost every country with a nuclear power programme and every country that plans to go nuclear. In the first case it is a matter of dealing with a legacy of waste, and in the second it is an issue that ought to be resolved before new build

commences. The outlook is not all bleak; Finland and Sweden are well advanced, Canada is on the way, all three having had successful decision making processes.

At the other end of the scale comes the UK. For the UK a model was, so to speak, on the doorstep. It was with the strong "encouragement" of one of us (KB) that CoRWM visited both Finland and Sweden and indeed ultimately CoRWM adopted many of the features that were presented to them during that visit but most notably they must have rejected the Finnish site selection process, which set out to first identify the optimum locations from a geological perspective and then to engage with the communities. Instead CoRWM opted for experimenting with volunteerism. We say "must have" because these events took place after we left the committee; volunteerism was not discussed in the first 15 months of the committee's life.

We judge that the CoRWM made three seminal mistakes in its first months:

1. was led headlong into a 6 month long trial of a controversial PSE technique known as "deliberative mapping." This depleted funds, wasted nearly 20% of the allotted duration of the committee, and caused considerable internal friction. This expensive fiasco was embarked upon without even defining beforehand what would be a successful trial outcome, nor how it would contribute to the final disposal decision.

2. was to expend so much time on eliminating unlikely options. We disagree with the HofL, which implied that starting with a clean slate, all options on the table, was unnecessary. What was unnecessary was the time taken, 16 months, to eliminate even the most bizarre, namely projecting the waste into the sun with rockets. At this stage the committee was gripped by a zealousness and fervour, with associated blindness and deafness, akin to those with a belief that they would "save the world."

3. was that the committee was refractory to developing a strategy for dealing with the scientific and engineering aspects of the problem. Up to the time we left the committee's activities had focussed purely on public and stakeholder relations. Only after the furore raised by the House of Lords S&T Committee, the media, and our departure, did CoRWM erect a façade of serious scientific engagement, and this we suspect resulted only from pressure applied by the sponsor, DEFRA.

These three errors were fully apparent less than one year into the committee's life. We simply could not believe that a government committee sponsored at the highest level, in a highly technically developed European country, could be so reckless. This was the origin of the disaffection that eventually led to our departure from CoRWM. As a result of the work of Collins and Evans we now see that we were experiencing what they call the "second wave" in which social scientists (those at least of a particular schism) regard all participants as being equally knowledgeable. Even on matters of science, where we held contributory knowledge, the opinion of a public relations person carried as much, if not more, weight. At the time we described the situation as

"Alice in Wonderlandesque." Now thanks to Collins and Evans,[14] we at least can appreciate what was going on: it was not imagined.

In October 2004 one of us (KB) was asked by a senior civil servant from the Scottish Office, Elizabeth Gray, who had been on the recruitment panel, "how things were going with CoRWM" and as a consequence was invited for further discussions immediately prior to the plenary meeting of the committee in October. It was suggested by Gray that an independent review of CoRWM's progress would be appropriate. As from March 2004 our numerous approaches to the Chair had failed to rectify what we saw as a serious perversion of a decision making process and it was agreed with Gray that if the hoped for improvements did not materialise at the October 2004 meeting, a letter to the Chair detailing all the concerns would be copied to her. It was the copying of this letter, and its further transmission by Gray, which led through a kangaroo court convened by the Chair and an "investigation" by a so-described[15] independent representative of the Office of the Commissioner for Public Appointments, to the sacking of one of us and the resignation of the other. His report, the Roberts Review, upon which Morley leaned to justify the dismissal, is unavailable even through the freedom of information route. This is possibly because it contains criticism of the Chair, as was expressed to us by Roberts.

The primary concern expressed in that letter to Gray was the frank and open contempt in which some of the Committee held science; to quote one member, Lynda Warren, "the laws of science are as mutable as the laws of Parliament" or another, Fred Barker, "science on tap not on top." Fine maybe if he or any of the other members of the committee were competent to turn the tap.

The astonishing and indeed, for the future of technological risk assessment in the UK, alarming, thing is that there were scientifically qualified civil servants both in DEFRA (Dalton, the Chief Scientist, and Robert Jackson, who had a longstanding interest in radioactive waste management through the committee that preceded CoRWM), in the Scottish Executive (Gray), a Scientific Advisory Council in DEFRA (chaired from April 2005 by Professor John Beddington, now the Government's Chief Scientist), and in the Cabinet Office a Chief Scientist (Sir David King). The only visible response to the excoriating report by the HofL and the publicity surrounding our departure from CoRWM was the appointment of a four person advisory committee to CORWM around April 2005 with less than clear terms of reference. One can only assume that it was never the intention of DEFRA and the devolved administrations that CoRWM would produce scientifically sound recommendations; perhaps the Committee's real purpose, as suggested to one of us by Sir Bernard Ingham, was *"quite simply to cause delay"* in the interests of the anti-nuclear lobby.

In the event, and with the assistance of the Royal Society who appointed Professor Geoffrey Boulton, a geologist, to liaise with CoRWM, final recommendations were provided on time[16] and as might have been expected, proposing geological disposal as

[14] And others e.g. F. Furedi (2004) Where have all the intellectuals gone? Confronting 21st C Philistinism, Continuum Press: London.

[15] He was in fact a DEFRA-nominated business man with OCPA training.

[16] That the final report was on time is surprising given the time spent on early PSE failures and short-listing, and the immense complexity of the final stages of the task.

the preferred option[17]. Professor Ian Fells is quoted at the time by the Royal Chemical Society[18] as saying; *'and engineers have known for 50 years that deep geological disposal must be the way ahead.'* No analysis of the relative merits of the possible geologies, i.e., rock, clay or salt, no requirements for packaging; in short not anything at all about the difficult bits. So a proportion of membership of CoRWM have been persuaded that deep geological disposal is the best option but Wallace and his colleagues have not and we wonder what proportion of the UK population are so persuaded[19]; is there as a result of the CoRWM dispersal of some £7 million of the Treasuries beneficence any difference in public opinion? If not, and as it has failed to solve the science and engineering issues, that £7 million is wasted along with the 5 years it has taken to get here.

Only 6 weeks after the infamous letter was sent on 24 October 2004 the HofL published their excoriating judgement on CoRWM. It was a vindication of the battle that we had fought since January 2004. However, in 2007 the HofL said of CoRWM's final report[20]: *"In practice, much of CoRWM's time was devoted to "public and stakeholder engagement", to the exclusion of scientific analysis of the available options, and we were roundly critical of this preoccupation in our 2004 report Radioactive Waste Management. Nevertheless, when CoRWM reported, on schedule, in July 2006, it produced a well balanced report, around which it should be possible to build long-term consensus."*

Would it be unduly cynical to wonder if this "welcoming" tone would have prevailed had CoRWM recommended some other solution, such as long term storage? Were their Lordships not a bit disappointed that more technical progress had not been made and might they not have pointed out that this could have been achieved had their 2004 recommendations[21] been acted upon? Apparently, if the result is "what you want"[22] it matters little how it is obtained. This brings us right back to Deborah Oughton's point about efficiency and legitimacy; it could be surmised that CoRWM were *efficient* as far as HofL (and probably the Royal Society) were concerned, but in no way can their process be described as *legitimate* from a scientific and technical perspective, and we should remember that the HofL's Science and Technology Committee is one of two at the highest level of UK government. CoRWM's public engagement strategy was also vulnerable to the intrusion of bias of many kinds.

In 2007 a new CoRWM was appointed with a new Chairman and a more tightly defined remit. Whether it can build on the insubstantial and fractured foundation laid by its predecessor remains to be seen. Copious ammunition has been provided to those

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[17] Indeed, given the inexpert nature of the Committee they could hardly have sustained a scientific argument in favour of an option that went against the perceived wisdom.

[18] http://www.rsc.org/chemistryworld/Issues/2006/September/BuryRadioactiveWaste.asp

[19] As a siting process based on volunteerism is integral to the Government's strategy public opinion in the UK matters much more than it it did in Finland

[20] House of Lords Science and Technology Committee, 4th Repart of Session 2006/7, Radioactive Waste Management: an Update, 3 June 2007. See:
http://www.publications.parliament.uk/pa/ld200607/ldselect/ldsctech/109/109.pdf

[21] See footnote 4

[22] HofL reached the view in 1999 that deep geological disposal was the way ahead.

who do not favour deep disposal, or indeed any solution, and despite the 32 years that have elapsed since the urgency of the problem was recognised the UK still has the "hill to climb"; it does not have a technically viable strategy to deal with radioactive waste, whether legacy or from new build. Equally disturbing is that there are indications that so far as transparency, openness and inclusivity are concerned, and despite all the protestations of the importance of these attributes by government agencies, when it comes to the crux, the name of the game is still 'stonewalling.'

Compensation in Radioactive Waste Management: Ethical issues in the treatment of host communities

A paper for Nirex by Kate Rawles

May 2002

This paper has been prepared by Dr Kate Rawles under contract to Nirex. The paper has been reviewed by Nirex, but the views expressed and conclusions reached are those of the authors and do not necessarily represent those of Nirex.

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ABSTRACT

Any attempt to identify appropriate compensation for host communities raises ethical issues, whether or not these are explicitly recognised. After drawing attention to a key distinction between ethical acceptability and public acceptability, the paper outlines what the negative and positive impacts of hosting a radioactive waste management facility (RWMF) are likely to be, and suggests that compensation should be proportionate to these impacts, in terms of quantity and type, and chosen by due process. An analysis of the distinction between compensation, bribery and incentives is offered and the conditions under which an offer of reward is likely to be perceived as bribery rather than compensation are discussed.

Broader questions about the psychological relationship between motivation to accept an RWMF and financial compensation, and between financial compensation and the perception of social relationships between the host communities and other parties, are considered. The assumption that compensation must rest on the ability to compare compensation with negative impacts on the same scale is challenged, and comments offered about approaching ethical decision-making in a way that involves critical, reasoned debate rather than quasi-mathematical calculations.

Throughout the paper, attention is drawn to areas where ethical and/or value judgements are unavoidable, with the strong recommendation that these should be opened out for explicit debate. Provisional recommendations for identifying appropriate compensation, (process and outcome), and for ensuring that the relationships between host communities and the rest of society are ethically acceptable, are made. The paper closes with suggestions for further research.

PREFACE

This paper is part of an ongoing programme of research conducted by United Kingdom Nirex Limited (Nirex) and its contractors. It is a component of the research into one of a number of options for the long-term management of radioactive waste in the UK.

The paper began as an attempt to work out how compensation could be distinguished from bribery in the context of rewards offered to communities that agree to host a radioactive waste management facility (RWMF), and to consider the question of what would count as appropriate compensation in any given case. It soon became clear, however, that these questions were part of a broader set of issues concerning the relationships between host communities and the rest of society, with the key question being how to ensure that these relationships are ethical ones. This move from specific to broader issues is reflected in the structure of the paper. The first part, (sections 1 - 2.4) focuses on the sorts of considerations that need to be addressed in identifying appropriate compensation, and the bribery/compensation/incentive distinction is tackled in section 2.5. The later part of the paper (sections 2.6 - 3.3) opens out a range of broader issues, including psychological questions about the conditions under which offers of reward are likely to be perceived as bribes; the relationship between the perception of bribery and the independence of the body offering it; philosophical questions about the nature of ethical decision-making and social justice questions about the relationship between poverty, discrimination, compensation and fairness.

The aim of the paper is in no sense to offer complete answers to these questions. Rather it is to offer an initial survey of the sorts of issues raised by any attempt to identify appropriate compensation, to indicate the breadth and reach of these issues, and to open them out for discussion and debate. Above all, the paper aims to draw attention to areas where decisions about how a host community should be compensated will inevitably involve value judgements and judgements about ethics, and it strongly recommends that these ethical and value judgements should be made explicitly, on the basis of critical, reasoned reflection and debate. More provisional recommendations are offered as answers to the question of how we ensure that the relationships between host communities and the rest of society are ethical ones. These are summarised in section 1.2, and offered fully in section 3.2. These recommendations have arisen from the arguments in the course of writing the paper, and are endorsed by the author. They should, however, be understood in the spirit of attempting to open a dialogue rather than to close it.

EXECUTIVE SUMMARY

Questions about appropriate compensation for host communities, and the distinction between compensation and bribery, inevitably have ethical dimensions. These need to be tackled in the broader context of relationships that exist between host communities and society as a whole. The overall purpose of this paper is to initiate debate about how we ensure that these relationships are ethical ones. It aims to identify ethical issues and value judgements involved in this debate, to open these issues and judgements out for critical debate, to offer some answers in the form of provisional recommendations, and to suggest areas for further research.

Key recommendations include that compensation should *not* be offered by a body that stands to gain financially from agreement to accept it; should *not* be offered as an inducement to act in a way that is unethical or illegal, or that undermines significant social relationships; and should be proportionate to negative impacts. Decisions about RWMF location(s) should be based on criteria independent of the compensation offer and questions about the continuance of the nuclear industry must be kept open and must not be influenced by the outcome of the compensation debate. The processes for making these decisions should include involvement of a wide range of stakeholders, be open, accountable, well-reasoned and sensitive to relevant background contexts eg poverty. Ethical and value judgements should be made explicitly, and on the basis of reasoned debate.

It should be recognised that public acceptability and ethical acceptability are not the same thing and that ethical judgements are informed and developed through critical reflection and dialogue. They can and should be critically evaluated. It should also be recognised that the term 'host community' can obscure important and relevant differences within a group of people, and that the boundaries of a community are often unclear.

Sites for RWMF's must be chosen by due process.

Attempts to identify appropriate compensation assume that there is something to be compensated for. Negative impacts of hosting an RWMF could include actual harms, risk of harms and fear of harms, to a range of goods or values, including human health and well-being; the environment; the community; the landscape; the quality/character of place; reputation and self-esteem. Positive impacts such as job creation or increased infrastructure could also be present. This raises the question of whether the level and kind of compensation should be established independently of positive impacts, or whether they should be considered part of a compensation package.

If compensation is to be appropriate, issues of process as well as outcome need to be considered. The process by which compensation is decided should be open, guided by clear and reasonable criteria, and informed by stakeholder dialogue and relevant expertise. Compensation should not be decided by exclusive use of cost-benefit analysis procedures, and consideration should be given to how the interests of those who will be affected by the siting of the RWMF, but who cannot take part in the decision-making processes, might be represented. Compensation should be proportionate to negative impacts, in terms of both quantity and kind.

What counts as appropriate compensation in this case cannot simply be deduced from existing legislation.

Various preliminary points concerning what is offered, when, why and to whose benefit can be made in attempting to distinguish compensation from bribery and from incentives. These suggest that, for an offer of reward to constitute a bribe rather than compensation or an incentive, the offer must be intended to persuade someone to perform an action or make a decision they would not normally or otherwise do; the action or decision will be illegal or unethical; and persuading the bribee to perform the action/make the decision will benefit the briber in some way. Compensation, by contrast, is not offered with the intention of changing behaviour and does not have the result of persuading the persons compensated to perform unethical or illegal actions.

This analysis initially seems to suggest that, for an offer of reward to be construed as compensation rather than bribery in the circumstances under discussion, the offer of reward (i) must not be made with the intention of persuading the community to agree to be a host community, and (ii) the reward must not be offered as compensation for an action or decision that puts others at risk in a way that would be considered unethical. Given that compensation offers are almost certain to have some influence on the community's decision, the first condition seems to suggest that bribery is inevitable. In response. it could be argued that the rationale behind the judgement that a given site would be appropriate for hosting an RWMF is more important than the intentions of those offering compensation to the host community. The first condition could therefore be amended as follows: (ia) There must be reasons for selecting a potential site or sites that make sense independently of the compensation offer. If this argument is valid, an offer of reward that was intended to influence the judgement of members of a potential host community could reasonably be construed as compensation and not as a bribe so long as there were robust, independent reasons for locating the RWMF on this particular site.

The second condition is also problematic. It suggests that a reward offered for actions or decisions that are unethical - for example, because they entail harm or risk of harm to others - constitutes bribery rather than compensation. Given the time-scale over which radioactive waste remains potentially dangerous, agreeing to host an RWMF would indeed seem to entail harm or risk of harm to others, including others who cannot be party to the decision. Risking harm to others without their consent would normally be construed as unethical behaviour.

In response, it could be argued that the decision which jeopardises non-consenting others is not that of co-operating in the management of existing waste but that of creating the waste. This is not the decision taken by the host community. On the other hand, the host community could be making a decision that jeopardises a particular group of people, and ones with whom they have special relations, such as grandchildren. It is at least clear that the decision to generate energy or deterrence in a way that generates radioactive waste raises serious ethical issues. This suggests that this decision should be regularly reviewed; that risks to people and environment should be minimised; that ways in which future generations and non-humans could be represented in decision-making should be considered; and that the question of where the RWMF is to be hosted should be kept separate from the question of whether radioactive material should continue to be produced. Note that this is not to take a position on the question of whether we should continue to generate nuclear energy and deterrence but to suggest that this form of production (and others) generates unavoidable ethical problems as well as energy, and should be kept under review.

A necessary though not sufficient condition of bribery is that the offer of reward, if successful, will benefit the person or body offering it. In addition, the offer is more likely to be

perceived as a reward if the body offering it stands to gain. In this case there is more chance of reward being perceived as compensation if the body offering it is independent from the nuclear industry. Further "contextural, procedural and consequential" conditions, under which offers of reward are more likely to be perceived as compensation rather than as bribes, are outlined.

There is evidence to suggest that, where a community has an intrinsic reason - such as willingness to contribute to the public good - to accept a so-called NIMBY facility, offers of financial compensation reduce rather than enhance this willingness. One possible explanation is that the offer transforms an ethical relationship into a monetary one in a way that undermines the initial motivation through loss of self-control and/or impaired self-esteem. This raises tactical and ethical issues for the hosting of RWMF's, at least in cases where civic motivation is present. Possible responses include non-financial, socially beneficial forms of compensation (eg schools) or community ownership of the facility in a way that enhances control. Further evidence suggests that the way compensation offers are perceived and reacted to will vary according to the kind of social relations that exist between the parties involved, and on the norms of behaviour associated with these relations. This suggests that in seeking to identify appropriate compensation, attention should be paid to the way members of a potential host community understand the relationship between themselves, the waste management facility, and those offering compensation. A further point is that compensation offers can cause offence, for example, if offered for serious injury or loss of life.

It is sometimes assumed that compensation requires direct comparison between the compensation and the negative impacts being compensated for, and hence that, where these are different in kind, a common scale is required. Classical utilitarianism, and decision-making procedures based on it, make this assumption, with the common scale often taken to be money. On this view, the aim of compensation is to balance the benefits of compensation against the costs of the negative impacts, and to do this a monetary figure must be put on both.
But it can be argued that some values cannot be converted into monetary currency, and that money is not a neutral measuring rod. For example, some social loyalties and value commitments can be understood as *constituted* by a refusal to treat them as tradable commodities. To accept a price in these cases is an act of betrayal, and to offer a price is an act of bribery that erodes the relationships in question. This in turn amounts to an erosion of human well-being as these kinds of relationships are, arguably, central to a full human life. Thus a significant question becomes whether there are circumstances in which agreeing to host an RWMF, and to accept compensation for this, could be construed as a betrayal of the kinds of relationships or values that are constituted by a refusal to put a price on them. If so, compensation should perhaps be of a kind that honours the relationship commitments in question (eg a school). It is at least arguable that in these circumstances compensation should be refused or, better, not offered.

It is suggested that in some circumstances, perhaps including the one under discussion, there may be no ethically unproblematic option, no clear right answer. This is in contrast to the view that costs and benefits can always be reduced to a common scale which in effect denies the possibility of genuine ethical dilemmas. It is argued that the view that rational decision making requires the trade-off of costs and benefits in this way is mistaken. Where decisions have an ethical dimension what is required is not an algorithmic approach but dialogue and deliberation to establish and critically assess the rationale behind different positions and different values. This is not found in cost benefit analysis, which effectively

treats values as subjective preferences and hence as not open to critical assessment. Moreover, approaches that aim to balance costs against benefits can be compatible with violations of rights, and the belief that there is always a right answer can lead to ethical complacency rather than to a commitment to reviewing the context in which a no right answer situation has arisen. In this context, an awareness that all options for the management of radioactive waste have ethical drawbacks should lead to the question of whether to continue energy and deterrence production in this way being continuously under review.

The underlying aim of compensation can be perceived in different ways, for example, as an attempt to trade-off costs against benefits (consequentialist); to fulfil a set of obligations (deontological); or to meet the goal of acting virtuously.

In conclusion, questions about how communities who agree to host RWMF's should be compensated cannot be answered without making a range of value judgements and without raising related ethical issues, including what the nature of the compensation ought to be, who should make the value judgements involved in deciding this, and by what process. Three further points are, first, that assumptions about how decisions with ethical dimensions should be made are not neutral in terms of the values embedded in them or the decisions they are likely to generate. These assumptions, as well as those about the underlying aim of compensation, should be opened out for critical scrutiny. Second, an ethical relationship between society and the host community will not be achieved if the main reason that the community agrees to accept an RWMF, and the compensation that goes with it, is pre-existing poverty. This raises important outstanding questions about the relationship between ethical decision-making and social justice. Third, since all forms of energy production have implications for the well-being of people and the environment, the relationship between the ethical issues raised by radioactive waste management, and the management of other forms of energy related waste, would be worth exploring.

Questions about appropriate compensation for communities that agree to host an RWMF should be considered in conjunction with a broader set of questions about the relationships between the host community and the rest of society. For these relationships to be ethical, it is argued that a range of requirements concerning both process and outcome need to be met and that the debate should include reference to the broader context of energy consumption and generation.

Questions for further research include whether and how issues of pre-existing poverty and social injustice affect ethical decision-making in this context; how effective forums for the discussion and resolution of issues with an ethical dimension could be created; how decision-making procedures in which the interests and values of future generations and others might be represented; and how the ethical issues raised by nuclear energy production compare and relate to those raised by the production of energy by other means.

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1 INTRODUCTION, RECOMMENDATIONS AND PRELIMINARY POINTS

1.1 Introduction and aims

The context for this paper is as follows.

- Society as a whole, which in this case means residents of the United Kingdom, benefits from the consumption of electricity, including that generated by nuclear power plants, and from nuclear deterrence.
- This form of electricity generation and deterrence produces radioactive waste.
- A small sub-section of society will be selected, by a legitimate process, as a host community for a facility for managing this waste.
- The host community will bear a particular set of negative impacts that society as a whole will not. It could also accrue specific positive impacts (for example, jobs).
- The host community couldreceive benefits for the negative impacts.
- These benefits could bein addition to those resulting from electricity consumption and deterrence.
- The cost of providing these benefits will be borne by society as a whole.

The paper began as an exploration of two questions: what would count as appropriate compensation for communities that host radioactive waste? And, how can compensation be distinguished from bribery in this context? In the process of trying to answer these questions, it became clear that they were part of a broader set of issues, and could not be separated from them. These issues all have ethical dimensions to them. One purpose of this paper is to identify and draw attention to these ethical issues, and to the ethical and value judgements that will inevitably be made in responding to them.

Any attempt to identify appropriate compensation for host communities raises issues that are ethical in nature. Most obvious of these is what this compensation ought to be; others include who should make this decision and how. What sort of information is available about the implications of hosting a waste management facility? How is this information presented and who does and does not have access to it? Who has authority, power, or the right of veto in this context? And so on. Ethical judgements will be made in selecting the process by which decisions about appropriate compensation are reached, as well as in selecting appropriate compensation itself.

The question of what constitutes a legitimate process for the initial selection of the host community is also fundamentally ethical in nature. Although it is not the purpose of this paper to try to work out in detail what would count as a fair or due process in this regard, some outline comments will be offered. This is because it is at least arguable that an attempt to establish appropriate compensation for a host community cannot be separated from questions about the nature of the process used to select that community in the first place. Conversely, questions about what will happen to the host community will clearly inform the site-selection process. These issues may thus sometimes need to be considered together.

The concerns outlined above shade into a broader set of ethical questions relating to the social context within which the matter of compensation is to be resolved. What is the nature of the relationships that are already in place between ‘society as a whole’ and the host

community? For example, what sorts of decision-making processes already exist for making decisions about compensation, and who takes part in these processes? Who identifies the negative impacts *as* negative and who decides whether/at what point it is reasonable to expect a host community to bear them? Is the host community significantly poorer than other parts of society? Does it already play a role in bearing the negative impacts of the nuclear industry? Is the host community in any way disenfranchised in terms of political or economic power*? And so on.

Thus, although the question, how should communities who host radioactive waste management facilities be compensated? may initially appear to involve a (relatively) simple comparison of negative impacts on the one hand with positive impacts and benefits on the other, it rapidly becomes clear that identifying appropriate compensation also, and crucially, involves examining and evaluating the social structures that provide the background for these issues. Questions about appropriate compensation are, therefore, only one aspect of a more fundamental concern, namely, with *how we ensure that the relationship between society as a whole and the host community is an ethically acceptable one.* Significant ethical issues arise, not just in relation to the comparison of benefits and negative impacts as independent end products, and the process by which this is done, but also with regard to the broader set of relationships and social structures within which this comparison is taking place. It is this range of issues, questions and judgements that form the heart of this paper.

The purpose of the paper is to open up a discussion around the central ethical concern identified above as ***how we ensure that the relationship between society as a whole and the host community is an ethically acceptable one.*** The aims of the paper are:

- to identify key ethical issues raised by this central concern;
- to begin an exploration of these issues and to invite further discussion;
- to identify specific areas in the debate about compensation and host communities where value judgements and/or judgements about ethics are unavoidable;
- such judgements are often made implicitly: a function of this paper is to draw attention to them so that they can be opened out for critical discussion, and then made explicitly, on the basis of reasoned debate;
- to offer a preliminary set of recommendations;
- to indicate some of the areas where further research and discussion would be of value. These are listed at the end of the paper in section 3.3 and indicated in the text with an asterix*.

The paper should be read as work in progress and not as a polished and finalised piece of research.

1.2 Summary of key recommendations

It is argued here that, in order for the relationship between host communities and the rest of society to be an ethically acceptable one, the following general recommendations will need to be observed:

- ethical judgements and value judgements should be identified and not made by default
- ethical acceptability and public acceptability should not be taken to be the same thing
- compensation should be both proportional and appropriate in relation to the negative (and positive) impacts involved

- compensation should *NOT* be offered as an inducement to act in a way that is unethical or illegal, or that undermines significant social relationships
- compensation should *NOT* be offered by a body that stands to gain financially from the agreement to accept it
- decisions about the location of radioactive waste management facilities should be made on the basis of criteria that are independent from the compensation offer
- questions about whether energy and deterrence should continue to be produced using nuclear technology must be kept open and must not be influenced by the outcome of debate on compensation for host communities

moreover,

- there should be consistent and significant involvement of a wide range of stakeholders from an early stage in the decision-making processes
- decision-making processes should be open and accountable
- decisions should be made in a way that elicits and refers to the reasoning behind different points of view and not just how strongly they are held
- decisions should be made in a way that is sensitive to the background context, e.g. relative levels of poverty

These points should be taken as applying to a range of different decisions, including how negative and positive impacts are to be identified, how host sites are to be selected and what compensation is to be offered.

1.3 Preliminary points

a) ethical acceptability and public acceptability

There is an increasing emphasis on the need for decisions about radioactive waste management to be publicly acceptable, both in the United Kingdom, and elsewhere. For example, the Swedish document, *Responsibility, equity and credibility - ethical dilemmas relating to nuclear waste* (2001), opens with the following statement:

"High-level radioactive waste and spent nuclear fuel are inevitable by-products of nuclear power. Finding a long-term solution for disposing of these dangerous materials… is not just a question of developing technology and disposal sites that will protect people and the environment from radiation over long time spans; *it is also a question of finding solutions that are acceptable to the public." 1* [my italics]

The emphasis on public acceptability has generated an increase in public involvement in decision-making about radioactive waste, in the form of consensus conferences, public meetings, seminars and so on. Clearly, public involvement and public acceptability must be key components of a long-term strategy for radioactive waste management, for both ethical and tactical reasons. However, it is important to make the point that they are not enough in themselves to ensure that the decisions reached will also be ethical ones. This is because ***public acceptability and ethical acceptability are not the same thing***. A decision could be both accepted by the public (typically meaning the majority) and ethically unacceptable. The often cited alleged majority in favour of reintroducing hanging is, arguably, a good example here. Similarly, while public involvement in decision-making may be necessary if the decision is to be ethical, it is not sufficient. That there is a high degree of public involvement in decision-making does not guarantee that the outcomes will be ethical ones.

A different way of making this point is by pointing out that a requirement to find solutions that are acceptable to the public does not mean, find *any* possible way of getting the public to accept these solutions. Certain kinds of approaches to acquiring public acceptance, such as withholding relevant information, deception, brain-washing, bribery or threat, are implicitly ruled out. These are ruled out on ethical grounds, not according to whether or not they would work. In other words, an ethical position is already implicit in the concern to make solutions acceptable to the public, and it is this concern that is in fact the primary one. Both concerns should be kept explicit. Solutions must be ethically *and* publicly acceptable.

Why is it important to separate these concerns?

- because if the focus is only on how to gain public approval, there is a real danger of the exercise becoming solely a public relations one rather than an ethical one;
- because if it is assumed that ethical and public acceptability are the same thing, we lose sight of the fact that just because someone thinks that something is right and ought to be done, it doesn't follow that this thing *is* right and ought to be done.

The underlying point is that ethical decision-making requires reflection and critical deliberation on the rationale behind different points of view. We need to know *why* the majority or 'the public' think something should be done before we can tell whether doing it would actually be the right thing. Ethical judgements can and should be critically evaluated. Some are held on the basis of better grounds than others or are based on more humane

principles. Ethical and value judgements need to be informed and developed as a process of critical reflection and dialogue.

Some, but by no means all, methods of public consultation involve processes of dialogue and critical discussion. Some simply involve eliciting currently held opinions and then entering these into a decision-making process that is indifferent to the reasons why these opinions are held. Part of an attempt to ensure that host communities are treated ethically might be, therefore, to create forums where constructive and rigorous ethical deliberations can take place.**

b) what is a 'community'?

There is a danger of talking about 'the host community' in a way that implies that it is a homogenous group, when in fact it is likely to include a wide range of people with disparate interests, values and different perceptions of risk. For example, pregnant women, or parents with children, may well have very different attitudes to risk from male teenagers. There are thus important issues about how different interests, attitudes and values *within* the host community are to be fairly represented in the decision-making processes.

A further set of issues arises with regard to the boundaries of the host community. Where does the host community end? Is it contiguous with the district council or the county council, or is it defined by other criteria altogether? If the site is in or near a national park, does the host community include those who regularly visit the area?

The point here is not to try to answer these questions but to draw attention to them, and to suggest that the notion of a 'host community' can obscure important and relevant differences within a group of people. It will be assumed that this caution is borne in mind when the term 'host community' is used in this paper.

2 IDENTIFYING APPROPRIATE COMPENSATION

2.1 Site-selection process

It can be argued that, in any given case, it will be inappropriate to consider the question of fair compensation unless the community that is to host the waste management facility has been, and can be seen to have been, chosen by due process.

In outline, a fair or due process will be one which is:

- genuinely open; i.e. not intended to reach a prearranged outcome
- guided by criteria that are clear, explained and reasonable
- informed by debate and dialogue held by well-informed representatives of all significant stakeholders and carried out at local and national levels
- is consistently sensitive to the question, whose interests are not represented and whose voices are not being heard?

This generates the need for an imaginative approach to deliberative decision-making procedures, that will constitute an effective extension of current democratic process. Establishing the exact nature of these procedures is beyond the scope of this paper. Clearly, however, it is necessary for both ethical and tactical reasons to find ways of moving beyond the so-called "decide-announce-defend" approach to decision-making procedures; and beyond any other procedures which are not open to public scrutiny or in which public consultation plays a minimal role.

In short, a due process will be one which:

- can generate robust answers to the question, "why us, and was it fair?" (or better, one in which this question would never arise);
- pays serious attention to deliberation carried out between a broad base of representatives;
- can demonstrate, and show the validity of, the chains of reasoning involved.

Throughout this paper it will be assumed that the site or sites will have been chosen by a process that meets these and any other conditions held to constitute due process. 2

2.2 Effects on the host community - negative and positive impacts

The attempt to identify appropriate compensation rests on the assumption that there is something to be compensated *for*. Chambers Twentieth Century Dictionary defines the verb,

to compensate: (from the Latin *compensare,* to weigh one against another) "to make amends for, or to recompense: to counterbalance" and,
compensation: "act of compensating: amends for loss sustained".

In ethical and in legal contexts, compensation would typically be understood as the attempt to make amends for perceived or actual loss, injury, harm or damage, to persons or

property; or for the imposition of certain levels of risk - although legal dictionaries tend to define compensation more narrowly than this. For example,

“Payment for loss or injury sustained, e.g., as under Criminal Damage Act, 1971, s8” 3 or simply,

“Monetary payment to compensate for loss or damage.” 4

The notion of compensation will be used in the broader sense in this paper.

a) negative impacts

In the context under discussion, compensation would be to a particular community, for the negative impacts considered to follow from agreeing to host a radioactive waste management facility. A first question, then, is what these negative impacts are likely to be.

There are a range of possible impacts that would be relevant here. These can be divided into:

(i) actual harms;
(ii) risk of harms;
(iii) fear of harms***

i) actual harms

- to *human health*, physical and/or mental, now and in the future
- to *human well-being*, including peace of mind and happiness, now and in the future
- to the *environment*, including ecological systems and processes, and individuals of other species, now and in the future
- to the *community*, for example, harm to the local economy via loss of income from tourism; from ‘blight’: the reluctance of companies to invest in the area and the consequent impact of this on local economic and social development
- to the *aesthetic value* of the *landscape*. This consideration featured strongly in Cumbria County Council’s case at the Nirex RCF Inquiry (1995-96). The County Council argued against the Sellafield site, on grounds “that the RCF surface development adversely affects landscape and rural character and in particular adjoining Lake District National Park”. 5 Aesthetic impact (as well as safety considerations) also featured in the Secretary of State’s reasons for rejecting the RCF (1997) “the adverse impact on visual amenity…and the natural beauty of the National Park caused by the surface elements of the proposed RCF are serious and …. warrant refusal of the application.” 6
- to the *character/quality/nature of the place*. In focus groups conducted by Lancaster University, (see *Front of the Front End* paper), a recurring theme was people’s conviction that the waste management facility would change the place they live into a place they want to leave. This often lead to a desire to go away and start a new life somewhere else - in uncomfortable tension with the recognition that family ties, economic constraints, etc, may make this unfeasible. 7
- to *reputation and self-esteem.* There is an important point here about social stigma and self esteem. For example, the opinion was voiced at a recent Cumbria County Council meeting that the West Coast of Cumbria is perceived by outsiders as a dumping ground for radioactive waste and dead cattle. 8

ii) risk of harms

- to human health, mental and/or physical, now and in the future
- to human well-being, current and future
- to the environment, current and future
- to the community
- to the landscape
- to the character/quality/nature of the place
- to reputation and self-esteem

iii) fear of harm

Fear of harm is not necessarily the same as risk of harm. Fears can, arguably, be more or less rational or justified. Difficult questions arise about the extent to which compensation would be owed in cases where the fear was held to be completely groundless. But it should be noted that fears held to be groundless can still have a detrimental impact on people's lives and well-being. They are thus not unreasonable candidates for compensation. In *Front of the Front End*, for example, people expressed awareness that their fears might not be justified, but indicated that these fears still adversely affected their lives. 9

Possible negative impacts on the host community can, then, be sketched in as above, and further information about the nature of negative impacts in previous particular cases can be found in the sources referenced below. 10

Clearly, the nature of the actual or likely negative impacts in a given case will need to be established in order to identify appropriate compensation. But a preliminary set of ethical issues can already be identified. Describing something *as* a negative impact involves making a value judgement: it does more than give factual information, it describes the thing as *undesirable* in some respect. Value judgements will thus already have been made, implicitly or explicitly, before the issue of compensation is even raised, simply in virtue of talking about negative - or positive - impacts. Deciding whose views about what counts as negative are to be acknowledged and whose are to be disregarded involves making further value judgements. Both sets of value judgements have ethical implications in this context.

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Ethical issues/value judgements:

What counts as a negative or a positive impact?

Whose views about what counts as negative or positive impacts ought to be taken into consideration?

Arguably, the question of what counts as negative and positive impacts should itself be open to public discussion and debate, and not decided in advance of this debate by 'experts'.

A further point is that there will be levels of negative impact considered inappropriate for any community to bear, no matter what compensation might be offered. Examples would be if the risk to human health were very high, or the 'blight' effect so great that quality of life were radically undermined. For example, in a Swiss study of the decision-making process for

siting a municipal waste disposal facility (landfill), "[a]ll groups were convinced that a substantial health risk was unacceptable". 11

In many cases, certain kinds of negative impacts have already been judged as unacceptable. In the UK, for example, ethical judgements to this effect are embedded in the regulatory mechanisms. Significant harm to human health, or particular kinds of environmental damage, would be examples. Such impacts are dealt with, not via a mechanism for compensation, but by the existence of a regulatory system and framework designed to ensure that these impacts do not occur. These regulatory mechanisms need to be working, and seen to be working. *That such mechanisms exist, however, in no sense indicates that the ethical judgements implicit within them cannot or should not be reviewed.*

Ethical issues/value judgements: At what point should negative impacts be considered too high for any community to bear? Who should decide this, and by what process?

b) positive impacts

The implications for a community that agrees to host a radioactive waste management facility might be positive as well as negative. Positive impacts could include, for example, job creation or increased infrastructure; and these could be benefits that are both immediate and that persist over longer time-scales.

Questions follow from this about the relationship between positive impacts and compensation. The kinds of positive impacts referred to here would not have been intended as compensation, and they would have arisen independently of the compensatory process. They could, nevertheless, be considered as constituting part of the compensation package when this is calculated. Alternatively, it could be argued that compensation should be considered and established only in relation to the negative impacts of the facility.

If positive impacts were considered part of compensation, issues about commensurability would be raised. In what sense does an increase in jobs (for example) compensate for an increase in fear of harm to health? The question of commensurability arises with any form of compensation, and will be returned to below.

Particular to this context are questions about fairness that arise if positive impacts are included as part of the compensation package. With regard to the fairness of the *process,* it might be held that it is unfair to include positive impacts in the process of calculating compensation; that, as a point of principle, the amount and nature of compensation should not be affected by positive impacts that were not intended as compensation and that arose independently of the compensation process.

On the other hand, if compensation were established independently of any positive impacts, this could be held to result in unfair distribution. Communities in which the presence of a waste management facility did not lead to positive impacts but only negative ones would end up with less overall benefits after compensation than communities in which the presence of the facility did lead to positive impacts - for these would stand in addition to compensation.

This illustrates a tension that is not uncommon between procedural justice and distributional justice. (The classic case is Robin Hood: robbing from the rich to help the poor can be seen as violating (some notions of) procedural justice in order to further (some notions of) distributional justice).

In this case, (some versions of) procedural fairness would suggest that compensation should be established independently of positive impacts, while (some versions of) distributional justice would suggest that positive impacts be considered part of compensation, at least if there is to be more than one host community and if positive impacts are likely to differ.

A further point is that the presence of positive impacts would effectively reduce the amount of compensation to be provided. This could be considered an unmerited advantage to the provider of the compensation.

Ethical issues and value judgements:

Should the existence of positive impacts influence the amount and nature of compensation offered in relation to negative impacts? If so, what form should this influence take?

2.3 Appropriate compensation

a) process

Suppose, then, that a process for identifying negative and positive impacts has been identified, and conclusions reached about what the relevant negative and positive impacts are in a given case. Judgements will then need to be made about how compensation that is appropriate, given these impacts, is to be decided. What process should be used, and who is to be involved in it? A key issue will be the extent to which members of 'the public' are to be involved.

Arguably, the question of appropriate compensation should itself be open to public deliberation, with dialogue and debate at national and local levels. Constructing a fair process in this context will thus involve considerations similar to those outlined in the context of host community selection. In outline, a fair process will be one which is:

- genuinely open; i.e. not intended to reach a prearranged outcome
- guided by criteria which are clear, well explained and reasonable
- informed by debate and dialogue held by well-informed representatives of all significant stakeholders and carried out at local and national levels
- can demonstrate, and show the validity of, the chains of reasoning involved
- informed by relevant expertise including ethical/philosophical - i.e., expertise that can reveal the presence of value judgements and offer some analysis of these. This will be in addition to scientific and technical expertise.

In addition, it will be argued here that the identification of appropriate compensation

- should NOT be made exclusively or primarily by utilising a cost-benefit analysis comparison of negative impacts with the benefits of compensation. This point will be developed below (see section 2.8).

A further key issue will be that of how to develop a process for identifying appropriate compensation in cases where some of those to be compensated cannot take part in the process. This might be, for example, because they are young children. There are a number of contexts in which adult representatives are appointed to represent the interests of children who are affected by decisions they cannot be party to. That future generations of people are likely to be affected by the negative impacts of the facility, and may therefore merit compensation, raises more complex issues, as does the possible impact on a range of non-human species and the environment in general. How to design ways of effectively and fairly representing the interests of future generations and non-humans is clearly a key challenge here****.

Ethical issues/value judgements:

Who should be involved in the process of identifying appropriate compensation, and what should this process be?
Should we try to take into consideration the interests of those who cannot take part in this process and, if so, whose interests and how should this be done?
With regard to future generations, how far into the future should compensation be required to reach?

It will be assumed here that the process for identifying compensation will be developed in a way that responds to these challenges and that meets the criteria outlined above, as well as any other criteria that might be identified at a later date. It could then be argued that appropriate compensation will be whatever is decided upon as a result of this process. It will be suggested here, however, that some independent criteria constrain what will count as a fair outcome of this process, and that these criteria can be identified in advance of the process. For example, the compensation will need to be proportionate in quantity, and of the right kind.

b) proportionality - negative impacts and quantity of compensation

Compensation can be inadequate in terms of quantity - for example, a small amount of money for a very serious injury. This raises a series of difficult questions about how the seriousness of different harms, risks and fears is to be quantified, and how this scale of seriousness is to be related to the quantity of compensation.

In whatever way these questions are eventually answered, there is clearly a sense in which we meaningfully say, for example, that losing a leg is a more serious harm than losing a toe, or that the risk of contracting leukaemia is more serious than the risk of flu; and that compensation should be proportionate to the seriousness or weightiness of the risk or harm or fear in question.

Compensation can be disproportionate in being inadequate. Compensation could also be disproportionate by being excessive. For example, if the negative impacts on the host community turn out, in fact, to be relatively minor, huge amounts of compensation could be both intrinsically disproportionate and amount to unfairness towards the rest of society, which is footing the bill.

Ethical issues and value judgements:

What constitutes proportionality between compensation to the host community and the negative impacts borne by this community?
Who should decide this and by what process?

c) propriety - negative impacts and *kind* of compensation

It may well be the case that different kinds of compensation will be appropriate for the different kinds of negative impacts that could be incurred by the host community.

Compensation needs to be appropriate in the sense of effective and fitting; in the sense of being a suitable kind of response to the negative impact in question. For example, counselling and the provision of information could be an appropriate response to certain sorts of fear; while actual harms, for example, to health, would call for other forms of response - including treatment - which in turn would not make sense if the impact is a risk. Those who see themselves as stigmatised by the presence of radio-active waste often argue that appropriate compensation should include improved infrastructure and the development of high-status jobs - and so on.

Ethical issues and value judgements:

What counts as appropriate compensation for a given set of negative impacts?
Who should decide this and by what process?

2.4 Legal compensation

There are, of course, a range of existing contexts in which various forms of compensation may be offered in recompense for harm, risk of harm or fear of harm; and a range of legal guidelines for identifying the sort and quantity of compensation held to be appropriate in particular cases. Three points should be made in response to the optimistic thought that existing guidelines could be used to decide appropriate compensation in this case.

First, it can be argued that there is something unique about radioactive waste management, the kinds of harms it may entail, the length of time for which these harms persist and the way radioactivity is perceived and understood - the sorts of social meanings it has for people.

Second, even supposing that guidelines exist for the compensation of harms that are relevantly similar to those under discussion here, the existence of legal guidelines is no guarantee of their ethical adequacy. Current levels of compensation for industrial accidents in British law, for example, are often held to be unacceptably low and significantly out of proportion with what losing a leg actually means in terms of a person's subsequent need to rethink their life plans, deal with pain, disability and the overall impact on their quality of life. Compensation *could,* of course, be adequate; but it won't necessarily be.

Third, in existing legislation and literature on compensation, the identity of the person(s) to be compensated is usually clear. In this case, however, while those to be compensated will include current members of the host community, (whose identity will presumably be reasonably straightforward) they will also include people who are to live in this community in

generations to come. Key questions here, as already indicated, will be how far into the future compensation is required to reach and how we identify appropriate compensation for people who are not yet alive, and cannot take part in debate.

In short, while current compensation legislation is certainly worth examining with a view to what light it may shed on the current issue, it will not be possible simply to deduce what counts as appropriate compensation for host communities from existing legislation.

2.5 Compensation, bribery and incentives

If compensation is perceived as bribery, it may act as a disincentive to accept whatever is being compensated for (see section 2.7). In addition, bribery is considered unacceptable for ethical and not just tactical reasons. What distinguishes bribery from compensation and incentives?

Compensation: to make amends (to someone) especially for loss or injury.
(The Collins Paperback English Dictionary)
Incentive: that which incites to action (Chambers Twentieth Century Dictionary)
Incentive: a motivating influence; stimulus; an additional payment made to employees to increase productions (The Collins Paperback English Dictionary)
Bribe: a sum of money or another reward offered or demanded in order to procure an (often illegal or dishonest) action or decision in favour of the giver (New Shorter Oxford English Dictionary).
Bribe: something offered to influence the judgement unduly or corrupt the conduct (Chambers Twentieth Century Dictionary).
Bribery: the offence of taking, or bestowing, or promising, a price, reward or favour intended to influence the judgement or conduct of a public official. In its legal sense it implies corruption. Eg Gardner v Robertson 1921 SC 132. (L.B.Curzon ed; Dictionary of Law).

In an attempt to identify the features that distinguish bribery from compensation or from incentives, a number of preliminary points can be made as follows.

a) what is offered

- the fact that money is offered is neither necessary nor sufficient to constitute a bribe
- not all forms of financial reward constitute bribery
- bribery is not limited to money - bribery can be achieved with material goods, or opportunities (opera tickets, hotel rooms)
-
- what is offered has to constitute a ‘reward’ of some sort

b) when it is offered

One obvious thought is that while compensation is normally offered retrospectively, bribery is done in advance. But this is not an adequate way of distinguishing between the two.

- if it were *known* that compensation would follow the installation of a radioactive waste management facility, knowledge of the compensation could act as a bribe, even if the actual hand-over of the money or goods were after the event

- incentives are offered in advance, but do not normally constitute bribery

c) why it is offered

What we *can* clearly say is that

- a bribe is offered in order to persuade someone to act or to make a decision they would not normally or otherwise do or make

the action or decision

- involves harm or risk of harm to others, now and/or in the future
- is in other ways unethical, or goes against the principles of the person being bribed, or is illegal

The purpose of an incentive is also to give someone a reason to act in a way they would not do otherwise, such as work harder, or take risks. In this respect it is similar to a bribe. The difference is that the cost involved - the extra work or the risk (for example, when divers are paid 'danger money') - is borne by the person accepting the incentive.

Where there is a cost or negative impact that will be borne by someone other than the person accepting the incentive, the reward is open to being construed as a bribe. It would definitely constitute a bribe in cases *where agreeing to negative impacts that will affect others amounts to unethical behaviour.* Similarly, if the action encouraged by the reward is unethical, illegal or unprincipled in other ways, accepting/offering the reward is a case of bribery rather than incentive.

d) who benefits

A further feature of a bribe is that

- it is offered in order to influence actions or decisions in a way that is beneficial to, or in the interests of, the briber

Again, this may also be true in the case of an incentive, for example, when an employer offers an incentive to employees to work harder. Thus, in order for a reward to be construed as a bribe rather than an incentive or as compensation the following must all be the case:

Bribe:

- intended to persuade someone to perform an action or make a decision they would not normally or otherwise do
- the action or decision is illegal, or is unethical, either in that it entails unacceptable levels of risk or other negative impacts for others, or in other ways
- persuading the bribee to perform the action/make the decision benefits or is in the interests of the briber in some way

In contrast,

Compensation:

- is not offered with the intention of changing behaviour
- does not have the result of persuading the persons compensated to perform unethical or illegal actions

Incentives:

- intended to persuade someone to perform an action or make a decision they would not normally do otherwise
- action or decision is not unethical or illegal
- action or decision may be in the interests of those offering the incentive
- may entail risks to the person accepting the reward, but not to others
-

e) conditions of compensation

If this analysis is correct, it seems to suggest two conditions that would need to be met if offers of reward to communities considering whether or not to accept a radioactive waste management facility (RWMF) are to be construed as compensation rather than as bribery. These conditions are:

(i) The offer of reward must not be made with the intention of persuading the community to agree to be a host community.
(ii) The reward must not be offered as compensation for an action or decision that puts others at risk in a way that would constitute unethical behaviour, or that is illegal, or that is unethical in other ways.

On first sight, both conditions suggest that keeping on the side of compensation rather than bribery will be extremely difficult. Indeed, the first condition initially seems to imply that, in such a context, bribery is inevitable. The availability of compensation is one of the factors that will be included in discussion and it will almost certainly influence the decision. Moreover, to be realistic, one of the reasons for offering it will be in order to persuade a community to agree to host a RWMF.

One response would be to suggest that the question of compensation should not be discussed until after a decision about where the facility has been sited has been reached. But this goes against a range of conclusions about the importance of involving host communities in discussions from a very early stage. A second response would be to concede that offers of reward in this context do in fact constitute bribery. A third response, which is favoured here, would be to argue for a modified condition (i) as follows.

For the offer of a reward to constitute compensation rather than bribery:

(ia). There must be reasons for selecting a potential site or sites that make sense independently of the compensation offer.

These reasons will, presumably, take the form of a set of criteria referring to geological, geographical and other features of potential sites. These criteria should not simply be chosen and announced but should be informed by a process of public debate and deliberation, so that members of potential host communities will have been involved in their selection. The rationale behind the criteria should be transparent, well explained and understood to be robust. In short, the judgement that this is an appropriate site for a waste management facility must be made on the basis that this is a good site judged according to a range of appropriate and appropriately chosen criteria.

Why might it be legitimate to modify condition (i) to (ia) in this way? It was argued that a feature of bribery is that its intention is to influence judgement. It is this feature that seemed to suggest that, in order to distinguish compensation from bribery, it needs to be established whether there was an intention to influence judgement by offering a reward and/or whether the judgement was in fact influenced by this offer. But it could be argued that the more important concern is with *the nature and grounds of the judgement that this is an appropriate site for hosting a RWMF*. If there are good independent grounds for the choice of potential sites then there is a sense in which the intentions of those offering compensation for agreeing to accept a RWMF on such a site are not all that relevant. If this judgement makes sense independently of any offer of reward then, (assuming this argument to be a valid one), the offer can be understood as compensation rather than bribery - and this can be the case even if there is evidence to suggest that intention to influence the judgement was a feature of the situation. Needless to say, it would be a clearer case of compensation rather than bribery if this intention were not present.

The second condition claims that *you cannot compensate someone for agreeing to act unethically*. The notion of compensation does not make sense here. If a person is persuaded by reward to act unethically, the reward is a bribe. It cannot be construed as compensation.

The question here, then, will be whether agreeing to host a radioactive waste management facility will harm or risk causing harm to people or the environment or animals in a way that is unethical. Agreeing to something that will or might harm oneself would not normally be considered unethical. So risks to those party to the agreement will probably not be ethically problematic - provided that the agreement is genuinely reached without coercion and with a full understanding of the implications. But agreeing to something that will or might harm those *not* party to the agreement is much more problematic. To a certain extent, whether agreeing to something that risks harm to these groups is unethical, and hence whether the offer of reward is compensation or bribery, will depend on how serious the risks and harms are. The actual nature of the negative impacts of the facility will thus be important in distinguishing compensation from bribery. If the negative impacts of the RWMF are, say, more traffic, and some planning blight, then, arguably, the offer of reward could constitute compensation rather than bribery, even if the negative impacts will affect those not party to the agreement - because imposing these less serious impacts on others would not necessarily amount to unethical behaviour.

The problem is that, given the nature of radioactive waste, and the length of time for which it remains potentially extremely dangerous, it is inevitable that the negative impacts will include some degree of risk of serious harm to future generations of human beings, and to present and future generations of non-humans, none of whom can give their consent. Given that exposing others to significant risks without their consent is normally considered unethical, the second principle also seems to suggest that any attempt to compensate for agreeing to host radioactive waste management facility will in fact amount to bribery.

A response to this refers to the fact that the radioactive waste that constitutes the ethically problematic risk in question already exists. The community is not agreeing to accept compensation in exchange for the *creation* of the waste, but in exchange for co-operation in the *management* of it, by agreeing to let this happen in a particular place. So in a sense the community is not making a decision that jeopardises future generations - this decision has already been made. On the other hand, community members could be agreeing to jeopardise a particular group of future people, and those with whom they have special and ethically significant relations with, for example, their children and grand-children.

f) choosing between undesirable options

It seems that the following at least is clear.

- there is a serious question about the ethics of agreeing to something that will pose significant risks to those not party to the agreement
- agreeing to the production of radioactive waste must be seen as falling into this category
- therefore there is a serious question about the ethics of deciding to *generate* radioactive waste or to use nuclear deterrence

This does not necessarily mean that the decision to produce energy or deterrence in this way should not have been made, all things considered (see section 2.8). However, it does suggest that the conditions under which the production of radioactive waste have been judged to be a reasonable thing to do, and the claimed need for energy produced in this way, should be kept under constant review. And it also suggests that the compensation case under discussion is inevitably carried out in a context which is ethically problematic - there is a sense in which we are bound to be dealing with a set of options, all of which are undesirable in some way.

How might this situation be mitigated? One reason why the action of agreeing to accept reward for hosting a RWMF could be deemed as inevitably unethical (and rewards deemed as constituting bribery rather than compensation) is because it will have serious negative implications for future generations of people and for current and future generations of non-humans, neither of which groups can take part in negotiation about compensation.

- clearly, then, there is an absolute priority on keeping risks to people and environment to minimum. But this presumably goes without saying. Less obviously, perhaps,
- one way forward would be to try to devise ways in which future generations and non-humans can meaningfully be represented in negotiations about issues that significantly affect their interests.

Again, it is worth pointing out that we are in fact familiar with legal and other forms of representation for infants and young children who cannot be party to negotiations that affect their interests, so this recommendation may be less problematic than it first appears.

Further, it is argued here that the deliberate production of a substance known to be potentially lethal to various forms of life, including human, over thousands of years, is inevitably problematic from an ethical point of view. This strongly suggests that:

- if there is any possibility that agreeing to host a RWMF will amount to a partial or full legitimisation of continued radioactive waste production then the compensation/bribery distinction will be seriously eroded. Therefore
- the question of where and how the RWMF is to be hosted should be genuinely separate from the question of whether radioactive material should continue to be produced

NB. This does not amount to taking a position on whether or not we should continue to generate energy using nuclear technology or to employ nuclear deterrence. It is to claim that there are unavoidable ethical problems with the production of energy or deterrence in this way (as there are with other forms of energy and deterrence production) and that there are very good reasons for ensuring that agreeing to host a radioactive waste management facility does not amount to an endorsement of the nuclear industry. Whether or not the industry should continue is a question which should be kept open, not closed by default.*****

2.6 Bribery, benefits and independence

A feature of bribery that has not yet been discussed is that the offer of reward is for an action or decision that benefits or is in the interests of the briber. This feature alone is not enough for a reward to constitute bribery, as incentives also manifest it (see section 2.5 above). But all cases of bribery will have this feature. In other words, it is a necessary but not sufficient condition of bribery that the offer of reward, if successful in the way it intends to influence, will benefit the person or body offering it.

Although from a logical point of view, the fact that the person or body offering the reward stands to benefit does not mean that the offer is necessarily a bribe, the offer is, nevertheless, more likely to be *perceived* as a bribe, if the person making it stands to gain.

There are various links here between the issues of trust, perception and benefit that strongly suggest that *the body offering the compensation should not have, or be perceived to have, anything to gain by it*. This will not be the case if the body offering the compensation is closely associated with the nuclear industry. It follows that there is a much greater chance of compensation being perceived as compensation rather than as bribery if this body is, and is seen to be, genuinely independent from the nuclear industry.

a) perception of bribery

Distinguishing between a logical analysis of the bribery/compensation distinction, as offered above in section 2.5, and a psychological one, we can raise the (psychological) question of the conditions under which an offer of reward is likely to be perceived as compensation rather than as a bribe.

Recent work by Edmundo Claro argues that, for this to be the case, “contextual, procedural and consequential” conditions need to be met, as follows.

Contextual:

- affected communities understand that the proposed facility meets a genuine need, i.e. that it “is needed from a societal perspective”
- affected communities understand “that the future consequences of doing nothing about it would be worse for everyone”

Procedural:

- "public or citizen participation is a major factor in the acceptance of locally undesired facilities"
- in most cases those who protest against unwanted facilities "claim that they are done an injustice because they have not participated in the process that leads to the siting decision"
- procedural aspect of trust: "if the participation process has allowed the development of trust, both siting proponents and authorities are seen as really acting so as to protect the interests of the host community"

Consequential:

- health and environmental safety; if health and environmental risks associated with a technology are perceived as too high, "then the technology is deemed unacceptable and rejected"
- this is related to the safety record and history of previous management. Two ways of lowering perceived safety levels are:
- risk mitigation, aimed at "preventing, reducing or eliminating adverse impacts from noxious facilities before they occur", and
- confidence strengthening via communication that emphasises that the operators and enforcers are competent at their jobs

Claro suggests that, "if these conditions have not been met, especially if safety is not assured, and if distrust is operative, compensation offers will often be interpreted as bribes, and opposition will increase as a result". 12

b) summary of bribery/compensation distinction

Bribe:

- intended to persuade someone to perform an action or make a decision they would not normally or otherwise do
- the action or decision is illegal, or is unethical, either in that it entails unacceptable levels of risk or other negative impacts for others, or in other ways
- persuading the bribee to perform the action/make the decision benefits or is in the interests of the briber in some way

For an offer of reward to constitute compensation rather bribery in the circumstances under discussion:

(i) there must be reasons for selecting a potential site or sites that make sense independently of the compensation offer
(ii) it must not be the case that the reward is offered as compensation for an action or decision that puts others at risk in a way that would constitute unethical behaviour, or that is unethical in other ways, or that is illegal

Whether this is in fact avoidable in this case is debatable. Given this:

(iii) an absolute priority must be given to keeping risks to people and environment to minimum
(iv) attempts should be made to devise ways in which future generations and non-humans can meaningfully be represented in negotiations about issues that significantly affect their interests
(v) if there is any possibility that agreeing to host a RWMF will amount to a partial or full legitimisation of continued radioactive waste production then the compensation/bribery distinction will be seriously eroded. Therefore
(vi) the question of where and how the RWMF is to be hosted should be separate from the question of whether radioactive material should continue to be produced.

There is a further, related set of psychological issues about the conditions under which an offer of reward is likely to be perceived as compensation rather than as bribery. Key points here are that:

i) potential host communities should understand the social context and need for the facility
ii) potential host communities should be active participants in discussions about siting
iii) there should be conditions of trust between communities, those offering compensation, managers of the facility and regulators
iv) health and safety must be, and must be seen to be, a priority
v) the body offering the compensation should not have anything to gain
vi) therefore the body offering the compensation in this case should be, and be known to be, independent of the nuclear industry

2.7 Financial compensation

a) financial compensation and motivation

In a case in Switzerland, respondents were asked if they were willing to permit the construction of a nuclear waste repository within the geographical boundaries of their community. Respondents were then asked the same question, with the additional information that the Swiss parliament had agreed to financial compensation for all residents of the host community. In the first instance, 50.8% agreed to accept the repository. This dropped to 24.6% when compensation was offered. 13

The authors of the study suggest that one possible explanation is that the compensation was perceived as a bribe, and the facility was rejected for this reason. The distinction between bribery and compensation has been considered above (see section 2.5).

A different explanation is explored and advocated by Frey and Jegen in their discussion of this case. They claim that most attempts to compensate members of a community financially for accepting a so-called NIMBY facility - such as a nuclear waste management facility - are unsuccessful, in the sense that the facility is rejected, even when the compensation is substantial.

Their thesis is that, where there is some ‘intrinsic’ reason to accept the facility, such as willingness to contribute to the public good, sense of civic duty, or sense of ethical responsibility to the society as a whole, the offer of financial compensation acts as a disincentive. The offer of financial compensation transforms an ethical relationship to a

monetary one, in a way that undermines the initial motivation. The external motivation 'crowds out' the intrinsic motivation - i.e. the motivation coming from within the person.

They suggest a commonplace example of 'crowding out'. A child is asked to mow the family lawn. If a financial reward is then offered, it rapidly becomes the case that the child will not mow the lawn without being paid to do so, even if he or she were willing to do so before. " The induced unwillingness to do anything for free may also expand to other household chores…." (!) 14

In a rather more rigorous study, conducted in Israel, the number of parents arriving late to collect their children from a day-care centre was recorded. A significant monetary fine was then introduced for collecting children late. After an initial period, the number of late parents substantially increased. The authors suggest that "[t]he introduction of a monetary fine transformed the relationship between parents and teachers from a non-monetary one into a monetary one" - and that the effect of this is consistent with the 'crowding out' hypothesis.

Frey and Jegen offer two suggestions about how this might work psychologically. The first is de-motivation through loss of self-control - the control shifts from motivation internal to oneself, to motivation that is external. The second is impaired self-esteem - offering money to do something is perceived as a failure to acknowledge, or rejection of, the motivation that already exists, "[t]he person feels that his or her involvement and competence is not appreciated which debases its value. An intrinsically motivated person is denied the chance of displaying his or her own interest and involvement in or approval of an activity or project, when someone else offers a reward for undertaking it". In both cases it is suggested that the result is that pre-existing motivation is undermined. 15
A further example is the commodification of water, and the phenomenon of previously co-operative people who, once water has become a privately owned resource that customers pay to consume rather than a public good, come to resist prohibitions against lawn-watering in dry summers.

From the point of view of those concerned with radioactive waste management there are two main issues here. One is a tactical one. If these authors are correct, offering financial compensation in the attempt to secure acceptance from a host community for a radioactive waste facility may be counter-productive. It may undermine a pre-existing willingness to do something perceived as in the overall public interest.

The second point is an ethical one, to the effect that that there is something intrinsically undesirable about transforming a willingness to contribute to public good into a financial relationship. There is a general point here about transforming non-market values into market values, and this clearly connects with the argument made below (see section 2.8b) that certain kinds of relationships are degraded if financial compensation is offered, or betrayed if accepted. If the transformation from non-market to market values contributed to the erosion of self-esteem and self-determination this would be a further ethical argument against it.

Clearly a key question here will be the extent to which the ethical or civic motivation actually exists, as the considerations offered above may be irrelevant if no such motivation is there in the first place. A further question that arises here is whether and under what circumstances it would be ethical to *encourage* the development of civic motivation, and how this might be done.

Leaving this for future consideration, and assuming for the moment that civic motivation is already present, Frey and Jegen suggest that one response would be to offer forms of compensation which are socially beneficial, such as schools or fire stations. 16 Presumably the thought here is that the ethical motivation would not be eroded by this kind of compensation; and that it would thus be more ethically commendable. Some of the pro's and cons of this approach will be outlined in the section on constitutive incommensurability (section 2.8b).

In the case discussed by Renn et al, monetary compensation was rejected in favour of "a model of joint ownership of the facility by the Canton and the selected community". In this case, the ownership was literal, and had the advantage of generating revenue for the community. But it was also, and interestingly in the context of the above discussion, considered to be an advantage because of shared *control* between the Canton and the citizens. And this raises the question of whether 'ownership' in this context might be understood in terms of ownership of the issue, as well as, or even instead of, ownership in the literal sense. ******

b) financial compensation and perception of social relationships

Frey and Jegen's position is supported and developed in a recent paper by Edmundo Claro. Claro suggests that "many authors have argued that in-kind or public goods compensation is more effective in gaining local acceptance than financial incentives". 17 He cites North American and European evidence of examples where "the offer of financial compensation has failed to improve the rate of acceptance of such projects and has even substantially reduced acceptance" and suggests that "many scholars argue that non-monetary or in-kind compensation presents considerable advantages in gaining public acceptance whenever a facility is being rejected by the local population". 18

In his view, while the bribe effect or the crowding out effect may be relevant in some circumstances, it is often the case instead that "an agent rejects financial payments and agrees to public good compensation … because this seems the correct or appropriate way of behaving." 19

Claro's position is as follows. The choices that people make are influenced, and can be understood, by reference to self-interest, and to the consequences or outcomes of the choices. (In his view, both the bribe effect and the crowding-out effect offer explanations of this type). But Claro argues that there is a set of further important factors. These he calls 'procedural motives'.

"Whereas consequential motives are forward oriented and emphasise the consequences or outcomes emerging from actions… procedural motives are neither outcome nor forward oriented. Their focus is directed towards the action itself…. More specifically, procedural motives relate to "how one should behave in certain circumstances" …. they concern what one does, not what happens." 20

Claro's key claim is that how people think they should behave in specific circumstances will depend on the kind of social relations that exist between the parties involved, and on the norms of behaviour associated with these kinds of relations. Following other writers in this area 21 he suggests that there are three fundamental and distinct forms of social relations: communal sharing, equality matching and market pricing. Different norms of exchange are held to be appropriate in each case.

Consider these three basic forms of social relations in the context of exchange relations. Under communal sharing relations, goods are collectively owned. In this case, people are often prepared to contribute a great deal without expecting much if anything in return. Under equality matching relations, a contribution or favour would be expected to be matched in kind. Under market pricing relations, a contribution would typically be expected to be paid for.

An example is offered, involving three scenarios in which one person helps another to move house. What varies between the scenarios is the relationship between helper and helped. In the first, a son helps his father. This is taken to be a case of community sharing. In the second, the helper and helped are close friends, a case of equality matching; and in the third, the helper is a commercial removal person. In an experiment in which fifty-two university students were asked to read these scenarios and choose between no compensation, non-monetary compensation such as a gift or a meal and financial compensation, the response was as predicted: no compensation for the son, a pizza for the friend and monetary compensation for the professional remover.

In other words, the nature of the compensation held to be appropriate in different cases varied according to the nature of the relationships involved. Claro accordingly suggests that, in the case of siting a waste management facility, *"if someone who frames the siting problem as a communal sharing one is offered money as compensation, she will react with anger and indignation not only because the trade-off is bizarre, but because it threatens fundamental aspects of her understanding of social relationships and society".* 22 [my italics]

Claro suggests, following from this, "1) That those individuals that frame the siting problem as a communal sharing relationship would tend to accept a waste treatment facility in their community without claiming to be compensated. 2) That those seeing it as an equality matching instance would be inclined to accept the facility if in-kind compensation is offered in return. 3) That those understanding the relation as a market pricing one would be willing to accept it if enough monetary compensation is offered as payment." 23

Claro takes these claims to be testable, and he goes on to describe experiments underway in Chile, the provisional results of which offer confirmation of all three propositions.

Claro is interested in these issues largely from a tactical point of view: he writes as someone concerned to help solve an urgent need that exists in Southern Chile for a new solid domestic waste sanitary landfill site, in a context where immense local opposition exists to all current proposals. His arguments, if held to be convincing, clearly also have considerable tactical significance with regard to the siting of radioactive waste management facilities. They suggest that, *in the process of trying to identify appropriate compensation, careful attention should be paid to the way in which members of a potential host community understand the relationship between themselves, the waste management facility and those offering compensation.*

If Claro's argument is correct, there would be ethical as well as tactical reasons for supporting this conclusion. These ethical reasons are implied in the claim that offering financial compensation in cases where the siting of a waste facility is perceived as a communal issue, (or to put it in Jegen's terms, where it is perceived as an issue of public good and civic motivation, or where the problem is 'owned' locally as well as nationally)

“threatens fundamental aspects of [their] understanding of social relationships and society”. 24

Ethical issues/value judgements:

Careful attention should be paid to the way in which members of a potential host community understand the relationship between themselves, the facility and those offering compensation.
Judgements will need to be made about how to respond appropriately in the case of different perceptions of this relationship.

Frey, Jegen and Claro’s approach to the question of what will count as appropriate and effective compensation in different cases is primarily psychological, i.e., it uses psychological data and techniques to establish how people perceive and respond to different kinds of compensation offers.

The issue can also be approached from an ethical point of view. Compensation needs to be appropriate in the sense of not giving offence; of not being the kind of compensation that is inappropriate in an ethical sense. This sort of issue often arises, for example, in the context of offering financial compensation for injury or loss of life. “No amount of money could compensate for the death of x, and it is offensive to offer it”, would be a characteristic expression of this kind of inappropriateness. One way of understanding this sense of ethical inappropriateness is with reference to the idea of ‘constitutive incommensurability’. This is done below.

2.7 Ethical decision-making

a) commensurability

Some views about compensation and how it should be established rest on the assumption that it must be possible to perform a particular kind of comparison between the compensation and the negative impacts being compensated for. Where the negative impacts and the compensation are both financial, this is relatively straightforward. But some negative impacts are fundamentally different in kind from the sorts of compensation that might be offered. In this case, according to those who hold this view, a common scale is required, so that impacts and compensatory benefits that are of different kinds - risk of harm to health and better infrastructure, say - can meaningfully be weighed against each other, or made commensurable.

b) constitutive incommensurability

The view that commensurability is required for certain sorts of decision-making is inherent in classical utilitarianism. Classical utilitarianism, which underpins a number of contemporary approaches to decision making, states that the ethically correct action in any given context is the one that produces the best state of affairs - that maximises good outcomes. In order to establish which action will produce the best state of affairs, and hence to decide what ought to be done, it has to be possible to compare different options, and to see which option leads

to the best overall balance of negative and positive impacts. In order to do this, different kinds of negative and positive impacts need to be compared.

It is thus a fundamental assumption of utilitarianism that there is "a common measure of value through which different options can be compared in order to ascertain which produces the greatest total amount of value." 25 Classical versions of utilitarianism argue that the common measure of value is pleasure (Bentham) or the desire for happiness (Mill). Some contemporary versions have argued that the common measure is human preferences. In either case, "[p]art of the promise of the utilitarian and standard economic decision making tools such as cost-benefit analysis is that they offer a procedure for resolving value conflicts through the employment of a common measure through which different options can be compared and the losses involved in the choice of one option can be shown to be compensated by the gains it offers."

One way of understanding what is happening with compensation is precisely this: that negative impacts are being compared with positive benefits (compensation); that a trade-off is being made between the two, with the aim of producing a state of affairs which overall has a good or (if utilitarian) maximum balance of benefits over costs.

Some economists argue that monetary price is the best measure for making those trade-offs; that money is the 'common scale', or that "money serves as a measure of the exchange rate between different values." 26 On this approach, attempting to compensate for risk to health, say, will involve putting a financial figure on health, so that the figure offered is appropriate. If the compensation is to take a non-monetary form (eg better infrastructure) then a figure will need to be established for it, too, so that some kind of equivalence or proportionality can be achieved. It is the attempt to put a financial figure on negative impacts such as loss of life or harm to health that may be cited as causing offence in the sense indicated above.

Two main points are captured in the phrase 'constitutive incommensurability'. The first is that "there are many values which simply cannot be converted into monetary currency"; the second that money is not just a neutral measuring rod onetary transactions….are social acts which have a social meaning". 27 John O'Neill, for example, argues that certain kinds of social relationships are such that they are incompatible with market relations. Friendships and loyalties to family would be examples.

"Given what love and friendship are, and given what market exchanges are, one cannot buy love or friendship. To believe one could would be to misunderstand those very relationships. Some social loyalties - for example to friends and to family - are constituted by a refusal to treat them as commodities that can be bought or sold. *To accept a price is an act of betrayal, to offer a price is an act of bribery." 28* [my italics]

A similar point can be made about certain value commitments - they are constituted by a refusal to trade them off. A commitment to an environment or to a homeland can be of this form. This is famously illustrated in the following extract from a letter from a tribal person in the Narmada Valley in Western India, threatened with displacement as a result of the Sardar Sarovar Dam.

"You tell us to take compensation. What is the state compensating us for? For our land, for our fields, for the trees along our fields. But we don't live only by this. Are you going to compensate us for our forest? Or are you going to compensate us for our great river for her

fish, her water, for vegetables that grow along her banks, for the joy of living beside her? What is the price of this? How are you compensating us for fields either we didn't buy this land; our forefathers cleared it and settled here. What price this land? Our gods, the support of those who are our kin what price do you have for these? Our adivasi (tribal) life what price do you put on it?" 29

O'Neill argues that, where social relations and evaluative commitments *are* constituted by a refusal to put a price on them. "the very acceptance of a price on relations of kinship and a way of life is to betray them, the offer to corrupt. The use of the term 'compensation' in this context disguises what is going on". 30 What is going on is an erosion of these relationships. This in turn can be seen as an erosion of human well-being, since relationships of this kind are, arguably, part of what it is to lead a full human life.

It is worth asking whether there are circumstances in which agreeing to be a host community and to accept compensation for this could reasonably be construed as a betrayal of the kinds of relationships or value commitments "that are constituted by a refusal to put a price on them."

It seems likely that at least some of the various sets of relationships between current and future members of the community, members of the community and those outside the community, and community members and their environment will be the kinds of relationships in question. Examples would include the relationships between those agreeing to host the management facility, their children, grand-children and great grand-children; and the relationships between these people and their local environment.

These relationships might reasonably be seen to be betrayed if, for example, the negative impacts include significant risk to the health or well-being of current or future members of the host community; or significant damage to the environment, including the kind that would render it no longer 'a homeland' (supposing that it already is 'homeland').

One response here is to return to the point that significant risks to life and health should be ruled out in advance by the regulatory system. On the other hand, given the immensely long time-scales involved, it is not feasible to claim that all risk of serious harm can be regulated out of the picture for the next 100,000 years. Some risks are bound to remain in virtue of the inevitable uncertainties that accompany this time-scale. And even if the risk of serious harms to health and environment are taken to be negligible, it still makes sense to ask what other kinds of negative impacts will be involved in a particular case, and whether an offer of financial compensation in this case will erode the relationships and values involved.

If such erosion seems likely in a given case, what would be an appropriate response?

One would be to suggest that the compensation is not financial, but of a form that continues to embody the relationship commitments in question. So, e.g., if it is future generations of human community members that are in some sense threatened, then while accepting financial compensation might be conceived as a betrayal of this relationship, accepting a commitment to build and maintain schools and libraries might not. On the other hand, it could be argued that this is just a more subtle form of betrayal, and moreover, that it deprives people of autonomy in deciding how financial compensation should best be spent.

A second response would be to argue that, in the case of constitutive incommensurability, the host community would be correct to refuse to *be* a host community, and it would be

inappropriate to offer compensation of any form. If agreeing to the negative impact amounts to a betrayal of significant relationships to current or future generations of humans or non-humans, then the ethically correct response could well be to argue that these negative impacts are unacceptable. This strongly suggests a responsibility to be alert to these kind of circumstances on the part of those offering the compensation, so that the situation can be avoided.

Ethical issues/value judgements:

The compensators should be alert to the inherent ethical problems involved in offering compensation for risks, harms or other negative impacts, the acceptance of which amount to a betrayal of social or kinship relationships.
It should be questioned whether communities should ever be expected to bear these kinds of negative impacts.
Value judgements will need to be made in identifying what counts as betrayal of social or kinship relationships.

c) compensation and ethical wrong-doing

The issues around constitutive incommensurability relate to a similar point. It can be argued that one cannot compensate for an ethical wrong-doing; or that compensation doesn't make the ethical wrong-doing right.

It does not necessarily follow from this that it could never be acceptable to perform an ethically undesirable action. It might be, for example, that this is an unavoidable feature of the least worst option. What does follow is that there may be circumstances in which there is not a clear right answer; in which the interests and values involved conflict in a way that does not have a single clear resolution. For example, it could be that, given the existence of radioactive waste, there is no solution to the question of what to do with it that does not involve exposing people and environments to long-term risks that would normally be judged unethical.

The possibility of genuine ethical dilemmas is denied by some accounts of ethical decision-making, for example, that discussed above as utilitarianism and below as cost-benefit analysis. On these approaches, because it is held that all the values and interests involved can be reduced to a common unit of measurement, unless there are two options where the various costs and benefits come out exactly equal, there will always be a right answer - the option with the best balance of benefits over costs. And on these approaches, because benefits and costs are reduced to a common unit, the benefits are in effect taken to erase the costs.

It will be argued here that this approach is profoundly mistaken, and that it is important to recognise this for a variety of practical reasons.

d) rational decision-making: against algorithms

It is sometimes argued that rational decision-making *as such* must involve this kind of trading off of costs against benefits by reducing them to a common unit of comparison - such as money - and that "where a unit of calculation is absent rational choice is not possible." On

this view, rational choice *consists in* 'trading off' costs and benefits through the use of a common unit of comparison. 31

The position taken here, however, is that the possibility of trading off in this way is *not* a necessary condition of rational decision-making. Moreover, in the kind of context in question, where the decisions to be made have unavoidable ethical and evaluative dimensions, it is inappropriate to try to reach a resolution by this kind of algorithmic procedure.

The appeal to cost-benefit analysis rests on the assumption that ethical values are radically subjective. The assumption is that values are like personal preferences or tastes, such as for thick or thin-cut marmalade. If values are understood as preferences in this way, then, in cases where they conflict, the only rational procedure for decision-making appears to be to identify the preferences and how strongly they are held, and choose the option that satisfies many or most of them.

The assumption that ethical values are radically subjective and can be treated like preferences is, however, deeply flawed. Values are not like preferences in that they are, or can be, held for reasons, and these reasons can be critically assessed. Some reasons are better than others. Thus a rational response to a conflict of values is to ascertain and assess the reasons why the values are held. An attempt to resolve the kinds of issues under discussion should thus be done by dialogue and debate - by means of rational deliberation procedures. This rests on a very different account of what rational decision-making involves from the mathematical model outlined above.

"Given a procedural account of rationality, what matters is the development of deliberative institutions that allow citizens to form preferences through reasoned dialogue, not institutions for aggregating given preferences to arrive at an optimal outcome" 32.

Procedural accounts of rationality stress the ineliminable role of judgement, and allow room for the development and scrutiny of reasons for holding values. This is in strong contrast with the assumption that, where a calculation is not available, rational choice is not possible. Indeed it can be argued not only that cost-benefit analysis type procedures are not a necessary feature of rational decision-making, but that in this kind of context the cost-benefit type approach should be resisted. This is for a range of reasons, including the following.

A first group of reasons have already been discussed under the heading of constitutive incommensurability.

Secondly, cost benefit procedures are 'reason blind' - they ascertain the strength of people's preferences or values, and perform a calculation based on these - but not the reasons why these preferences are held. Deliberative, procedural notions of rationality, in contrast, emphasise the importance of reasons and of dialogue so that a reasoned position can be both explored and developed.

A third sort of problem with cost benefit type approaches is that the option that leads to the greatest balance of benefits over costs is perfectly compatible with the imposition of grave injustices to some people or with the violation of their rights.

Finally, it can be argued that cost benefit approaches lead to ethical complacency; that the conviction that there is always a right answer can itself be ethically problematic. Compare this attitude with that that follows from the view that, although the option that is probably the

least worst has been chosen, there is still nevertheless an ineliminable element of ethical undesirability about it. This keeps open the suggestion that *it would be better if the circumstances were such that this dilemma did not arise* and the possibility of exploring ways of preventing it from continuing to arise in the future. It tends towards an ongoing attempt to change the background circumstances and context within which the decision has to be made, and an ongoing alertness to the regrettable aspects of the decisions made in the context as it stands. It keeps open the question, what can be done so that in the future we have a different range of options to choose from?

Cost benefit analysis in this regard is profoundly conservative in the sense that it has no tendency to question the desirability of the circumstances in which the analysis is made, or to suggest that another set of options would be preferable. And, once the decision has been made, because it is characterised as the right decision, there is no reason inherent in the decision-making process to keep the situation under review. The right answer is the right answer, costs are outweighed by benefits, and that is that.

This is clearly of relevance in the context under discussion. Given that radioactive waste exists, it has to be managed, and the facility for this has to be located somewhere. Where it should go and how those who receive it in their community are to be treated are genuinely difficult questions. Arguably, given that radioactive waste remains potentially dangerous to human and non-human life for many thousands of years, there can be no clear right answer. An awareness that *all* options have ethical drawbacks does, however, suggest *the need for a continuous review of the circumstances that have lead to our being in a no right answer position*; that compel us to choose from a set of options all of which are ethically problematic in some way. For example, it suggests that the question of whether radioactive waste should continue to be generated should be continuously under review, and that claims to have 'solved' the issue of radioactive waste management by cost benefit analysis must not be allowed to contribute to the shelving of this kind of review process.

Ethical issues/value judgements:

What assumptions are being made about how decisions with an ethical dimension to them should be reached?
What values and assumptions are embedded in the decision-making processes that are used?

e) purpose or aim of compensation

The discussions above point to a set of deeper questions about what the underlying purpose or aim of compensation is taken to be. This can be understood in different ways. For example, it could be held that the aim of compensation is:

- to trade-off costs and benefits in order to achieve an overall outcome in which negative impacts are outweighed by compensation i.e. a consequentialist position
- to fulfil a set of obligations i.e. a deontological position
- to meet the goal of acting virtuously

Positions of these sorts are likely to underpin compensatory projects, though they may be held implicitly rather than explicitly. It is worth asking, therefore, what the underlying aim of

compensation is taken to be as different conceptions of this are likely to lead to different recommendations.

These claims could be explored further, and I would want to argue that it is a mistake to perceive compensation primarily as a consequentialist project. The immediate point, however, as argued above, is that it is not necessary to construe compensation as being fundamentally about trading off costs and benefits in order to achieve an optimal state of affairs. It could be construed in quite different ways e.g. as an attempt to fulfil obligations towards the host community that are generated by this kind of context; or as an attempt to act virtuously.

Ethical issues/value judgements:

What assumptions are being made about the underlying aim of compensation, and how these are to be understood?

3 CONCLUSIONS AND RECOMMENDATIONS

3.1 Conclusions and moving forwards

Questions about how communities who agree to host radioactive waste management facilities should be compensated cannot be answered without making a wide range of value judgements and without raising a range of related ethical issues.

One group of issues centres on the nature of compensation itself, what counts as compensation in relation to the negative and positive impacts involved, and how compensation is to be distinguished from bribery. These issues have psychological and legal dimensions to them as well as ethical, although it is the ethical dimensions that have been the primary focus of this paper.

Another set of issues centres on who should be making the range of unavoidable value judgements involved here. Examples include, what counts as negative and positive impacts, what counts as appropriate, what counts as significant fear and risk, and so on. A related third involves the process by which these judgements are made and a range of other decisions reached. To what extent is this process genuinely open, transparent and democratic? Whose interests and voices are included in debate and whose, inadvertently or otherwise, are excluded?

Attention to these issues will be a necessary part of ensuring that the relationships between host communities and the rest of society are ethical ones. But three further essential points need to be made.

First, it is important to note that, at a meta level, assumptions will inevitably be made about how decisions that have evaluative and ethical dimensions to them should be reached, and about what counts as reasonable or rational decision-making in this context. *These assumptions are not neutral in terms either of the values embedded in them or the results they are likely to generate* and they should therefore be revealed and opened out for critical scrutiny. Can we, for example, make such decisions using cost-benefit analysis? What sorts of values and what sort of views about the nature of ethical judgements are implicit in this,

and in contrasting, approaches to decision-making? A further area of assumptions concerns the underlying aim of compensation itself. Again, these assumptions will not be neutral, and should be examined.

Second, and even more crucial, all the attention to openness transparency, volunteerism and hidden assumptions in the world will not lead to an ethical relationship between society and a host community if the overriding reason that a community agrees to accept radioactive waste turns out to be pre-existing poverty. This has been strikingly documented in a key case concerning RWMF siting and North American Indians. The most important outstanding question is, in my view, that of understanding how issues of social justice relate to ethical decision-making and of exposing and clarifying the various relationships between poverty, social equality and justice and ethical decision-making in this kind of context.

Finally, the relationship between ethical issues raised by radioactive waste management and those raised by other forms of energy (and deterrence) production and consumption is significant and worth exploring further. Not consuming energy is not an option (though consuming less is); and all forms of production have some implications for the well-being of present and future generations of humans and other species. The generation of energy by nuclear means certainly raises extremely difficult and unavoidable ethical issues. Whether the ethical implications of the nuclear industry are significantly more problematic than those of other industries, as many people certainly believe, is an important question that remains to be comprehensively answered.

3.2 Recommendations

Questions about appropriate compensation for communities that agree to host a radioactive waste management facility need to be considered in conjunction with a broader set of questions about the relationships between the host community and the rest of society.

For these relationships to be ethically acceptable it is argued that:

re process

- the initial site-selection process should be open, transparent and informed by debate and dialogue held by well-informed representatives of all significant stakeholders and carried out at local and national levels
- the question of appropriate compensation should itself be open to public debate and dialogue at local and national levels
- great care should be taken to ensure that this debate is genuinely open and not merely ritualistic
- compensation should not be established exclusively or primarily by use of economic cost-benefit analysis procedures
- the question of whether energy should continue to be produced using nuclear technology, and therefore more waste generated, must be kept open and must not be influenced by the outcome of debate on compensation for host communities
- debate should include reference to the broader context of energy consumption, generation and demand, and not focused on nuclear energy in isolation
- questions of public acceptability and ethical acceptability should be distinguished

- ethical judgements and values judgements throughout should be acknowledged and made explicitly. Note that, in identifying appropriate compensation, ethical judgements will be embedded in both the process and the outcome

re outcome

- compensation should be proportionate to negative (and positive) impacts and of an appropriate kind

Where proposed compensation is financial, particular care should be taken to ensure that those offered it are not effectively being asked

- to betray significant social relationships (see section 2.8b)
- to accept compensation in exchange for performing actions or making decisions which are unethical
- to accept compensation in a way that will have the effect of undermining and eroding civic motivation

In addition,

- compensation should be made in a way that is sensitive to the features that distinguish compensation from bribery
- those offering compensation should not have, and should be seen not to have, anything to gain from the actions and decisions being made and should in this case, therefore, be independent from the nuclear industry
- particular attention should be paid to the difficult issue of how future generations and non-humans who cannot be party to negotiations might meaningfully be represented
- particular attention should be paid to aspects of the broader social context, for example, to the possibility that relative poverty of a potential host community might influence judgements about the acceptability of compensation

3.3 Questions for further research

* how do issues of pre-existing social injustice, poverty and inequality affect ethical decision-making in this kind of context? (see M.V.Rajeev Gowda and Doug Easterling; (1998) "Nuclear Waste and Native America: The MRS Siting Exercise" *Risk: Health, Safety and Environment* 229

** how can effective forums for the discussion and resolution of issues that have an ethical dimension be created?

*** is fear always of harm or are there other kinds of fear that might be relevant in this context, e.g., fear of the unknown?

**** how might decision-making procedures be developed in which the interests and values of future generations and others who cannot be party to the decision-making be represented?

(see, for example, John O'Neill, (2001); "Representing people, representing nature, representing the world" *Environment and Planning: Government and Policy, vol 19;* Avner de Shalit; Why Posterity Matters)

***** how do the ethical issues raised by nuclear energy production compare and relate to those raised by the production of energy by other means?

****** further understanding of the relationship between ethical decision-making in the compensation context, and issues of ownership, control and self-determination

(see, for example, info re Swedish and Finnish approaches, and particularly the notion that ownership of the issue at local and national levels is of primary importance and can be facilitated e.g. by offering money, not as compensation but to enable people to track and understand what is happening)

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Particular thanks to Elizabeth Atherton, Peter Bradbury, John Hetherington, John O'Neill and Brian Wynne for comments and discussion, and for information about relevant literature.

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Overview of CoRWM Recommendations and the Government Response

CoRWM's recommendations

- Geological disposal as end point for long-term management of higher activity wastes
- Robust storage in the interim, including contingency against delay or failure
- Implementation based on willingness to participate and partnership with potential host communities

CoRWM's Principles

- open and transparent
- uphold the public interest
- achieve fairness
- promote a safe and sustainable environment
- ensure an efficient, cost-effective and conclusive process

Overall Approach

- Ethics
- Participation
- Expert knowledge
- Democratic
- Deliberation
- Integration
- Implementation
- Interdependence

Proposals for implementation

- Open and transparent
- Staged process
- Initial screening
- Willingness to participate
- Partnerships
- Involvement and community packages
- Right to withdraw
- Democratic ratification

Government Response

- Accepts CoRWM's recommendations
- Invites local authority participation in discussions about implementation framework
- NDA as implementor
- Independent scrutiny by CoRWM successor

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Response to the Report and Recommendations from the Committee on Radioactive Waste Management (CoRWM)

By the UK Government and the devolved administrations

Llywodraeth Cynulliad Cymru
Welsh Assembly Government

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Department of the Environment
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Contents

Section 1: Overview

1.1 Introduction

In September 2001, Government (UK Government and the devolved administrations) instigated the first stage of its Managing Radioactive Waste Safely Programme (MRWS). The second stage began in July 2002[1] when Government published its response to the 2001 consultation, followed in 2003 by the appointment of the independent Committee on Radioactive Waste Management (CoRWM). Government commissioned CoRWM to oversee a review of options for the long term management of the UK's higher activity radioactive waste, and to recommend the option, or combination of options, that could provide a long-term solution, providing protection for people and the environment. Their objective was to provide recommendations which inspired public confidence and were practicable in securing the long term safety of those wastes. CoRWM began its work in November 2003 and delivered its recommendations in its report to Government on 31 July 2006.

Government has now considered CoRWM's report and is content that the Committee's method of working has resulted in a report which enables Government to be satisfied that the recommendations on the long term management option do "inspire confidence and are practicable". This document completes Stage 2 of the programme. It provides Government's response to those long term management recommendations, as well as to others in the report on public and stakeholder engagement. It also outlines the steps Government will take and the beginning of the next stage – Stage 3 of the MRWS programme – on implementation of the long term management option for higher activity radioactive waste.

1.2 CoRWM Process and Report

In summary, the three main elements of CoRWM's recommendations are that:

- geological disposal is currently the best form of long term management for the UK's higher activity radioactive waste;
- there should be a commitment to the safe and secure interim storage of the waste during the period it will take to plan and construct the geological disposal facility; and
- the UK should look to develop partnership arrangements, linked to appropriate involvement and benefit packages, with local authorities/communities as a means of securing facility siting.

Its report also contains a wealth of more detailed material on how these three main elements could best be delivered.

CoRWM undertook extensive engagement with stakeholders, and members of the public as well as considering expert and scientific evidence in arriving at its

[1] The MRWS programme stages set out in the Government's July 2002 way forward statement were: Stage 1 – the MRWS consultation; Stage 2- appointment of CoRWM, delivery of the committee's recommendations and Government policy decision; Stage 3 – formulation, including public debate, of implementation arrangements; and Stage 4 – start of implementation process.

recommendations. The Committee considered and reflected a range of viewpoints in its work and, on that basis, it arrived at a unanimous report.

In addition to the extensive quality assurance and peer review mechanisms established by CoRWM, an expert panel set up by Defra's Chief Scientific Advisor provided quality assurance and peer review on behalf of Government. CoRWM's final report has also been considered and reviewed by the cross-Government MRWS Implementation Planning Group.

1.3 Government Response

The reflection of a wide range of viewpoints, and a basis in sound science is key to providing recommendations which inspire public confidence for managing the wastes in the long term, providing protection for people and the environment. The open and transparent manner in which CoRWM has conducted its business has been ground breaking.

Accordingly Government welcomes CoRWM's report and believes it provides a sound basis for moving forward. Most recommendations can be acted on immediately; others require us to undertake more work.

In particular, Government accepts that geological disposal coupled with safe and secure interim storage is the way forward for the long term management of the UK's higher activity wastes. As CoRWM's report observes, geological disposal is the approach being adopted in the majority of other nuclear nations, including in Belgium, France, Finland, Germany, Japan, Sweden, Switzerland and the US. CoRWM's work has shown that this is also the appropriate way forward for the UK. Nevertheless, securing geological disposal represents a major challenge and will require commitment over many decades.

The circumstances surrounding the geological disposal of higher activity radioactive wastes are unique. In this context, Government is supportive of exploring how an approach based on voluntarism (that is, willingness to participate) and partnership, as recommended by CoRWM, could be made to work in practice. There are also important issues of how this could be integrated with the assessment of the geographical and geological suitability of possible sites. Government therefore proposes to undertake more work on these issues. In doing so, it will engage with stakeholders, including the nuclear safety and environmental regulators[2], to prepare an implementation framework on which it will consult more widely as soon as practicable next year.

It is clear that the implementation programme itself will have a number of stages at which decisions will have to be taken. Therefore, Government also accepts CoRWM's recommendation that the process should be staged so as to incorporate a series of appropriate decision points. This will allow the programme and progress to be kept under review, including on cost and value for money grounds, so as to allow further decisions to be taken at the appropriate points. Equally, Government needs to set the desired end point and to make the intended direction of travel clear.

[2] the Health & Safety Executive, the Environment Agency the Scottish Environment Protection Agency and the Office for Civil Nuclear Security

This document supports statements made by Ministers of the UK Government, the Scottish Executive and the Welsh Assembly Government to their Parliaments and Assembly in response to CoRWM's report.

1.4 Implementation of Stage 3 of the MRWS Programme

In light of CoRWM's report and recommendations, Government has been considering not only how it might take forward the next stage but also which body, or bodies, should do so. This has been on the basis that the key immediate matters to be resolved are the identification of:

- how the process will proceed, including how potential host sites would be identified, recognising that only sites which are deemed to be geologically suitable will be considered; and
- the body which will have responsibility for the long term implementation of geological disposal and for an interim safe and secure storage programme which protects the environment.

Government has decided that:

- it will further develop and consult on the process for implementation, including site selection criteria; and
- the Nuclear Decommissioning Authority will be given the responsibility for developing and ensuring delivery and implementation of the programmes for interim storage and implementing geological disposal.

Further detail on these decisions is included in Section 2 in our response to CoRWM's individual recommendations.

1.5 Indicative Timetable for MRWS Stage 3

The timetable for the first steps to implement CoRWM's recommendations is indicative and recognises the staged approach that we have agreed will be taken.

2006

- begin a programme of public and stakeholder engagement on the detail of implementation of geological disposal, including a voluntarist/partnership approach, and site selection process and criteria.
- development of an interim storage programme based on the NDA's current "forward stores" project as described in its Strategy (March 2006).

2007

- public consultation on:
    - the Government's framework on the implementation process, including a voluntarist/partnership approach and site selection;
    - an outline geological disposal delivery programme.
- decisions on the interim storage programme.

2007/8

- decisions on:

    - the siting process;
    - the partnership approach;
    - the geological disposal delivery programme.
- begin Stage 4 of the MRWS programme – implementation of the interim storage and geological disposal programmes.

The development and implementation of future stages of the MRWS programme will require commitment by Government, other bodies directly involved in its delivery and continued public and stakeholder support over many decades. CoRWM's report, and the proposals set out in this response, provide the basis for achieving the long term management of the UK's higher activity wastes.

Government is committed to taking forward this important and long-term task to ensure the safe and secure management of our radioactive waste. It is committed to continuing the high standards that CoRWM has set, and we commend the members of the Committee for the work they have done on our behalf.

Section 2: Detailed Response to CoRWM's 15 Recommendations

2.1 Introduction

This section provides Government's response to the 15 specific recommendations in CoRWM's report. In some cases this has been made on individual recommendations but, where a number of recommendations are clearly interrelated, such as on public and stakeholder engagement we have provided a consolidated response.

2.2 Detailed Response to CoRWM's Recommendations

Recommendation 1: Within the present state of knowledge, CoRWM considers geological disposal to be the best available approach for the long-term management of all the material categorised as waste in the CoRWM inventory when compared with the risks associated with other methods of management. The aim should be to progress to disposal as soon as practicable, consistent with developing and maintaining public and stakeholder confidence.

Government accepts this recommendation. It intends to move forward as fast as is practicable to develop a strategy for the delivery of geological disposal, in a manner that is scientifically sound, develops and maintains public confidence, and ensures the effective use of public monies.

The Nuclear Decommissioning Authority (NDA) will be given responsibility for planning and implementing geological disposal. The NDA already has statutory responsibility, under the Energy Act 2004, for the disposal and the safe and secure interim storage of its waste in designated circumstances, and this is being provided for in its Strategy and Annual Plans[3]. Bringing together these two roles will create a single national organisation with a single point of responsibility for managing the UK's higher activity waste in both the shorter and longer term. The NDA will be responsible for both the programme to develop and deliver geological disposal, and for the programme of safe and secure storage until geological disposal is delivered.

This arrangement has the advantage of allowing one organisation – the NDA – to take an integrated view across the waste management chain, thereby enabling both long and short term issues to be addressed in planning and strategy development. The Government will require the NDA to develop the geological disposal concept and to agree an outline development plan that will be put out for consultation in 2007. The preparation of this outline plan will also help to define the costs and timescales of the programme.

Although the important skills and functions of Nirex will be required in developing geological disposal it is not required that these are maintained in a stand-alone organisation. By having a single body, the NDA, accountable for both the shorter term

[3] It is acknowledged that the NDA does not have responsibility for all UK wastes as MoD, nuclear operators and non-nuclear industry sectors also produce some higher activity wastes. The NDA will act as a UK-wide provider of geological disposal, and other waste producers will, where appropriate, pay their full and equitable share of the costs of long-term management of its radioactive wastes, including the operators of any new nuclear power stations as set out in the 2005 Energy Review.

management of its wastes and securing their ultimate disposal, the potential for blurring of responsibilities and accountabilities is avoided.

In order to enable the NDA to begin to undertake its new responsibilities as soon as possible, in the most efficient and effective way, Government proposes to augment the NDA's capabilities by incorporation of skills and technology from United Kingdom Nirex Ltd (Nirex). Following the Government's statement there will be a short period of consultation between Nirex and its Government-owned holding company, Nirex CLG Ltd[4], on this proposed ownership transfer and how it could best be brought about. A transfer of Nirex to the NDA would be prior to it being wound up as a separate company. Nirex is not a regulator. Rather it is an advisor to industry on the preparation of safety cases for submission to the regulators.

The independent nuclear safety and environmental regulators[5] are content with the Government's decision, that the NDA will be responsible for implementing the geological disposal programme. The regulators' main focus is on the technical and organisational components of delivery on the ground. Under the NDA's model of good practice, development work and day-to-day operation of a geological disposal facility would be undertaken by a contractor, chosen on the basis of an open competition. CoRWM set out how the geological disposal process will take decades, but there are good arguments for conducting a competition to appoint the contractor as soon as is practicable. The regulators believe that the Government's approach will present a framework that they can regulate in a strong and effective manner. From initial discussions, the regulators are also content with the NDA's implementation approach which they consider can be made to work in a satisfactory manner.
The regulators' support is of major importance, as strong independent regulation is key both to ensuring the safety of people and the environment and securing confidence and trust in the delivery arrangements for these.

The regulators are committed to continuing and constructive engagement with the NDA. They will take a particular interest in the NDA's plans not only to maintain but also enhance its skill base and intellectual property, and in ensuring that regulatory independence will not be compromised. Current arrangements for regulating the conditioning and packaging of intermediate level radioactive waste, which will be appropriately ring-fenced within the NDA's operational structure, will remain in place, and will be reviewed and improved as the geological disposal programme proceeds. Regulatory procedures covering the authorisation and licensing of geological disposal facilities will also be reviewed and updated.

Government will continue to review and develop policy as the geological disposal programme proceeds. Government will ask the NDA to develop a strategy and plans for the implementation of these proposals, and to ensure that the agreed arrangements are suitably reflected in its future Strategy and work plans. Revised governance arrangements for the NDA will be set in place later in 2006 which will recognise the existing joint statutory responsibilities of the DTI and the Scottish Executive, but also acknowledge the radioactive waste management policy interests of Defra and the National Assembly for Wales. DTI Ministers are answerable to the UK Parliament for the work of the NDA, which is an executive Non Departmental Public Body (NDPB) set

[4] Nirex CLG Ltd is jointly owned by Defra and DTI.
[5] the Health & Safety Executive, the Environment Agency, and the Scottish Environment Protection Agency, and the Office for Civil Nuclear Security.

up under the Energy Act 2004. There will also be appropriate consideration of the NDA's Strategy and programme for long term radioactive waste management by the independent advisory body proposed in the response to Recommendation 15 as part of its role in advising Government on its overall programme.

Government itself will lead in identifying the process and criteria to be used to decide the siting of facilities. This will include exploration of the concept of voluntarism and partnership arrangements and the procedures for assessing the suitability of sites. This is referred to in more detail in the responses to recommendations 10-14.

Development and construction of a geological disposal facility will take several decades, after which it will take many decades more to complete the conditioning and emplacement of the waste. In developing and implementing geological disposal, regard will be paid to consultation and legislative requirements, including strategic environmental assessment, environmental permitting and planning law.

Recommendation 2: A robust programme of interim storage must play an integral part in the long-term management strategy. The uncertainties surrounding the implementation of geological disposal, including social and ethical concerns, lead CoRWM to recommend a continued commitment to the safe and secure management of wastes that is robust against the risk of delay or failure in the repository programme.
Due regard should be paid to:

- **i. reviewing and ensuring security, particularly against terrorist attacks**
- **ii. ensuring the longevity of the stores themselves**
- **iii. prompt immobilisation of waste leading to passively safe waste forms**
- **iv. minimising the need for repackaging of the wastes**
- **v. the implications for transport of wastes.**

Government accepts this recommendation. The planning and development to deliver geological disposal will take several decades. Government considers that it is essential that radioactive waste is stored safely and securely at all times until its emplacement in a facility, in a manner that protects both people and the environment.

Safe and secure storage of radioactive waste is already a responsibility of the NDA, who manage this through Life Time Plans that are owned by NDA site licensee contractors who run the existing civil public sector nuclear sites. As detailed in its current Strategy, the NDA is reviewing its interim storage needs and it will now be required to take account of this recommendation by CoRWM in conducting the review. The outcome of the NDA's interim storage review will require approval by Government and, subject to that approval will be incorporated in a future review of the NDA's Strategy.

This review will pay due regard to the possibility of unforeseen circumstances in its planning, including possible delays in geological disposal facility development. It will ensure that a holistic view is taken through the complete waste management chain, ensuring that both long and short term issues are addressed in a fully coordinated and integrated manner.

In response to CoRWM's more specific points:

(i) The security of all stores is of paramount importance. The NDA's contractors are regulated and advised by the Office for Civil Nuclear Security and already take account

of such matters including the design and engineering of new stores and the refurbishment of existing ones in light of the risks to the security of their contents, now and into the future. This includes, but is not limited to, the vulnerability of the waste form and the degree of protection provided against attack.

(ii) The design of new stores will allow for a period of interim storage of at least 100 years to cover uncertainties associated with the implementation of a geological repository. The replacement of stores will be avoided wherever possible, but the NDA will ensure that its strategy allows for the safe and secure storage of the waste contained within them for a period of at least 100 years.

(iii) Government and regulators agree that wastes should be made passively safe as soon as practicable, consistent with the need to avoid any requirement for future repackaging and the attendant double handling of wastes. The NDA will consider this need in developing its Strategy and plans and will report on progress in its annual reports.

(iv) In developing its Strategy and plans the NDA will keep under review the packaging requirements, so as to minimise the possibility that waste will have to be repackaged whilst in storage, which, as CoRWM note, is considered undesirable by the regulators. The Strategy and plans will continue to be subject to independent regulatory scrutiny as at present.

(v) In developing its storage and disposal strategy in the coming years, the NDA will consider the implications for waste transport, in particular, to minimise movements of unconditioned waste as far as possible. In this it will also pay due regard to the existing waste distribution, and possible future arisings, as well as the need for safe and secure stores, and the uncertainties regarding siting of future disposal facilities.

A robust programme of interim storage must play an integral part in the long-term management strategy. Interim storage will also provide for certain categories of new wastes arisings which will require storage before disposal even after a disposal facility is operational.

Recommendation 3: CoRWM recommends a flexible and staged decision-making process to implement the overall strategy, which includes a set of decision points providing for a review of progress, with an opportunity for re-evaluation before proceeding to the next stage.

Government accepts this recommendation. It agrees that flexible and staged decision making will be the basis for successful implementation, as has been demonstrated by international experience. Government will set out the main elements and stages in an implementation framework for consultation as soon as possible next year. This will include consideration of the process for site selection and the approach to partnerships and public and stakeholder engagement. We refer also to the comments in response to recommendations 11 to 14.

Recommendation 4: There should be a commitment to an intensified programme of research and development into the long-term safety of geological disposal aimed at reducing uncertainties at generic and site-specific levels, as well as into improved means for storing wastes in the longer term.

Government accepts, in light of CoRWM's work and wider international experience, that there is sufficient evidence of the effectiveness of geological disposal as a means of managing the UK's higher activity radioactive waste in the long term. It is on this basis that it accepts CoRWM's recommendation that geological disposal is the best available approach, and has taken the decision to proceed to an implementation and siting programme.

In doing so, Government accepts that there is a requirement for ongoing research and development to ensure optimised delivery of the geological disposal programme, and the safe and secure storage of the radioactive waste in the interim. The NDA has a supplemental function under the Energy Act 2004 to carry out research into matters relating to the functions it has been given by direction of the Secretary of State under the Act, which currently include the storage and disposal of radioactive waste from those nuclear installations and sites it has been given designated responsibility for decommissioning and clean up. The NDA therefore already has the function of carrying out research related to the design, construction and operation of future facilities for intermediate level waste (ILW) and high level waste (HLW).

Ultimately, such research and development will have to support the preparation of a facility safety case that is acceptable to the regulators. Government will also expect the NDA to undertake appropriate horizon scanning activities which could have the potential to improve the future manner in which these functions and the long term management of the UK's higher activity radioactive waste are delivered, including learning from and engaging with overseas programmes.

In undertaking this work, the NDA will be required to have due regard to the views and requirements of Government and the independent regulators, as well as the advice received by Government from the independent advisory body referred to in the response to Recommendation 15.

Recommendation 5: The commitment to ensuring flexibility in decision making should leave open the possibility that other long-term management options (for example, borehole disposal) could emerge as practical alternatives. Developments in alternative management options should be actively pursued through monitoring of and/or participation in national or international R&D programmes.

Government accepts that failure to recognise the inevitability of change would only serve to constrain consideration of future policy and operational issues leading, potentially, to inappropriate decisions. The timescales are lengthy and issues, along with our understanding of the scientific and environmental considerations, may change.

Government recognises the need to take account of developments in storage and disposal options, as well as possible new technologies and solutions, and the need therefore to ensure that there is flexibility of decision-making in a process which is expected to take a number of decades. Government and the NDA will develop a framework which allows for the flexible delivery of a geological disposal programme. The framework will include monitoring of international research & development (R&D) programmes into safe and secure treatment and storage of waste and geological disposal technology as well as any new options that emerge (e.g. the use of deep boreholes for the disposal of some wastes).

Recommendation 6: **At the time of inviting host communities to participate in the implementation process, the inventory of material destined for disposal must be clearly defined. Any substantive increase to this inventory (for example creation of waste from a new programme of nuclear power stations, or receipt of waste from overseas) would require an additional step in the negotiation process with host communities to allow them to take a decision to accept or reject any additional waste.**

Government accepts that the inventory of materials for disposal will need to be clearly defined before agreements with potential host communities can be finalised and before technical options are developed in any depth. Government will ensure that decisions on the classification of the existing materials, and those committed from ongoing or new activities, are made in a timely manner. Consideration of wastes from any new nuclear build will be part of the considerations in developing a partnership approach. The NDA, working with Government will clarify such inventory estimates, based on CoRWM's work, decisions taken, and other developments, and publish its progress. These will take into account not only wastes that will arise from sites owned by the NDA but also wastes that have arisen, or will arise, from other organisations' UK nuclear activities.

Recommendation 7: **If a decision is taken to manage any uranium, spent nuclear fuel and plutonium as wastes, they should be immobilised for secure storage followed by geological disposal.**

Government accepts this recommendation. These materials are not currently considered wastes. The UK has large stocks of spent nuclear fuel, uranic materials, plutonium (from the reprocessing of spent fuel), Magnox Depleted Uranium (MDU – a by-product of Magnox reprocessing) and 'hex tails' (a by-product of the uranium enrichment process). The NDA is developing and assessing options for the future management of these materials for discussion with Government. The proposed approach will be reflected in future revisions of the NDA Strategy, which will require Government approval. The Ministry of Defence, working with the NDA, will also produce similar strategy. The Government will work with other owners, such as British Energy, to develop similarly clear strategies.

If, as a result of this work, a decision is taken to manage any uranium, spent nuclear fuel or plutonium as wastes, Government agrees that they should be immobilised for secure storage prior to geological disposal, and the NDA will publish progress on this.

Whether or not they are declared as wastes, Government accepts that such materials must be stored safely and securely at all times, and provisions are in place for such storage.

Recommendation 8: **In determining what reactor decommissioning wastes should be consigned for geological disposal, due regard should be paid to considering other available and publicly acceptable management options, including those that may arise from the low level waste review.**

Government accepts this recommendation. The NDA will review whether a safety case could be made for other non-geological disposal of reactor decommissioning wastes,

including on-site, or near-site, disposal in order to minimise transport. In doing this it will take account of the outcome of the Government's Low Level Waste management policy review, as well as public and stakeholder views. The NDA will use the outcome of these reviews, which will be published, in developing its outline geological disposal implementation plan.

Recommendation 9: There should be continuing public and stakeholder engagement, which will be essential to build trust and confidence in the proposed long-term management approach, including siting of facilities.

Government accepts this recommendation. It recognises the extensive and highly successful and innovative public and stakeholder engagement work carried out by CoRWM. Government is committed to continuing to work with the public and stakeholders and to build on the foundation of trust and confidence that CoRWM established.

Government and the NDA will therefore continue to develop a variety of mechanisms for engaging and working with the public and stakeholders. This coordinated, multi-mechanism approach will ensure that effective and early opportunities for ongoing engagement are offered. Mechanisms will include public consultations, site stakeholder group meetings and other forms of engagement. The outcome will influence decisions that are taken.

The NDA has a statutory obligation to consult with regulators and other bodies in carrying forward its programmes and plans. The NDA's Strategy, published in March 2006, affirms its commitment to open and transparent engagement with stakeholders.

Additionally, the advisory body (Recommendation 15) will operate in an open and transparent way taking public and stakeholder views into account and advising Government on the public and stakeholder engagement process.

Recommendations 10 to 14: *As has been said in Section 1, we are responding to these recommendations in a consolidated manner because these recommendations are interrelated.*

Recommendation 10: Community involvement in any proposals for the siting of long-term radioactive waste facilities should be based on the principle of volunteerism, that is, an expressed willingness to participate.

Recommendation 11: Willingness to participate should be supported by the provision of community packages that are designed both to facilitate participation in the short term and to ensure that a radioactive waste facility is acceptable to the host community in the long term. Participation should be based on the expectation that the well-being of the community will be enhanced.

Recommendation 12: Community involvement should be achieved through the development of a partnership approach, based on an open and equal relationship between potential host communities and those responsible for implementation.

<u>Recommendation 13:</u> Communities should have the right to withdraw from this process up to a pre-defined point.

<u>Recommendation 14:</u> In order to ensure the legitimacy of the process, key decisions should be ratified by the appropriate democratically elected body/bodies.

Government is not seeking to impose a geological disposal facility for higher activity wastes on any community. It agrees that previous experience in the UK and abroad has demonstrated the failures of earlier non-consensual approaches to implement long-term waste management facilities. Government is committed to seeking a solution based on a partnership approach. It believes that there is merit in the approach CoRWM has recommended.

The details of exactly what a voluntarist and partnership approach might entail, and how it would operate in practice, need to be considered and developed into the proposed Government framework for future stages of the MRWS programme. These matters will be considered in Government's work to develop an implementation and siting process framework on which we will shortly begin to engage stakeholders and which will be published for wider consultation in the first part of next year.

This framework is also closely related to Recommendation 5 and will consider the key stages for implementation. In developing this framework we will consider such matters as:

- What voluntarism and partnership arrangements could entail and how this might work in practice, including identification of key stages and decision points, and how willingness to participate and any ability to withdraw might be incorporated into arrangements;
- how key stages of a voluntarist and partnership process link with other key steps in the delivery of a geological disposal programme;
- how local communities, Government, local authorities and the implementing body would be involved including, in particular, the role of local and national democratically elected bodies;
- how interest from local communities could be mandated, registered and evaluated;
- how decisions would be taken at both the local and national level, including the role of local and national democratically elected bodies;
- how access to knowledge and information by the local community, appropriate stakeholder groups, and the wider scientific community is ensured;
- how potential suitable sites would be identified and assessed;
- the key decision-making points and how possible withdrawal at such points could be managed;
- what could be included in any possible participation and benefits packages, and when and how they would be defined and how we determine whether they are likely to be affordable or offer good value for money;
- aspects of siting and facility design that could be determined by the local communities; and
- how any new build wastes would be dealt with in the process.

Ultimately the facility developer will need to assure the regulators, through the development of safety cases, that the proposed facility will provide the required levels of protection. Therefore geological disposal facilities will only be built in a geologically suitable area. The suitability of potential sites or areas will be assessed against appropriate criteria in an open and transparent way. We will also consider how geological and scientific considerations will be meshed with other societal considerations as all of these criteria will need to be met for a successful programme.

Government will consider how the community involvement mechanisms used by the NDA and CoRWM might be developed to deliver a geological disposal programme and decisions on the siting of a facility. It recognises that partnership arrangements will be needed between host communities, Government and the NDA. We also recognise that local authorities will have a key role.

CoRWM's draft *'Proposals for Implementation'* report[6], published alongside its main report, provides a useful contribution to developing this framework. Government invites comments on this CoRWM report, including on any of the above matters, to be sent to the addresses below before **31 January 2007.** Government will be seeking CoRWM's advice in the coming months to inform the framework which will go out to consultation in 2007.

We will also develop the proposed framework in discussion with local government associations and their relevant sub-groups, for example NuLeAF (the Nuclear Legacy Advisory Forum), and also any individual local authority, or group of local authorities, which believe they have an interest at this stage. Expressions of interest in participating in these early discussions to inform policy formulation should be directed to the addresses below.

In England:

The Minister of State for Climate Change and the Environment
The Department for Environment, Food and Rural Affairs
17 Smith Square
London
SW1P 3JR

or to the following email address: radioactivewaste@defra.gsi.gov.uk

In Scotland:

The Minister for Environment and Rural Development
Scottish Executive
47 Robb's Loan
Edinburgh
EH14 1TY

or to the following email address: RadioactiveWasteTeam@scotland.gsi.gov.uk

In Wales:

The Minister for Environment, Planning and Countryside,
Welsh Assembly Government,

[6] CoRWM Document number 1703. Available from www.corwm.org.uk

Cathays Park,
Cardiff
CF10 3NQ
or to the following e-mail address: env-p&q@wales.gsi.gov.uk

In Northern Ireland:
Environmental Policy Division,
Department of the Environment,
Room 204,
20-24 Donegall Street,
Belfast
BT1 2GP
or to the following e-mail address: epd@doeni.gsi.gov.uk

Recommendation 15: An independent body should be appointed to oversee the implementation process without delay.

Government believes that an independent advisory committee should be established to provide advice on the development and implementation of the geological disposal facility development programme.

Experience with CoRWM and its predecessor – the Radioactive Waste Management Advisory Committee (RWMAC) – demonstrates that visible independent scrutiny and advice can provide reassurance to the public and stakeholders. Government therefore accepts the need for independent advice and scrutiny of the implementation process and the importance of appointing such a body without delay.

Accordingly Government will look to a reconstituted CoRWM, with modified terms of reference and expertise in its membership, to scrutinise the future MRWS programme and its implementation on behalf of Government and to provide it with independent advice on the programme. This will require the Committee to deliver an agreed programme of review and advice. Under the proposed arrangements sponsoring Ministers could also ask the committee to undertake reviews of other key radioactive waste management issues, of the kind undertaken by RWMAC in the past, as and when the need arises. When CoRWM was set up, Government announced that RWMAC would be put into abeyance and its position would be reviewed following delivery of CoRWM's report. Government has decided that RWMAC will not be reactivated. The reconstituted CoRWM will be Government's source of independent advice on radioactive waste matters.

Revised terms of reference are attached at Annex A, and a process of appointment for all posts in this Committee will commence shortly, and will be undertaken in line with Office of the Commissioner for Public Appointments (OCPA) guidelines.

Annex A Future Advisory Committee: Reconstituted Committee on Radioactive Waste Management (CoRWM) Draft Terms Of Reference

1. The reconstituted Committee on Radioactive Waste Management (CoRWM) will provide independent advice to UK Government and Devolved Administration Ministers on the long term management, including storage and disposal, of radioactive waste.

2. Sponsoring Ministers (from Defra, DTI and the Devolved Administrations) will agree a two-year rolling programme and budget for CoRWM's work on an annual basis. Any in-year changes will be the subject of agreement by sponsoring Ministers.

3. CoRWM will provide appropriate and timely expert advice on the delivery of a geological disposal facility for higher activity wastes under the Managing Radioactive Waste Safety programme. The work programme may include activities from assessing waste packaging options, reviewing geological disposal facility delivery programmes and plans (including those of the NDA), exploring site selection processes and criteria, and advising on the optimal approach to public and stakeholder engagement. The scientific and technical basis of these arrangements and plans will be a key component of the work. The committee will provide an annual report of its work to Government.

4. CoRWM shall undertake its work in an open and consultative manner. It will engage with stakeholders as required and it will publish advice (and the underpinning evidence) wherever possible in a way that is meaningful to the non-expert. It will comply, as will sponsoring departments, with Guidelines on Scientific Analysis in Policy Making (http://www.dti.gov.uk/files/file9767.pdf). Published advice and Annual Reports will be laid in respective Parliaments/Assemblies and CoRWM's Chair will attend Parliamentary evidence sessions as and when required.

5. With the agreement of CoRWM's sponsoring Ministers, other parts of Government, the NDA and the regulatory bodies may request independent advice from CoRWM. Relevant Parliamentary Committees may also propose work to sponsoring ministers, for consideration in the advisory committee work programme. Sponsoring Ministers may also ask the Committee to provide advice on other radioactive waste management issues.

6. The Committee will liaise with Health and Safety Executive advisory bodies, and any advisory bodies established by the environment agencies, in setting its annual work programme, and where there is a common interest.

7. CoRWM shall consist of a Chair and up to fifteen members. Seats will not be representative of organisation or sectoral interests and the skills and expertise which will need to be available to the Committee will vary depending on the programme of work. The relevant skills may include: radioactive waste management, nuclear science, radiation protection, environmental law, future environment changes, social science (including public and stakeholder engagement), geology/ geochemistry/hydrogeology, finance, economics, civil

engineering/underground construction technology, repository performance/safety issues, materials science, environmental impact assessment, local government, planning, regulatory processes and ethics. Sponsoring Ministers may review the membership of the Committee, and the skills and expertise required.

8. Appointments will be made following Office of the Commissioner for Public Appointments (OCPA) guidelines. Initial appointments will be for three years and sponsoring Ministers retain the right to terminate appointments at any time in light of individual members' performance, changes in CoRWM's work requirements, or completion of the work required of CoRWM.

9. The Committee, as agreed in the annual plans, may co-opt additional expertise to form temporary sub-groups to examine specific and defined problems.

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Some of the most important criticisms of the final report of the Committee on Radioactive Waste Management (CoRWM)

We were appointed to be members of CoRWM when the Committee was set-up in November 2003. We quickly became concerned at CoRWM's lack of professionalism as a policy making committee in general and specifically about the role scientific knowledge would play in its process. Our concerns were not allayed through an extensive correspondence with the Chair which reached a climax in October 2004, leading to the expulsion from of the Committee of one of us (KB) in April 2005 and the resignation of the other (DJB) in May 2005. We have been asked to comment on the final report of CoRWM (hereinafter referred to as CFR).

CFR states that "*CoRWM was deliberately established with a broadly based membership to consider a range of issues … it was not set up as a traditional scientific committee.*" Early correspondence one of us (KB) had with the Chair indicated that there was considerable uncertainty as to what kind of committee CoRWM was intended to be. Paragraph 5 of the CoRWM Terms of Reference give a clear indication that it was intended to be primarily a technical committee but, as is standard procedure now it would have some representation of "social" expertise. In the event there was no expertise on CoRWM directly related to radioactive waste management, earth and material sciences, etc., expertise that is central to identifying a safe option. This, rather than the solution offered by CoRWM, is the innovative aspect of CoRWM: it has had profound consequences. CoRWM also makes much of the transparency of its process yet its website, which today must be an essential tool of transparency, performs exceedingly poorly and, as we show below, key information simply is not readily available. CoRWM has not addressed the fact that it has lost two members and the report by a businessman (a Mr Roy Roberts) that was commissioned to expel one of us has not been released even to those it directly affects. There is correspondence between both of us and the Minister responsible containing professional criticism of CoRWM and this has not been satisfactorily answered nor is it available through CoRWM. The CoRWM process is simply not transparent, even stooping to the use of a PR agency on occasion, and we refer to this again below.

The foremost criticism to be made is that CoRWM has reported only a generic recommendation for the safe management of the UK's high level radioactive waste (put it in a hole in the ground rather than in a shed), that is, CoRWM is not specific about anything including the appropriate geology, packaging etc. for their proposed geological solution and has therefore not been able to optimise for safety and cost. In this respect CoRWM has not fulfilled its assigned task to advise on a "practicable" option (paragraphs 2 & 12 CoRWM Terms of Reference) that can be implemented in the reasonably foreseeable future, the term "practicable" referring directly to the need to consider the costs and benefits of alternative disposal options.

CoRWM now claims it was asked only to provide a generic solution, but we do not believe this is the case. In the more than a year we were associated with CoRWM we operated under the belief that CoRWM was required to produce a solution that could be implemented quickly after a short period for consultation (from private communication of KB with Ms Elizabeth Gray of the Scottish Executive, one of CoRWM's sponsors). In many tens or even hundreds of hours of committee meetings and personal discussions, and an extensive correspondence with the Chair, we were

not made aware that only a generic solution was required, and we challenge CoRWM to provide documentation to prove their assertion, and if they can produce it we shall wish to know from Defra why such information was withheld from us.

In the real world, that is, outside CoRWM, the issue of deciding between a geological solution and an indefinite storage is trivial compared with the more detailed specification of each; let us say it is less than 10% of the total solution and that is what CoRWM has provided.

Second, in any major policy decision it is absolutely the case that cost and benefit (the main benefit is the risk reduction of the chosen option compared with the status quo) must be considered. Given that the cost of nuclear waste disposal could exceed £70B and the risk will exist for thousands of years, it was never conceivable that a rational choice could be made in the absence of some quantification of these factors, yet CoRWM was vehemently opposed to doing this. Thus, whatever recommendation it made would, in the absence of proper consideration of these crucial factors, be entirely without substance. It beggars belief that in a society which promotes evidence-based decision making as does the UK that a decision with such immense consequences as this should be made without recourse to such information.

This failure to carry out even the most basic of technical assessments has another implication. It means that CoRWM ultimately had no choice about which option to recommend. It is well known that every other agency that has considered the matter has recommended deep disposal. CoRWM could not have made any other recommendation because it had nothing substantive to back it up, and to do so would have unleashed an avalanche of criticism. Only by following the same path as everyone else could CoRWM hope to avoid this onslaught.

Third, our concerns about the use of science are not in anyway satisfactorily resolved despite repeated statements in CFR that CoRWM was committed to making the best use of scientific knowledge. According to the report of their self-appointed evaluators, Faulkland Associates (FA), CoRWM did not formulate a science strategy prior to January 2005 and then it was poorly documented and to a degree the science strategy has been "back-fitted" to the real course of events (R08; page 35). To our certain knowledge, up to December 2004, CoRWM were pathologically averse to adopting any science strategy. As the only two members of CoRWM with truly "science based" careers our efforts to steer the Committee's process to incorporate a science strategy met with determined resistance, even hostility, from some members and the Chair. There was a less than welcoming reception in January 2005 (see Minutes) to the announcement that Defra's Chief Scientist, Howard Dalton, would appoint an advisory panel to assist him in advising the Ministers on the CoRWM science strategy. This announcement followed closely the Fifth Report of Session 2003-04 of the House of Lords Science and Technology Committee (HoLC) of 10th December 2004[1], which savagely criticised CoRWM for its lack of scientific competence. Indeed the report is scathing to a remarkable degree, even at one point pillorying the proceedings of a CoRWM meeting some members of the HoLC had attended.

FA's report is revealing in that it notes that although Dalton's primary role was to advise Ministers, he also "*raised issues as necessary with the Chair*" (R08; p 47). The paper trail as to Dalton's role is sparse in the extreme. The secretariat note of a

[1] See: http://www.publications.parliament.uk/pa/ld200304/ldselect/ldsctech/200/200.pdf

meeting on 8 March 2005 (CoRWM Doc 1017) to discuss his role records nothing of substance about what was decided; it does little more than identify who attended. We have been able to trace very few reports of what advice Dalton may have offered CoRWM. The only report of his Panel we can find (October 2005) makes the following interesting observations:

"2) The meeting discussed much of the work previously carried out in the specialist's workshops. Whilst this helped refine some of the issues, the fact that the original experts were no longer present led to misunderstandings -it is not clear how such differences in opinion between specialists and CoRWM members will be handled.
3) There was concern over the dominance of some CoRWM members who appeared to demonstrate entrenched views.
4) Considering the large effort put into the MCDA process when it is only a tool in the decision making, would this effort be better devoted to looking at the options in more detail?" (taken from "Dalton panel feedback on CoRWM's recent workshop to test the Multi-Criteria Decision Analysis" October 2005; no document number).

These three comments are very illuminating. The first illustrates what we regard as the profound weakness of the "science input on demand" approach adopted by CoRWM. Each specialist group was insulated from the others and CoRWM; the second illustrates a prevalent feature of CoRWM, namely that only some voices on the Committee were "heard" by the Chair; and the third indicates that the Dalton Panel at that time (less than a year before final reporting was due) expected much more than a generic solution from CoRWM.

In Chapter 8 of CFR, CoRWM state that Dalton advised CoRWM on "*quality assurance*", the *"peer review process"* and the *"membership and scope of the specialist panels".* (Para 5, p 56). Each of these aspects of CoRWM's process is worth looking at in more detail.

Much, in respect of the use of science, is made in CFR of the quality assurance (QA) group, which, with the exception of two external members, one attending two of the four recorded meetings we can trace, and the other, for only one, was an internal committee. We understand that one of those external members, Geoffrey Boulton, a geologist from the University of Edinburgh, was tasked by the Royal Society (RS) to maintain a "watching brief" over CoRWM. The other external member was Brian Wynne, a Professor of Science Studies at Lancaster University specializing in the application of the 'sociology of knowledge'. Little is recorded of the comments of these members apart from some acerbic remarks by Boulton at the meeting in May 2005 (this report has not been assigned a document number).

FA address the quality assurance aspect of CoRWM's work on pages 44 and 45 of their report (R08). Their opening comment:

"We believe that CoRWM's expectations of its QA programme were unrealistic and it found itself unable to carry out the activities listed above [essentially its terms of reference] *in a sufficiently rigorous way."*

summarises their generally highly negative opinion of this aspect of CoRWM's work.

The peer review panels are also cited by CoRWM to support the quality of science input, which CoRWM admits was "variable" (CFR Ch 8 para 2). FA note that some 200 names were on the panel, which was *"monitored by the QA group"*. FA comment

on p 45 of R08 *"it is not clear why so many reviewers were needed – as far as we can tell only a small proportion were ever used."* They also note that the peer review process had little impact on the science input. This has not deterred the Chair of CoRWM from citing the large number of peer reviewers as 'proof' of CoRWM's commitment to good science.

For the quality of their science input CoRWM (CFR Chapter 8 page 58) lean heavily on the involvement of specialist panels. These were appointed on the advice of the Dalton Panel and the external members of the QA panel (Para 16, p 58). This advice is described as "*independent*". In their report of December 2004, the HoLC say of CoRWM (Para 3.9) *"we do not believe it can even be considered an "intelligent customer" for technical advice without additional expertise."* Apparently CoRWM agrees, because it seems to claim that it outsourced or relinquished its ownership of this vital part of its remit to a few individuals (Dalton's panel and Boulton) rather than have the appropriate expertise appointed to CoRWM.

We don't doubt the scientific competence of the individual specialist panel members; what concerns us is, in the words of FA, the "decision-driven model" (R08; page 34) for inputting the science, which boils down to an essentially "experts on tap" strategy with the "tap" being operated, in respect of "what to ask" and "who to ask", by CoRWM, whose scientific incompetence we don't doubt.

In CFR (Chapter 8, Para 30) it is reported that CoRWM's use of science was subject to an external review at a one-day meeting by scientists and engineers including the Dalton panel. "*The review was conducted on a non-attributable basis and although a full note was taken, this is not a public document. A short summary note is available."* As of 2 December 2006 this document, cited as number 1700, is not available on the CoRWM website. We are left to imagine why, given CoRWM's claim to transparency and auditability.

Finally, Document 1339 records that with the assistance of Boulton, meetings with CoRWM of the RS (7 November 2005; Chaired by Boulton and attended by Dalton and his Panel) and the Geological Society (9 January 2006) were held. Coming as they did at the time CoRWM was in the closing stages of its decision making process, they are significant.

Given the apparently strong, if not pivotal, role of Boulton, a geologist, the potential for influence of the Geological Society, and the role of the RS, already in favour of a geological solution, in the so called "science strategy", it might not be surprising that the outcome of CoRWM's deliberation was a "geological solution". This is not to say that the outcome is incorrect, it may well be that it is not, but what value does the tax payer get for his >£5 million paid in the expectation of an independent recommendation? There is no "paper trail" to show that the "scientific ignoramus" that was CoRWM was in any position to resist the influence of vested interests, and the role of Dalton and his panel in the CoRWM process is as far from transparent as it is possible to be.

Had these so called advisory entities (RS and Geological Society) been contracted in November 2003 to the task assigned to CoRWM, there is little doubt that the proposed solution would be geological but it would have been much more detailed and we don't doubt properly optimised for safety and cost so that site selection and implementation could be immediately addressed. They would also have recognised

the need for and been capable of conducting, an effective public consultation process.

What the public have not got for their money is a solution that can be implemented (and we don't mean further rounds of public consultation but rather finding a suitable place to dig a hole) and thereby starting to reduce the risk and cost they are presently exposed to, nor the assurance that the geological solution has not been chosen in the interests of those with a vested interest, that is, an independent assessment.

In essence CoRWM has been forced by its lack of scientific expertise and its inherent antagonism to science (it could have enlisted technical support from the beginning if it had wished, as was indeed envisaged in CoRWM's Terms of Reference, but it repeatedly refused to do so) to outsource the most important aspect of its mandate, namely to reach an independent recommendation for a practicable option. Scientific considerations are central to this remit and CoRWM was predictably unable to meet that challenge. Dalton, as Defra's Chief Scientific Advisor, should have recognised the lack of balance of membership expertise on CoRWM at the outset but he failed to do so. He was brutally alerted to this failure by the HoLC in December 2004[2] and chose to appoint an unaccountable advisory panel to serve as compensation for the lack of necessary expertise on CoRWM. In so doing he undermined CoRWM's independence; even if that were not actually the case, that is how it can all too easily be construed. In addition his response was slow (announcement of his involvement in January, policy meeting in Defra in March and first recorded comment by the Panel in October 2005) and valuable time was lost. Consequently the science strategy was not thought through and the "expertise on tap" strategy favoured by CoRWM was allowed to continue with all the limitations that has. It is this, in our view, that limited CoRWM to offering only a generic solution, which they have dishonestly then "back-fitted" as the original intention as they had no conceivable basis on which to recommend anything else.

What concerns us most is that this essentially political maneuvering appears to have been condoned by the "scientific establishment". That risks bringing discredit on science itself. Due to the support, or at least the lack of sanction, they have received from bodies such as the RS, CoRWM has been able to evade its responsibility to answer the professionally legitimate criticisms we and others have made, in good faith, of its process. In effect we believe that the RS has weighed in the balance on the one hand "the good of science" and on the other "getting what they regarded as the appropriate outcome from CoRWM"; the latter, it appears, won. Science has been manipulated for political ends. We are sure that the tax payer would be pleased to hear from the RS their defense of the CoRWM process and its outcome in terms of value for their money now and in the future. Nor should the time wasted by CoRWM be overlooked – this has resulted in continued and unnecessary exposure of the public to the on-going risk of temporarily stored nuclear waste, surely a legitimate public concern in this age of terrorism.

Prior to issuing their excoriating report in December 2004 the HoLC took verbal evidence from, among others, the Minister of State responsible for CoRWM, the now sacked Elliot Morley. One, now it seems, prescient question put by the HoLC was

[2] The HoLC state: "We cannot understand why Defra's Chief Scientific Advisor was not directly involved in the formation of a committee that will be providing advice to Ministers on crucial scientific and technical matters." (Para 3 under Section 1.4, p 6)

would he, the Minister, "*fly on an aircraft the engines of which had been selected by a committee with a wide range of opinion …. but relatively limited technical expertise?"* This turns out to be good analogy for what has happened. Following this warning the "committee" were allowed to continue with their project but the Minister delegated his "chief aeronautical engineer" to assist them and he in turn helped them to recruit the assistance of the country's leading "aeronautical engineers" who cooperated on the basis that they would confine their input to answering any questions raised by the "committee" and not look at how their advice was applied. In launching their "innovative choice of engine" the "committee" claimed that it would be safe because they had sought the advice and endorsement of the country's "finest expertise".

Would this be a suitable engine to fit to a passenger aircraft?

Keith Baverstock
David J Ball
5 December 2006

Dear *******,

Congratulations on your Winter 2010 Newsletter, which is a highly effective and interesting document outlining progress on the MRWS process. We read with considerable interest the views presented on page 3 on the question "Is West Cumbria's Geology Unsuitable", and would like to take this opportunity to offer the CoRWM position on the views expressed, both of which have inaccuracies. Our position is informed by our collective understanding of the requirements of the level and quality of geological knowledge that is needed in order to move from the high-level considerations of unsuitability used in the BGS screening study to the more specific assessment of potential suitability that the MRWS process will involve moving forward to Stage 4. This position is also conditioned by and offered in the light of the MRWS process and the proposed framework for site identification that is being developed and will be the subject of consultation later in 2011.

It is clearly of singular importance to the progress of the MRWS process, and engagement of the Partnership within it, that there is some confidence that potential subsurface sites may exist within West Cumbria. We recognise this, and agree that it would be poor use of public resources, as well as community time, effort and capacity, to travel down the path towards a Decision to participate if there clearly was no prospect of potentially suitable sites being identified for subsequent assessment.

Our position is that there is no robust scientific case to support the contention that all of West Cumbria is geologically unsuitable. Likewise, there is no basis for the opposite contention. At the present point in the MRWS process it is important to recognise that the amount and quality of geological information available across that part of West Cumbria not excluded by the BGS site screeing report is highly variable, and for most of the region insufficient to make an informed decision on whether a selected sub-area is suitable. Equally,this in no way implies that all or any of the remaining area is definitely unsuitable. More work needs to be done on the assessment of existing geological and related information in order to differentiate sub-areas to highlight those that may be potentially suitable and so contribute to the identification of sites for further study and investigation. Even those areas for which considerable geological information is available will need to be evaluated using consistent and robust site identification and assessment methodologies.

The process of moving from non-excluded area to sites and thence to site investigation is a stepwise one that will involve the stepwise

gathering, development, assessment, and integration of geological and other information, underpinned by robust processes of analysis, review and accountability. This must be borne in mind and balanced against the natural tendency to project oneself further forward in the process and thereby risk missing critical steps.

Turning once more to the articles on page three of the Newsletter, we consider that it is important to highlight their deficiencies in order to assist you in your work.

Professor Smythe argues that 'scientifically all of West Cumbria is unsuitable', and quotes this as a conclusion of the 1995-1996 planning Inquiry. Firstly, if this argument is to be made, it must be subject to the same rigour and quality of analysis as the counter claim that all of West Cumbria is suitable, a claim that is not and has not been made. Secondly, Professor Smythe misrepresents the conclusions of the Planning Inquiry. Careful reading of the quoted report (******) reveals that the Inspector, whilst noting the then current IAEA guidelines, did not at any stage reflect upon or draw conclusions on the suitability or otherwise of West Cumbria as a whole. His report, and that of the technical assessor, whilst drawing on evidence and views relating to other parts of West Cumbria, was focused on that small area for which planning approval was sought for construction of an RCF. Professor Smythe also states that 'the rocks and underground flow of water are too complex and unpredictable', and claims that the UK is ignoring international guidelines that relate to this. The relevant international guidelines were, at the time and until very recently, contained in IAEA document 111-G-4.1, 1994 "Siting of Geological disposal Facilities" (http://www-pub.iaea.org/MTCD/publications/PDF/Pub952e web.pdf). The guidelines on site selection in that document (pages 10-11) are described as general guidelines and that there would be a need to account for site-specific circumstances. These guildelines are, we understand, soon to be superseded by a new set of IAEA guidelines (Geological Disposal of Radioactive Waste (WS-R-4) - http://www-ns.iaea.org/downloads/standards/drafts/xds334.pdf), available in draft form.

Alun Ellis, in his statement in support of further geological investigations in West Cumbria, correctly outlines in general terms the process for moving from the BGS report and non-excluded areas to identification of potential sites. However, in the final sentence of his submission there is an important error. It is incorrectly stated that the information produced on the site near Sellafield in 1997 'showed that groundwater flows and flow paths at that location were consistent with the safe disposal of intermediate-level waste'. CoRWM members, in a set of comments on

the draft NDA Briefing note on Geology (December 2010), challenged this assertion and suggested a correction that is consistent with the results of the surveys referred to by Ellis. The revised and final NDA briefing note of 2nd February 2011 has taken note of this challenge and now states 'showed groundwater flows and flow paths which Nirex concluded did not exclude the possibility of safe disposal', which more correctly reflects the situation that should be conveyed to the Partnership and public.

We trust that you find these comments of use in your continued deliberations on and engagement with the MRWS process as it moves from Stage 2 and 3 to Stage 4.

With regards,

Don Bradman, Sachin Tendulkar, Jack Hobbs and Brian Lara
Committee on Runs Winning Matches

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A Note by the British Geological Survey and Nirex on the Suitability of UK Geology for Siting a Repository for Radioactive Waste

In 1986 the BGS undertook a study that identified approximately 30 % of Great Britain as potentially suitable to host a repository for intermediate-level radioactive waste. In response to queries from CoRWM, Nirex has commissioned the BGS to review this work and to provide an updated assessment, based on current understanding, for all the higher activity wastes being considered by CoRWM. Based on its geoscientific databases and the expertise of its specialist staff, the BGS is confident that it should be possible to identify areas of the UK in which geologically suitable sites for the disposal of radioactive waste could be found following a detailed evaluation programme, and subsequently confirmed by in-depth site characterisation activities.

The BGS has reviewed the characteristics of existing ILW/LLW disposal concepts and the geological factors relating to packaged HLW/spent fuel (KBS-3 concept) and believes that the geological conditions that would be suitable for the former will also be appropriate for the isolation of the latter. The biggest difference between the wastes is that the latter are heat generating but we do not believe that the amount of heat generated, especially after an extended period of active management (of order 50 years, for example), is a major issue and that a repository can be designed to minimise the impact of the thermal input.

It is planned that this analysis will be published as a report to Nirex later in 2006 following an appropriate level of peer review. Nevertheless, it can be concluded that rather more than the previously determined 30% proportion of the UK land mass would provide a potentially suitable geological setting for a repository.

A variety of different rock types in a number of geological situations offer potentially suitable repository host rocks. These vary from low permeability ‘hard’ rocks through potentially plastic clays to halite/anhydrite beds. The ‘constructability’ of the different rock types varies greatly: their responses to the excavation of a repository will be different and there will be different issues relating to the rock type and the depth of excavation. While these may place constraints on the design of a repository, the BGS believes that engineered solutions will be available to overcome these issues in all of the geological environments considered. Therefore the proportion of the UK land mass that would be geologically suitable in terms of the long-term isolation and containment of radionuclides would not be significantly reduced for a phased repository option that incorporated a period of reversibility of up to hundreds of years.

Clearly, the geological options for the safe long-term management of higher activity radioactive wastes in the UK are varied and in total represent a sufficiently high proportion of the UK land mass so as not to be prohibitively restrictive. This conclusion is not affected by consideration of a phased geological repository that provides for an extended period of reversibility.

British Geological Survey/ United Kingdom Nirex Limited

March 2006

EDITORIAL

Keith Baverstock and David Ball

The Importance of Nuclear Waste as an Issue for E&E

We should declare a personal interest in the issue of radioactive waste management at the outset; our interest in the subject, as assessors and managers of risk, was stimulated in 2003 on learning of the intention of the British government to create an advisory group known as the Committee on Radioactive Waste Management (CoRWM). We applied to become members, drawn by the challenge of the problem, social as well as technical, and its obvious importance in a small country which had for decades failed to come up with a 'solution' to its burgeoning stockpile of waste. Both of us had extensive experience of advising on risk assessment and management in relation to a diversity of hazards. We were both appointed but, as it transpired, spent less than one and a half years as members of CoRWM. We will return to this experience later, because it reflects on the present-day tendency of governments and regulators (and also CoRWM) to lay claim to attributes of transparency, openness and inclusivity. First though, we welcome the invitation to be guest editors of E&E and to look back with the benefit of hindsight on how the issue of high level radioactive waste management in particular has developed more globally.

It is worth noting why radioactive waste is a fitting topic for this journal. The short answer has to be that the unresolved issue of nuclear waste is regarded by many as the Achilles' heal of the nuclear fuel cycle, while at the same time nuclear power is gaining favour as, at the least, an interim measure in the global challenge to ensure continuing security of electricity supply during the C21st while also reducing greenhouse gas emissions. What might be unusual for E&E, however, is that in this issue we have invited a highly multidisciplinary group of authors to contribute. This is because, as mentioned above, the process of reaching a decision about what to do with nuclear waste entails both highly technical and complex socio-political issues.

The Papers in this Volume

The opening paper, by Gordon Thompson, sets the scene by providing an historical account of the US effort, so far unsuccessful, to dispose of high-level radioactive waste. As the author says, it is important to understand the reasons for this disappointing outcome, for on the one hand the process of deciding is consuming large amounts of human capital, and, of greater importance, the unresolved situation poses a continuing risk of a large release of radioactive material to the atmosphere. Because of the failure to find a more lasting solution, most high level waste is currently stored at reactor sites in high-density configurations in water-cooled pools. Loss of cooling water could result from accident or attack, leading to a pool fire and, potentially, a

Performance of CoRWM
comments from Rachel Western [1]

27th Jan 2010

Introduction

In September 2001, at the very start of the: '*Managing Radioactive Waste Safely*' (MRWS) programme the Environment Minister, Michael Meacher stated: [2]

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

In this document it will be shown that the Committee on Radioactive Waste Management (CoRWM) is not acting responsibly – for it is telling the Government what it wants to hear – and not what it needs to hear.

Thus although [as CoRWM (ii)] it has been carrying out extensive interviews with those in the radioactive waste field, it has chosen **not** to be the messenger that informs Government of the alarming state of radioactive wastes in the UK.

Three Problematic area of Waste Management

This problem affects three different aspects of radioactive wastes management in particular:

i) the fact that there is no technical case for disposal - and there is no certainty that further research would supply the necessary results

ii) the Sellafield plutonium separation site is running at a constant state of near emergency – and there are insufficient funds to resolve the problem

iii) Sellafield has been allowed to build up stocks of 100t of plutonium unchecked. This is enough for 7,500 bombs & neither the industry, nor the Government have any credible idea of what to do with it.

CoRWM

In response to these three problems,

i) **Disposal Science**

CoRWM certainly does state, in a forthright manner, that there are currently problems with the science of radioactive waste disposal. However, it appears unable to conceive that further 'cranks of the research wheel' might not actually eventually be able to provide a scientifically robust evidence base.

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[1] Dr Rachel Western BA (Oxon) PhD MRSC - Member of Nuclear Waste Advisory Associates (NWAA) and Nuclear Researcher for Friends of the Earth (Cumbria Groups)
[2] "*Government looks for Public Consensus on Managing Radioactive Waste*" – DEFRA Press Release – 12th September 2001, 132/01

Such a position is both contrary to 'scientific method' and also contrary to the position of the Environment Agency.

ii) Sellafield Emergency Status

Waste fuel taken out of a reactor has the property of 'almost instant lethality'. Sellafield liquefies this material & thus makes it much more liable to be dispersed.

CoRWM are either ignorant of the processes undertaken at Sellafield – or otherwise aim to deliberately mislead both the Government and Public. Obviously both are unacceptable.

It is essential that Government has an accurate picture of waste practices undertaken – in order that decision making may be optimised

iii) Plutonium

Due to the fact that Sellafield still applies a military technique to waste fuel management; the UK plutonium stocks have been allowed to increase more or less unchecked. The NDA Plutonium Options report of January 2009 indicated there is no 'credibe option' in place. However, CoRWM reported to Government that the NDA plutonium research was: '*an example of good practice*'.

Once again CoRWM did not give an indication to the Government or to the Public of the nature and degree of the problem that must be faced.

CoRWM + Questionable Practices

During 2009 CoRWM has delivered its work in ways that are extremely questionable. Three examples are.

(1) Reneged on Commitment to Commission Study Disposal Science

In response to my comments on the (Spring 2009) draft disposal document – in which I drew attention to the generic scientific problems identified at the 1990s Inquiry; CoRWM said that they were going to 'commission a study into the lessons to be learned from the Inquiry.'

Instead they drew attention to a presentation on local political issues that had already been delivered.

(2) Failed to Consider NII reference wrt Sellafield Issues

The failure to consider a Nuclear Installations Inspectorate (NII) reference on Sellafield – on the grounds that (a) it was concerned with Sellafield and not the NDA; and (b) it was concerned with interim storage was quite extraordinary.

Clearly Sellafield is an NDA site and CoRWM is concerned with interim storage.

(3) Re-wrote note of Planning Meeting Such that it was Less Accurate

The meeting concerned was the Cumbria County Council Waste Planning Framework meeting of November 2009. The particular part of the note altered was that relevant to the statement made by the Nuclear Installations Inspectorate (NII) representative.

This alteration is extremely significant for two reasons: (a) the veracity of the NII participation at the meeting had been the subject of much contention (over a period of twelve months), and (b) given that Planning Law has changed, Planning Inspectors and also the Public must be able to rely on officials

The fact that – not only are the Public unable to rely on officials – but on top of that, when officials are challenged (through the channel of complaints procedure) those such as CoRWM deem it appropriate to re-write history – provides no assurance that forthcoming decisions will be taken with due diligence.

Failure to Deliver Effective Consultation

The '*Managing Radioactive Waste Safely*' programme was meant to deliver a **'**national debate' which 'inspired public support and confidence'.

Quite clearly it has manifestly failed to do this.

The extent of the failure may be illustrated that whilst the Government are perfectly willing to pay for on advice on how to **implement** Policy, CoRWM are not prepared to pay for advice from academic and professional specialists on the merits of Policy. [3]

The NDA does not have a 'Credible Evidence Base'

Nuclear Energy Companies have begun to make Pre-Application documents available concerning the 'Environmental Impact' of the reactors that they wish to build. However, Nuclear Waste Advisory Associates (NWAA) have become aware that the the Nuclear Decommissioning Authority has no: credible evidence base' for its policies on radioactive waste.

As such DECC's contention that the 'Disposability' of the waste fuels that would arise from the proposed 'New Build Reactors' can be assured is without foundation.

It was the role of CoRWM to inform Government of this fact. But it did not discern this information & so was not able to provide notification

[3] even to the extent of .failure to pay travel expenses in advance - in order to ensure that an invited consultant would be is able to attend a workshop.

Contents

Supporting

Evidence Base

for Comments

Technical and Scientific Background

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 initial element.

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

The element 'Number' 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 central 'nucleus' may be unstable – due to the 'wrong' balance of positive and neutral particles.

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

'Radionuclides'

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

Why Radionuclides are Dangerous

In the process of becoming stable (through decay) radionuclides release particles and / or energy. The particles and energy released

are able to damage DNA

DNA [4]is the 'blue-print' for life. If it is damaged, cancer (either fatal or non-fatal); or alternatively birth defects may result.

[4] deoxyribonucleic acid

What is a "Sievert" ?

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

the energy (per unit weight) of the exposure

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

one joule [5] of 'harm' to one kilogram is called one **'Sievert'**

The Nature of the 'RadWaste' Problem

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 [6, 7] 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*'.[8] 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*'. [9]

---

[5] A joule is a unit of energy

[6] 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)

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

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

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

Lethality associated with Waste Fuel

Source:

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)

On page 21 of this report at para 3.5.2: the following two figures are provided:

1) the lethal **dose** is given as 5,000 'milli-Sieverts' [10]

2) a dose **rate** of one million 'milli-Sieverts' **per hour** is quoted

(one year after one tonne of waste fuel has been taken out of a reactor – when standing at one metre distance from the waste fuel rod)

From these two figures it is then calculated [11] that:

To stand one metre from:

- one tonne of waste fuel,
- one year after its removal from the reactor

- would kill you in twenty seconds.

On page 23 of the NDA 'Disposability' report for Westinghouse 'AP1000' [12] type fuel [13], a weight of approximately 600 kilograms per 'AP1000' fuel assembly is quoted. (see Table B4)

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[9] Two particular activation products of concern are 'carbon-14' and tritium (a radioactive form of hydrogen.)
[10] milli = one thousandth – (for defintion of 'Sievert' see 'Technical section at the start of this document)
[11] (by reference to Figures 3-8a and b (See pp 22- 23)
[12] 'AP' – Advanced Passive
[13] "*Geological Disposal Generic Design Assessment: Summary of Disposability Assessment for Wastesand Spent Fuel arising from Operation of the Westinghouse AP1000* "
NDA (Oct '09)
http://www.nda.gov.uk/documents/upload/TN-17548-Generic-Design-Assessment-Summary-of-DA-for-Wastes-and-SF-arising-from-Operation-of-APPWR-October-2009.pdf

The figure quoted for the weight of an 'EPR' [14] fuel assembly is also roughly 600 kilograms. [15] (See page 29 – Table B9)

Therefore:

- One fuel assembly of either 'AP1000' or 'EPR' type fuel weighs roughly half a tonne.
- This means that standing next to one of either of these fuel assemblies could kill you in about a minute.[16]

Possible Impact of one radioactive atom on DNA

Extensive measures [17] are in order to ensure that the likelihood of someone actually7 standing near to a waste fuel rod is very low. However the 'instant lethality' information is relevant as it provides an indicator of the composite hazard associated with the individual radioactive atoms in the waste fuel.

The National Radiological Protection Board (NRPB) (now part of the Health Protection Agency, the 'HPA') has published a technical paper which states that it is possible that the damage to DNA caused by just **one** radioactive atom would be sufficient cause cancer.

Thus, the NRPB state:

> "***a single radiation track*** *(the lowest dose and dose rate possible) traversing the nucleus of an appropriate target cell has a finite probability, albeit very low, o****f generating the specific damage to DNA that results in a tumour*** *initiating mutation.*" [18]

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[14] 'EPR' – European Pressurised Reactor

[15] "Geological Disposal Generic Design Assessment: Summary of Disposability Assessment for Wastes and Spent Fuel arising from Operation of the UK EPR"
NDA Technical Note no. 11261814
NDA – October 2009
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

[16] assuming that the waste fuel had been removed from the reactor one year earlier and that you were standing one metre away.

[17] Such as extremely thick walls / windows at nuclear reactors or at the Sellafield plutonium separation site on the Irish Sea coast in Cumbria. In addition, when the waste fuel rods are shipped to Sellafield, they are carried in thick casks.

[18] "*Risk of Radiation-Induced Cancer at Low Doses and Low Dose Rates for Radiation Protection Purposes*"
NRPB (1995) (National Radiological Protection Board)
Added/updated: 29 August 2008
Volume 6 , No. 1
ISBN 0-85951-386-6

This statement is not the same as saying that every individual exposure to radioactivity will result in cancer. However, it is saying that there is the potential.

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http://www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb_C/1195733754925?p=1219908766891

Radionuclide Composition of RadWastes

The initial fission products within a waste fuel rod comprise the chemical elements zinc to dysprosium, [19] in addition there are heavy elements of the 'actinide' series (such as plutonium and neptunium). The 'activation product' wastes which arise due to the take up of 'neurons' by the fabric of the reactor building also need to be taken into conmsideration.

The Nirex (2007) Inventory [20] main report Table 6.2 (pp 66 –67) lists:

'Radionuclide activities in all wastes'

NB – the composition set out by in the Nirex (2007) Table listed here – will be very different than the initial raionuclide composition of a waste fuel rod. This is because a number of the radionuclides found in the waste fuel at the time of removal from the reactor decay quickly.

Thus:

Atomic Number	Name of Element	Radionuclide
1	Hydrogen	H-3
4	Berylium	Be-10
6	Carbon	C-14
17	Chlorine	C-l36
18	Argon	Ar-39
		Ar-42
36	Kyrpton	K-40
20	Calcium	Ca-41
25	Manganese	Mn-53
		Mn-54

[19] Saddington K and Templetone W L (of UKAEA – United Kingdom Atomic Energy Authority)"Disposal of Radioactive Waste" Pub: George Newnes Limited (1958) – See Fig One – page 3
[20] The 2007 UK Radioactive Waste Inventory Main Report [Defra/RAS/08.002; NDA/RWMD/004] (March 2008)

26	Iron	Fe-55
27	Cobalt	Co-60
28	Nickel	Ni-59
		Ni-63
30	Zinc	Zn-65
34	Selenium	Se-79
36	Krypton	Kr-81
		Kr-85
37	Rubidium	Rb-87
38	Strontium	Sr-90
39	Yttrium	Y-90
40	Zirconium	Zr-93
41	Niobium	Nb-91
		Nb-92
		Nb-93m
		Nb-94
42	Molybdenum	Mo-93
43	Technetium	Tc-97
		Tc-99
44	Ruthenium	Ru-106
45	Rhodium	Rh -106
46	Palladium	Pd-107
47	Silver	Ag-108m
		Ag-110m
48	Cadmium	Cd-109
		Cd-113m
50	Tin	Sn-119m
		Sn-121m
		Sn-123

		Sn-126
51	Antimony	Sb-125
		Sb-126
52	Tellurium	Te-125m
		Te-127m
53	Iodine	I-129
55	Caesium	Cs-134
		Cs-135
		Cs-137
56	Barium	Ba-133
		Ba-137m
57	Lanthanum	La-137
		La-138
58	Cerium	Ce-144
59	Prasecoymium	Pr-144
61	Promethium	Pm-145
		Pm-147
62	Samarium	Sm-147
		Sm-151
63	Europium	Eu-152
		Eu-154
		Eu-155
64	Gadolinium	Gd-153
67	Holmium	Ho-163
		Ho-166m
69	Thulium	Tm-170
		Tm-171
71	Lutetium	Lu-174
		Lu-176
72	Hafnium	Hf-178n
		Hf-182

78	Platinum	Pt-193
81	Thallium	Tl-204
82	Lead	Pb-205
		Pb-210
83	Bismuth	Bi-208
		Bi-210m
84	Polonium	Po-210
88	Radium	Ra-223
		Ra-225
		Ra-226
		Ra-228
89	Actinium	Ac-227
90	Thorium	Th-227
		Th-228
		Th-229
		Th-230
		Th-232
		Th-234
91	Protactinium	Pa-231
		Pa-233
92	Uranium	U-232
		U-233
		U-234
		U-235
		U-236
		U-238
93	Neptunium	Np-237
94	Plutonium	Pu-236
		Pu-238
		Pu-239
		Pu-240
		Pu-241
		Pu-242
95	Americium	Am-241
		Am-242m
		Am-243

96	Curium	Cm-242
		Cm-243
		Cm-244
		Cm-245
		Cm-246
		Cm-248
98	Californium	Cf-249
		Cf-250
		Cf-251
		Cf-252

Sr90, Ru106, Cs137 and Ce144
are in the equilibrium with the short-lived daughter radionuclides
Y90, Rh106, Ba137m and Pr144
(respectively)

The radionuclide content of radioactive waste changes with time and the computer programme "*RadDecay*"

http://www.radprocalculator.com/RadDecay.aspx

can be used to give an indication of:

- the decay path of one radionuclide to another, and also
- the radioactivity that is released in the process

Radionuclides Exist in Combination with other Chemicals

It is the radionuclide that causes the harm. However, generally speaking [21] 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

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

- 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.

Disposal

EA & Acceptable Harm from Disposal

The February 2009 Environment Agency (EA) 'Criteria for RadWaste Disposal' document [22] sets out [23] the Environment Agency's view – in quantitative terms – the degree of harm due to disposal, that the EA would deem to be acceptable.

Thus, the Environment Agency refer to a baseline [24] of a:

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

of developing either [25]:

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

The EA state [26] that this:

"*indicates the standard of environmental safety we are looking for*"

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

20 micro Sieverts per year [27 , 28]

(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
an exposure level that was higher than 20 micro Sieverts. [29]

---

[22] "*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]
[23] page 46 (para 6.3.10)
[24] page 47 (paragraph 6.3.1)
[25] page 47 (para 6.3.15)
[26] page 46 (para 6.3.11)
[27] Environment Agency Disposal Guidance (Feb '09) page 47 – para 6.3.17
[28] (NB – 'micro' – means one millionth)
[29] also para 6.3.17 – page 47

The 1990s Nuclear Waste Inquiry

In the 1990s the UK body 'Nirex' [30] planned to undertake excavation work near the Sellafield site in Cumbria, in preparation for the burial of radioactive waste.

A Planning Inquiry was held into the proposal in which the generic scientific arguments against the project were examined at some length.

The proposal was rejected by both the Inspectors and also the Secretary of State for the Environment – and this was partially on the grounds of the scientific inadequacy of what had been put forward.

Background of 1990s Inquiry [31]

Over a period of 66 days from September 1995 and February 1996 there was a Public Inquiry at Cleator Moor, Cumbria into an appeal by United Kingdom Nirex Limited, Britains nuclear waste disposal body, against the refusal of Cumbria County Council to grant planning permission for a 'Rock Characterisation Facility' on land at Longlands Farm, Gosforth, Cumbria.

The initial excavation of shafts and tunnels (a so-called 'RCF') was intended to demonstrate the practicability of a deep underground radioactive waste repository, which UK Nirex hoped could eventually be located alongside. The site is close to the Sellafield Nuclear Site (which is a Plutonium Separation Facility) and just outside the Lake District National Park boundary.

The scheme would have involved sinking two 5m diameter shafts to depths of up to 1020m and opening out galleries in the Borrowdale Volcanic Group of rocks from and in which extensive scientific and engineering investigations and experiments would be conducted.

The inquiry heard detailed evidence from Nirex, and from many objectors including Friends of the Earth, Greenpeace and the Irish government.

Early in 1997 John Gummer, Secretary of State for the Environment, formally rejected the Appeal.

[30] the 'Nuclear Industry Radioactive waste Executive'
[31] This text is largely based on text from the Web-Site of Colin Knipe (http://www.jpb.co.uk/knipe.html) BSc(Hons); Ceng; CGeol who was the Technical Assessor at the Inquiry

Generic Scientific Problems with the 1990s Proposal

John Gummer , the Secretary of State for the Environment, based his rejection of the 1990s proposal on the evidence of the reports presented to him by the Inquiry Inspector, Mr C S McDonald, and also the Technical Assessor, Mr Colin Knipe.

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

> "*new and untried with more experimentation and modelling development indubitably required*" [32]

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*" [33, 34]

Conclusions of Colin Knipe - Technical Assessor at 1990s Inquiry

Colin Knipe was the Technical Assessor at the (Sept 1995 – Feb 1996) Planning Inquiry into whether or not the Nuclear Waste Agency 'Nirex' should be given permission to begin excavation works at their proposed nuclear waste disposal site.

The planned excavation was called an 'RCF' – or 'Rock Characterisation Facility' – and was proposed as an intermediate stage between a programme of boreholes (to investigate the water flow system at the site) - and a full commitment to excavating the caverns that would be required for underground nuclear burial.

In Mr Knipe's Report he stated that:

> **Chapter - "C SCIENCE & TECHNICAL PROGRAMMES"**
>
> "C.142 *The evidence suggests that considerably more experimentation and model development is needed on radionuclide solubility, sorption and general thermodynamic relationships over the range of temperatures and chemical conditions"*
>
> "C.144 *There is a general need for the Nirex science programme to be advanced on all fronts"*
>
> ….

[32] 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
[33] McDonald (1997) p277 para 8.56
[34] 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

(j) modelling in more detail the effects of the construction and operational phases of the proposed RCF on groundwater conditions and how the RCF might affect the post-closure performance and risk of an adjacent repository, i.e. an up-to-date equivalent of Nirex Report 560 [D.57];

Statements following the 1990s Assessor's Report

John Gummer [35] (March 1997)

On the 17th March 1997, the Environment Secretary John Gummer announced that he agreed with the Nirex Inquiry Inspector's recommendation that the proposal to begin excavation work at the planned nuclear waste disposal site should be rejected. He stated:

> *"I remain concerned about the scientific uncertainties and technical deficiencies in the proposals presented"* [36]

DEFRA – (September 2001)

This position was confirmed in September 2001 – at the launch of the:

> "***Managing Radioactive Waste Safely"***
>
> > ***Proposals for developing a policy for managing solid radioactive waste in the UK***"

Consultation Document – thus at page 9, para 1.3, the document states:

> "*In March 1997 the then Secretary of State for the Environment decided not to give Nirex [37] planning permission for the RCF[38]. This decision called into question whether at that time an underground repository for the disposal of radioactive wastes could be scientifically justified or publicly acceptable. This led to a completely new look at radioactive waste management policy in the UK.*" [39]

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[35] Secretary of State for the Environment under John Major
[36] Department of the Environment News Release: '*John Gummer Refuses Nirex Planning Appeal*' 17 March 1997, page 2
[37] Nirex – the 'Nuclear Industry Radioactive Waste Executive' [now subsumed in the 'NDA' – the 'Nuclear Decommissioning Authority'
[38] RCF – Rock Characteristion Facility
[39] "Managing Radioactive Waste Safely - Proposals for developing a policy for managing solid radioactive waste in the UK" – DEFRA – (September 2001) http://www.ni-environment.gov.uk/ra_waste.pdf

(2009) CoRWM + Disposal

At the end of July 2009, CoRWM published their final version of their report on Disposal. [40] Prior to this in April 2009 CoRWM had published a draft version of the Disposal report – and invited comments.

At the end of May (2009) I submitted my comments on the draft, and the primary point that I made was that it had not taken into consideration the conclusions of the 1990s Inquiry into the proposal to begin excavation works at the site where the nuclear industry planned to bury radioactive wastes.

The reason that I drew attention to this decision was that it was based on generic scientific arguments and not simply site specific geological considerations.

If disposal were to be progressed – it needed to be demonstrated that these difficulties had been resolved.

CoRWM's 'Phantom Report' on the 1990s Inquiry cf Generic Scientific Problems with Disposal

On the same day (July 31st) that CoRWM published the final version of their report on Disposal, they also published a log of their response to the comments that had been made on the Draft.. (See Doc 2592 [41])

In this log CoRWM stated- in response to my comments that CoRWM::

> " is ***pleased to note that a study is to be commissioned on the key lessons*** that can be learnt from both the siting process conducted ***and the Inquiry.***
>
> (page 15)

However, the study **to be** commissioned by CoRWM on 31st July was in fact a study ***that had already been presented*** (on 14th July). Moreover this presentation **did not** address the scientific issues that were the cause of my concern.

[40] CoRWM Report (2550) – Final Report on Disposal - Published 31st July 2009
http://www.corwm.org.uk/Pages/Current%20Publications/2550%20CoRWM%20Report%20on%20Geological%20Disposal%20Final%2031%20July%2009.pdf
[41] http://www.corwm.org.uk/Pages/Current%20Publications/2592%20Log%20of%20Comments%20on%20Consultation%20Draft%20GD%20Report%20Final%2031%20July%2009.pdf

E-mails wrt CoRWM's 'Phantom Report'

10th Sept – CoRWM to Rachel Western

- no plans to review John Hetherington presentation

Adam Scott to Rachel Western (by E-mail
10th Sept 2009

Dear Rachel,

Please accept apologies for our not answering your and Phil's (18 June) question at all adequately. We've checked our records and this is the position:

An early draft (version 5, published on 10 June) of the log of comments (doc.2592) on the draft Geological Disposal Report said, in relation to your response, that "a study is to be commissioned on the key lessons that can be learnt from both the siting process conducted and the Inquiry. As part of their scrutiny function CoRWM will critically review this report when available."

That reflected thinking at the time by Members involved with this part of the Report. But the process of reviewing respondents' comments, and revising the Report where necessary, continued through June and July. A revised draft of the log, published on 17 July, did not contain the final sentence about a CoRWM "review". Nor did the final (31 July) version. This was circulated on 31 July together with an e-bulletin and the Report itself. There is no proposal in CoRWM's work programme to carry out such a review. We have checked our understanding with Members, which is that CoRWM would look at the study, and other relevant information such as the Partnership's discussion of John Hetherington's findings, as part of their overall role of scrutinising the MRWS process generally and developments in Cumbria more particularly. There was no intention to review the study in the sense of criticising its findings, only to review what information could be drawn from it. As it turned out, I believe there was a presentation by John Hetherington rather than a formal report to the Partnership.

I'm copying this to Phil. Glad you could both make it yesterday; hope the event was of some value to you.

Best wishes,

Adam

14th July – Partnership Meeting

John Hetherington Presentation

- presentation looked at Community + Local Govt involvement
- **did not look at status of current generic science**

‘Partnership’ Meeting - 14th July 2009

John Hetherington Presentation

‘Lessons from the Nirex Process’

http://www.copeland.gov.uk/pdf/Mtg%20Rpt%2014Jul09-v2.pdf

[pages 3 – 6 (inc discussion)]

~~~~~~~~~~~~~~~~~

In fact rather than examining the current status of the generic scientific issues raised in the 1990s Inquiry; John Hetherington addressed the issue of:

“*Engaging Local Government and Community Stakeholders in Repository Development*”
~~~~~~~~~~~~~~~~~

31st July – CoRWM Resp to Comments

- my comment on 'rigour of the Inquiry process'
- CoRWM Resp – that Study is to be commissioned on key lessons form the Inquiry

Log of CoRWM's Comments on Responses to Cons on Disposal

Doc 2592 (31st July 09)

My comment

"*The 1990s Public Inquiry process enabled a far more rigorous process of scrutiny of the case for disposal.*" (page 14 of log doc)

CoRWM Comments

"*The first issue is* ***more rigorous than what****?*" (page 15)

"*a study* ***is to be*** *commissioned on the key lessons that can be learnt from both the siting process conducted and the Inquiry*." (page 15)

http://www.corwm.org.uk/Pages/Current%20Publications/2592%20Log%20of%20Comments%20on%20Consultation%20Draft%20GD%20Report%20Final%2031%20July%2009.pdf

The Rigour of the Inquiry Process

"*In addition to the Inspector and Assessor's reports, the Inquiry documentation comprises of the Proofs of Evidence (and their associated references) plus the transcripts of the cross examinations of the witnesses*."

[See page 5 of my May 2009 Response to the CoRWM Consultation on Disposal]

….the key to the rigour of the 1990s Public Inquiry process was that **referenced** literature could be **cross-examined in front of a Planning Inspector** who was assisted by a **Technical Advisor**.

Study to be Commissioned

In fact CoRWM were referring to a study that had already been commissioned (by the Partnership – in March 2009 (see below).

18th June – Phil Davies to Adam Scott

- questions wrt nature of study on 1990s Inquiry

Phil Davies to Adam Scott (CoRWM) - 18th June 2009

Dear Adam,

STUDY COMMISSIONED INTO NIREX INQUIRY.

I note in Document 2592 (Log of Responses to Consultation on CoRWM's Geological Disposal Report), on p.19, in response to a comment by Dr. Rachel Western on the 1990's Nirex Inquiry, you state that **CoRWM are "pleased to note that a study is to be commissioned** on the key lessons that can be learnt from both the siting process conducted and the Inquiry. As part of their scrutiny function CoRWM will critically review this report when available".

Do you have any information about this study, eg:
Who is commissioning it?
Remit, terms of reference and scope?
Is the contract being advertised, and if so where and when?
Value of the contract?
Who is paying for it?
Completion date?

Thanks

Phil

6th July – CoRWM to Phil Davies

- the Study is being undertaken by the West Cumbria Partnership

CoRWM to Phil – 6 July 2009

From: Simon.Mussett@decc.gsi.gov.uk
To: phil_davies_2000@yahoo.co.uk
Date: Monday, 6 July, 2009 13:00:01
Subject: CoRWM Response

Dear Phil,

Thank you for your emails and please see a response … below:

1. Nirex Inquiry Study

The study is being undertaken/commissioned by the West Cumbrian Partnership as part of their work programme. You will be able to find out more information on their website (http://www.copeland.gov.uk/westcumbrialive/Default.aspx?page=0) or by emailing them at co-ordination.unit@westcumbria.gov.uk.

March 2009 – W Cumbrian Partnership

- to commission paper from John Hetherington on 1990s Inquiry

March 2009 - Partnership

cf - **17th March 'Partnership' Meeting**

[http://www.copeland.gov.uk/PDF/Mtg_Rpt_170309_v2.pdf]

Work Plan - Appendix 4, p 22

6 – Learning the Lessons from 90's

Task *: Understand lessons learned from 1990's*
Output *: Understanding of history, lessons learned, and how to apply learning*

Process*: Request a paper setting out high-level advice to the Partnership on how it can learn the lessons from the 1990s*

Authored by: ***Hetherington*** *Nuclear Consulting*

Circulate lessons paper to Partnership in advance for reading
Also, circulate NIREX review of the Site Selection Process (Jun05)

Discussion on 14 July (tbc)

Identify any outstanding questions to address, and how

Coverage*: Focus on: Key advice for this Partnership given the learning from 1990s*

Timing *: 14 July*

Disposal + Scientific Method – EA cf CoRWM

In November (2009) Francis Livens [member of the Committee on Radioactive Waste Management CoRWM (ii) and also Professor of Radiochemistry at the University of Manchester] said: [42]

> "*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.*"

And also in November 2009 Clive Williams of the Environment Agency stated:

> "*work may or may not indicate that an acceptable safety case can be made.*" [43]

The question is – if we invest enough effort and money – will we necessarily 'get there in the end' – or should we be 'taking a few steps back' and pausing for thought.

EA (Nov 2008) – Research may not Solve Problems

The fact that money and effort invested in future research may not indicate that safe disposal is possible was referred to extensively in November 2008, in the Environment Agency's response [44] to the (Summer 2008) NDA [45] Consultation on their research programme:

The following is a compilation of the points made. (The headings and the emphasis are added – and were not in the original document)

<u>Not all Reasearch Outcomes would be 'Acceptable' wrt Disposal</u>

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42 "*Nuclear waste research resurfaces*" 'Chemistry World'
http://www.rsc.org/chemistryworld/News/2009/November/20110901.asp
Fri 20th Nov '09

43 E-mail from Clive Williams to Rachel Western and Adam Scott [CoRWM (ii) Secretariat] 16th November 2009

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

45 NDA – Nuclear Decommissioning Authority

"*4.3 Setting pre-defined research objectives and clear criteria for evaluating the output of R&D are essential to gain public confidence. A successful strategy to communicate the significance of the research findings will be vital. It is particularly important to counter any suspicion that research findings will be deemed "acceptable" regardless of what the research actually identifies.* "
(page 4 – para 4.3)

Testing is not the same as 'Confirming'

"*4.8 All references to underground R&D activities are stated to be to "confirm" aspects of site performance ("confirmatory tests"). No mention is made (in Figure 3.2 or elsewhere) of the role of URLs to enable trialling, testing or demonstrations of competing techniques*"
(page 5 para 4.8)

Confirmation Bias

"*4.9 The words "confirm" or "confirmatory" appear 15 times throughout the document. NDA should provide assurance that it can manage issues associated with "confirmation bias"* [1]
(page 5 – para 4.9)

[Footnote 1]
"Confirmation bias results in a situation where, once a view has been formed, new evidence is generally made to fit. Strong initial impressions structure the way that subsequent information is interpreted."

See for example "Uncertainty Communication, Issues and good practice" Penny Kloprogge, Jeroen van der Sluijs and Arjan Wardekker (December 2007)
http://www.nusap.net/downloads/reports/uncertainty_communication.pdf
(page 5 Footnote [1])

Research may identify additional questions

"*Section 2.1.1* (of NDA Research Consultation document) *states: "further research will be carried out during a geological disposal facility development process in order to reduce uncertainties".*

[EA]
" Further research has the potential to increase uncertainties, e.g. by revealing unforeseen complexities or additional processes influencing the system under study. While a well defined and executed research programme can answer fundamental questions, uncertainty is a normal characteristic of science, and as such, ***additional questions (and uncertainties) are often raised****. It is the management of these uncertainties, e.g. prioritising and deciding how to address them that is important.*" (page 6 – Re: Section 2.1.1)

Research / System Development - Relationship not easy to trace

"Much R&D has been commissioned over the last 20 years but its impact on the evolution of NDA's facility design is not easy to discern. ... The claimed link between R&D and the development of the DSS [Disposal System Specification] and facility design needs further substantiation. Similarly for the feedback between the generic safety assessments and R&D."
(pp 6 – 7 Re: Section 3.1.1)

CoRWM - Further Research will Resolve Problems (Oct '09)

Although CoRWM (ii) state that

> *"Fundamental research may also reveal unknown issues or phenomena that have not yet been considered but which may be of crucial importance"*
>
> (see para 2.4 of the finalised (Oct '09) R&D report (Doc 2543) [46]

and

> *"...fundamental research provides the detailed understanding that underpins safety cases and facility designs. It can also reveal hitherto unknown issues that need to be considered."*
>
> (para 2.37)

CoRWM seem to feel that enough 'cranks of the research wheel' will – in due course - **necessarily** provide the data needed to deliver a Safety Case for Disposal

Thus at page 89 (para 6.1) CoRWM state:

> "*In particular, CoRWM is convinced that enough is currently known about geological disposal to engender confidence that it is the right way forward.*"

It is important to note that this view is at odds with the Environment Agency perspective that it is possible that further research may indicate that it is not possible to make a safety case for the disposal of nuclear waste.

Problems with Disposal Science (Jan 2010) - NWAA

In January 2010 the Nuclear Waste Advisory Associates [47] (NWAA) gave evidence to House of Commons Select Committee on 'Energy and Climate Change' as part of their Inquiry into:

> "*The Proposal for National Policy Statements on Energy*"

The 'NWAA' evidence focussed on the technical problems associated with the proposed burial of radioactive wastes

> **Link to Evidence**

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46 http://www.corwm.org.uk/Pages/Current%20Publications/2543%20CoRWM%20Report%20on%20RD%20Final%2030%20October%202009.pdf

47 http://www.nuclearwasteadvisory.co.uk/page.asp?Id=28&preview=0

http://www.nuclearwasteadvisory.co.uk/uploads/5964MemorandumforNuclearWasteAdvisoryAssocisates%5BFinal%5D.doc

The Executive Summary is set out below

Executive Summary

1.1 This memorandum examines the evidence for the Government's assertion that effective arrangements will exist for waste produced by new reactors.

1.2 We note that four former members of the Committee on Radioactive Waste Management (CoRWM (i)) have written to the the Secretary of State to express concern that the Committee's recommendations have been seriously misrepresented in the Draft National Policy Statement for Nuclear Power Generation, and state that: *"It is unknowable whether or not effective arrangements will exist …"*

1.3 Nirex's application to begin excavation work at their proposed disposal site near Sellafield in the 1990s - the so-called 'Rock Characterisation Facility' (or 'RCF' proposal) was rejected on generic scientific grounds (as well as for site specific reasons). The implications of this rejection have still not been fully examined or resolved.

1.4 Technical problems and uncertainties described by the Environment Agency (EA), and the European Union Joint Research Centre (EU JRC), as well as the uncertainties regarding radionuclide properties detailed in this memorandum, such as their solubility and sorption – or even their presence as a gas - could mean estimted contamination levels calculated for a deep geological disposal facility are in error by a factor of 10,000 to 1,000,000 which clearly has implications for the risk estimates.

1.5 Resolution of the problems raised at the Nirex RCF Inquiry, and more recently by the EA and EU JRC, is not a simple matter of providing sufficient funding for researchers over the next few decades. It may, in fact, not be possible to resolve all of the issues. Further research may not produce the required answers or it may identify further serious problems that simply had not previously been realised. Therefore it may not be possible to make a safety case for deep geological disposal. So, the Government's confidence that effective arrangements to dispose of waste from new reactors will exist is premature.

1.6 The task at hand for a waste disposal applicant is to demonstrate that the resultant dose would be less than 20 micro sieverts[1] per year. This memorandum addresses the current status of the nuclear industry's ability to utilise reliable and meaningful data in order to forecast the likely health impact of placing nuclear waste in a deep underground disposal facility – in order that such a project would not 'recklessly endanger people in the future.

1.7 We conclude that achieving such a dose target is simply not scientifically demonstrable or achievable in practice. It is in the nature of chemical elements and geological and biological systems to behave in a variable and hence unpredictable

manner such that they make reliable risk/time calculations into the far future not only difficult but virtually impossible.

1.8 The Government's evidence (produced as part of the Nuclear National Policy Statement consultation) refers very specifically to the Finnish disposal project. It claims that the Finnish Regulator ('STUK') "*did not identify any reason why the project couldn't move forward*".[2] But this does not provide an accurate representation of the STUK evidence base.

1.9 New reactor fuel would be 'high burn up' fuel which is hotter and more radioactive than spent fuel from existing reactors and unlike anything generated in the UK before. Such waste fuel would require longer storage at the reactor site and would be more fiercely radiotoxic. The Government is relying on disposability assessments of this new type of fuel carried out by the Nuclear Decommissioning Authority (NDA) to reach its conclusions. But these assessments have still to be reviewed by the Environment Agency (EA). However, the EA review is not due until Spring 2010 and therefore the results of this project will not be available to be fed into the Government's Public Consultation on this matter, thereby denying consultees access to crucial information.

1.10 The Nuclear industry has failed to present independent information to either the Nuclear NPS or the Justification process on conditions for workers and the public in the countries that mine and process uranium for new reactors. Two previous public inquiries into new reactor construction in the United Kingdom (UK) have recommended that an evaluation of these impacts should be carried out. Without a full evaluation of these impacts, including a Sustainability Appraisal, the Nuclear NPS is not fit for purpose

1.11 In short, the Government's conclusion "*…that effective arrangements will exist to manage and dispose of the waste that will be produced from new nuclear power stations"* is not supported by the evidence. The Nuclear NPS is, therefore, not "fit for purpose".

Notes:

1 micro = one millionth. A Sievert is a measure of radiation dose. It's units are energy - per unit weight - of exposure ; and it can be thought of in terms of the overall '*punch*' associated with the bombardment.

2 The arrangements for the management and disposal of waste from new nuclear power stations: a summary of evidence, DECC November 2009 para 121

https://www.energynpsconsultation.decc.gov.uk/nuclear/managementdisposalwaste/summaryevidencepaper/

Sellafield & Hazard Amplification

Decommissioning + 'Removing Hazard'

"*Dismantling a closed down nuclear facility and removal of its contents, both radioactive and non-radioactive, is known as decommissioning.* ***The key objective in decommissioning a nuclear facility is progressively to remove the hazard*** *within an overall framework that ensures the safety of workers and the public, and protects the environment.*" [para 3.15 (page 26)]

(Emphasis added)

Source:

"Managing Radioactive Waste Safely - Proposals for developing a policy for managing solid radioactive waste in the UK"

Department for Environment Food and Rural Affairs (DEFRA)
September 2001

Context Note - Sellafield

What Sellafield Does

Sellafield is a military site set up immediately Post War to provide plutonium for nuclear bombs.[48 , 49] 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*' [50] For this solvent based technique, it is of course necessary that the solid rods of radioactive waste are converted to liquid.[51] As a result the radioactive wastes left over from the plutonium extraction are liquid. Because they are intensely radioactive they are known as '*Liquid High Level Waste*' (or Liquid HLW) [52, 53]

Sellafield continues to separate plutonium from other nuclear wastes even though [54] the military requirement has been met.[55]

Thus, essentially Sellafield::

- converts **Solid** Radwaste into the more dangerous **Liquid** form;

- whilst – at the same time - building up unwanted stocks of the nuclear weapons material Plutonium.

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[48] 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)

[49] 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

[50] The technique used is 'Plutonium Uranium Refining by Extraction' – or 'Purex' - see Gmelein Handbook – Transuranium Chem (x30) AI II p209

[51] This is achieved by dissolving the rods in acid.- see Gmelein Handbook – Transuranium Chem (x30) AI II p209

[52] 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

[53] Nuclear Installations Inspectorate – March 2009 Newsletter (pp15 – 16)
http://www.hse.gov.uk/nuclear/nn45.pdf

[54] 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

[55] "*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*"

Sellafield – Use of Military Technique to Treat Waste Fuel

The techniques applied to spent fuel waste management at the Sellafield site have changed little since the military origins of the site. Sellafield was first set up immediately following the Second World War to provide plutonium for nuclear weapons. In order to achieve this a chemical extraction process was developed.

Thus at Sellafield spent nuclear fuel rods are dissolved in hot nitric acid and then subjected to a 'solvent extraction' process to separate the uranium and the plutonium, and concentrate the intensely radioactive 'fission products' in the nitric acid.

When the decision to subject nuclear fuel rods from the non-military nuclear power stations was made it was confidently argued that the fission product stream could readily be turned into glass (vitrified) – and also that the plutonium and uranium product streams would prove to be a valuable resource.

However, in fact it has proven to be very difficult to achieve the vitrification of the nitric acid/HLW stream, and also – rather than bringing in funds, the reprocessed uranium and separated plutonium stocks are going to require funds in order to develop a long term approach to their management.

Sellafield – Jan 2009

The following text is largely based on my (Jan 2009) response to the NDA Consultation on their (2009 – 2012) Business Plan – in order to demonstrate that there was sufficient evidence available to CoRWM to deliver a strong message to Government that far-reaching intervention was required at the site in order to protect both the Public purse and Public and Worker safety.

The primary objective set out in the NDA's (2009 – 2012) Draft Business Plan was:

> "*to deliver value for money through:*
>
> *a reduction of the risk associated with high hazards and ensuring radioactive waste continues to be put in a passively safe form*" [56]

This is the direct reverse of the way that the NDA was functioning at the start of 2009 – as is documented in my (Jan 2009)

> *Response to the Nuclear Decommissioning Authority (NDA) Consultation on their (2009 – 2012) Business Plan*

My Consultation response was largely based on CoRWM documentation available at that time – in addition statements in the press and statements from the regulator.

[56] NDA Draft Business Plan (2009-2012) page 8

CoRWM References wrt Waste Fuel Treatment (as of Jan 2009)

CoRWM [1] on Storage and Management Research – Draft doc (Jan 2009)

CoRWM 'Working Group C' – "*Report on Research and Development for Conditioning, Packaging and Interim Storage of Radioactive Wastes and the Management of Spent Fuels, Plutonium and Uranium*" DRAFT
Document Number: 2389 (19th January 2009)

CoRWM [2] (NII + EA) – [Re: SF + Pu + U Management] (Dec 2008)

CoRWM Meeting with HSE and the Environment Agency on Management of Spent Fuels, Plutonium and Uranium
Document Number 2520 (9th December 2008)

CoRWM [3] NDA - [Re: SF + Pu + U Management] – (Aug 2008)

CoRWM - Meeting with NDA – Re: Management of Plutonium, Uranium & Spent Fuels
Document Number: 2418 (8th August 2008)

The situation was of such concern to the regulators at that time, that they pointed out that the NDA's main site (Sellafield) was effectively breaking the Law. [57]

Although in the Business Plan, an objective of achieving savings of £240 million over three years was set out, [58] it was not at all clear how this can be achieved.

For example on 22nd January 2009, the NII stated that:

> "*The NII has [indeed] written to the NDA [on 26 September 2008] regarding delays in funding decisions for key strategic projects involving the future replacement of Sellafield Highly Active Storage Tanks and associated evaporators, and requesting urgent explanations, justifications and plans for recovery of the situation.*" [59]

The NII went on to say that :

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[57] Sellafield Quarterly Report for 1 July 2008 – 30 September 2008
http://www.hse.gov.uk/nuclear/llc/2008/sellafield3.htm
[58] NDA Draft Business Plan (2009 – 2012) [Published November 2008] page 26
[59] Letter from Mike Weightman (HM Chief Inspector of Nuclear Installations and Director, Nuclear Directorate – Health and Safety Executive) to Dr Rachel Western (22nd January 2009)

> "*[t]he NDA has since provided the funding necessary to allow the relevant projects to progress at the necessary pace*"

However, it is hard to see how this can be the case given that the July 2008 NII Newsletter (pp 15 – 17) indicates that of the order of five additional HLW storage/treatment units are required. **Each individual unit has a cost of the order of several hundred millions pounds.** [60]

Sellafield and the Risk of Two Million Fatalities

Liquid wastes are particularly dangerous. Thus in a June 2006 an NDA (Nuclear Decommissioning Authority) document on 'Radiological Hazard Potential', the NDA Engineering Directorate[61] wrote:

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

In the year 2000, British Nuclear Fuels (BNFL) estimated that the likelihood of a plane crashing into the liquid high level waste tanks on the Sellafield site was:

one in 100 million a year.[62]

In the following following year, the 9/11 plane crash took place. It may therefore be seen that BNFL's one in a 100 million estimate of a plane crash is demonstrably far too low. However, given that BNFL had argued that the risk of such a plane crash was so low, the HLW tanks were not designed to be able to withstand such an aircraft impact.[63]

Thus – if there were to be a 9/11 at Sellafield the radioactive contents of the tanks would be released.

Some idea of the possible implications of such an event may obtained from the evidence which Gordon Thompson, (an American nuclear expert) submitted to the House of Commons Defence Select Committee in January 2002 – just four months after 9/11.

Dr Thompson referred to Sellafield as a [64]

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60 *"Multi-million pound bill for Sellafield"* By Alan Irving (Whitehaven News) Wednesday, 08 October 2008
http://www.whitehaven-news.co.uk/news/1.251885

[61] 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
[62] '*Assessing the risk of terrorist attacks on nuclear facilities*' Parliamentary Office of Science and Technology Report - Report 222, July 2004 (page 79)
[63] POST (2004) page 79.
[64] http://www.irss-usa.org/pages/documents/UKDefCttee01_02_000.pdf, p2

and compared the potential for release from the Sellafield tanks with the radioactive release from Chernobyl.

The Parliamentary Office of Science and Technology have reported that the radioactive fall-out from such a release could result in the need to evacuate the area between Glasgow and Liverpool [65]

Such an accident / attack at Sellafield could result in two million people contracting fatal cancer. [66]

Uranium and Plutonium Stockpiles now Recognised as a Liability

At the initiation of the both the Magnox and also the AGR reprocessing projects (B205 and THORP) it was felt that the uranium and plutonium products would prove to be financial assets; however, as is shown below – this has not proven to be the case.

The Threat Presented by Separated Plutonium

Spent fuel rods can only be handled remotely, due to the very intense radiation field, which makes its diversion or theft a rather unrealistic scenario. [67] However separated plutonium can be handled without radiation shielding – which means that expensive measures are required to ensure that it is not stolen by anyone who may wish us harm.

Although plutonium is dangerous if taken into the body by inhalation or ingestion it does not require remote handling.

Despite the fact that there is no economic value for the separated plutonium (rather it has an associated cost) the UK has built up stocks of 100 tonnes. [68] Although this plutonium originates from 'civil' nuclear power stations – rather than reactors specifically designed to create military plutonium – there is no question of the fact

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

[66] 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.

[67] "*Global Fissile Material Report 2007*" International Panel on Fissile Material, page 117

[68] "*Uranium and Plutonium: Macro-Economic Study*" NDA Final Report (June 2007) page 2

that it could be used to make a weapon. [69] Frank Barnaby, writing for the Oxford Research Group, cites a figure of 13 kilograms, as the amount of 'reactor-grade' plutonium required to make a nuclear weapon.[70]

Given that there are 1000 kilograms in 1 tonne

100 tonnes of plutonium – is sufficient for:

$$\frac{100\,000}{13} \quad \text{weapons}$$

which is approximately equal to

7,500 (weapons)

Reprocessed Uranium

In addition to the plutonium product, another waste stream that arises from reprocessing is 'RepU' – or reprocessed uranium. Historically, it was argued that this product would be reused to manufacture nuclear fuel rods. However, CoRWM stated in its January 2009 draft document on research into radioactive waste management options, that the NDA currently has research and development in progress concerning the 'immobilisation' options for separated uranium. [71]

This indicates that the nuclear industry no longer see reprocessed uranium as a valuable resource – rather they see it as a liability.

Separated Plutonium

The NDA reported to CoRWM in August 2008 that plutonium is a liability because whichever management option is adopted it will cost money.[72, 73] One option being mooted for the management of the separated plutonium stocks is that it should be used to manufacture nuclear fuel rods.

Such plutonium-based fuel rods are known as 'mixed oxide' fuels or 'MOX'. This is because such fuel rods are based on mixing plutonium oxide with uranium oxide.

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[69] "*Managing Plutonium in Britan: Current Options"* – Oxford Research Group 'Current Decisions Report' Number 21 (September 1998) pp 9-11 "*Will Mixed-Oxide (MOX) Fuel Make it Easier to Acquire Nuclear Weapons?*" Frank Barnaby

[70][See above (PP 10,11) – Frank Barnaby cites: " *Reactor-Grade Plutonium's Explosive Properties*" Mark, J. Carson. - Nuclear Control Institute., Washington D C (August 1990)]

[71] CoRWM [1] page 28 (para 5.8)

[72] CoRWM [3] page 2 (para 11)

[73] Plutonium is also a liability in the sense that pursuing any management option would entail risks – such as worker dose. CoRWM [3] page (para 11)

However, the present 'Sellafield MOX Plant' (SMP) works to a capacity of just 2-3 % of its design capacity. [74]

The NDA have reported that the market for MOX is limited. A rationale for MOX use may be to 'reduce the plutonium liability'. It is important to note that the NDA go on to say (in a meeting with CoRWM) that 'an incentive to users might be needed'. [75] Thus it may be seen that – as is the case with reprocessed uranium, the plutonium product of reprocessing is a liability, rather than a resource with a value.

In December 2008, the NDA sent a document to Government concerning plutonium.[76] However, the regulators were concerned that 'safety and security were not addressed enough' [77] in the document. Furthermore, the regulators did not see why the NDA plutonium document had to go to Government so soon – especially if it did not take sufficient account of stakeholders views. [78]

CoRWM stated in January 2009 that two years more research was required before a decision could be made between the different plutonium options. [79]

Failure of Reprocessing as a Waste Management Technique

It is often argued that reprocessing should continue as it is the optimal waste management approach for waste fuel. However, apart from the fact that reprocessing actually serves to increase the difficulties associated with radioactive waste; the reprocessing facilities (B205 for Magnox and 'THORP' for AGR fuel) have exhibited severe technical limitations. As a result – for both fuel types - it is envisaged that a 'dry storage' route will need to be adopted

Magnox Waste Fuel

The NDA claim [80] that Magnox reprocessing is the only 'proven' technology for the management of Magnox waste fuel rods. However, this statement does not address the fact that reprocessing only serves as an interim approach – generating wastes streams (in particular liquid HLW + plutonium) that have proven to be very problematic to deal with – and which currently present a number of unresolved issues.

The Environment Agency have pointed out that the cessation of Magnox reprocessing would be good for the environment because of the reduction of discharges that would result. [81] In particular, the Environment Agency have pointed out that the continued

[74] CoRWM [3] page 3 (para 13)
[75] CoRWM [3] page 3 (para 13)
[76] CoRWM [2] page 5 (para 25)
[77] CoRWM [2] page 5 (para 26)
[78] CoRWM [2] page 5 (pra 27)
[79] CoRWM [1] page 27 (para 5.7)
[80] CoRWM [3] (See 'CoRWM Reference List at Back of Document – for full details of the CoRWM References) – page 3 (para 16)
[81] CoRWM [2] – page 2 (para 11)

operation of the Magnox reprocessing facilities has implications for the UK Discharge Strategy. [82]

At present, considerable effort and resource is being put into keeping the Magnox reprocessing facilities in operation. [83] Even with this expenditure the regulators have pointed out that it will not be possible to reprocess the entire Magnox fuel inventory (due to the advanced corrosion of fuel in the 'Legacy Ponds). [84]

As an alternative to Magnox reprocessing – the regulators would consider an interim option of 'in-reactor' storage – prior to the development of purpose built dry storage facilities. [85]

AGR Fuel

The NII reported to CoRWM in December 2008 that the AGR position was 'less satisfactory' than Magnox. [86] Contingency strategies were needed and one of them would almost certainly involve dry storage. [87] Similarly,the NDA reported to CoRWM in August 2008 that 'it was clear that dry storage facilities would have to be developed at Sellafield.[88]

The Environment Agency reported to CoRWM in December 2008 that the regulators had been pressing for an oxide fuel strategy 'for years'.[89] The AGR inventory is divided into a proportion that is contracted for reprocessing, and the remainder that the NDA can manage 'as they see fit'. [90]

Benefits of a Cessation of Reprocessing

If reprocessing were to cease:

- it would also prevent further conversion of spent fuel rods into the particularly hazardous radioactive waste streams 'Liquid HLW' and the raw nuclear weapons material separated plutonium

- the aerial and liquid radioactive waste discharges that arise as a result of reprocessing would cease.

- the additional creation of the bulk ILW and LLW streams (both solid and liquid) created by reprocessing would also come to an end.

[82] CoRWM [2] – page 2 (para 8)
[83] CoRWM [1] – page 22 (para 5.6.1)
[84] CoRWM [2] – page 2 (para 12)
[85] CoRWM [2] page 2 (para 9)
[86] CoRWM [2] page 3 (para 15)
[87] CoRWM [2] page 3 (para 15)
[88] CoRWM [3] page 3 (para 17)
[89] CoRWM [2] page 3 (para 16)
[90] CoRWM [1] – page 24 (para 5.6.2)

CoRWM (Oct 2009) on Sellafield Hazard

CoRWM's final major document of 2009 was an (Oct '09) report to Government – concerned with Research.[91]

Purportedly, [92] the report considered issues associated with Interim Storage as well as Disposal. However, despite the fact that CoRWM were well aware of the problems at Sellafield – particularly wrt the problems associated with liquid HLW

Rather than making the problems at the Sellafield site quite clear to Government

Firstly - in the initial draft report Sellafield problems were only referred to in a footnote (on page 87)

And in the final draft CoRWM refer to the problems associated with waste fuel treatment (See [para A.22 and para A.24 – both page 104]. However the knock- on effects of these for both liquid HLW and plutonium stocks are not referred to and there is no reference to the severity of the problem.

In September 2009 the CoRWM Secretariat sent me a quite bizarre E-mail stating that:

- short-term operational matters at Sellafield were not a matter for CoRWM - even though the document was concerned with interim storage of radioactive waste – the majority of which takes place at Sellafield,

and

- extraordinarily - CoRWM considered that reference to Sellafield was somehow separate to reference to the NDA. Sellafield is as an NDA site. [93]

[91] http://www.corwm.org.uk/Pages/Current%20Publications/2543%20CoRWM%20Report%20on%20RD%20Final%2030%20October%202009.pdf

[92] See report title – "*Report on National Research and Development for Interim Storage and Geological Disposal of Higher Activity Radioactive Wastes, and Management of Nuclear Materials*"

[93] See the NDA Draft Business Plan (2010 –2013) http://www.nda.gov.uk/documents/upload/NDA-Draft-Business-Plan-2010-2013.pdf

CoRWM (2009) Text on HLW

i) essentially the same in Research + Storage Doc
ii) failure to draw attention to severe problems in HLW handling

CoRWM – July 2009 – (on Research) [94]

> *"The Context for R&D – **UK Higher Activity Wastes**"* - (page 18 para 2.11)
>
> "*Unlike countries such as Switzerland, Sweden and Finland, the UK has a vast array of various types of radioactive waste, a legacy of its early lead in military and civil power generation nuclear programmes. Higher activity wastes currently being stored (Defra & NDA, 2008a, b) include vitrified high level waste (HLW) in over 4300 1.34m high x 0.43m diameter steel canisters in a specialist store at Sellafield and about 40,000 packages of conditioned intermediate level waste (ILW)*"

CoRWM – June 2009 – on Storage [95]

> "*Diversity of **UK Higher Activity Wastes***" - (page 21 – para 5.1)
>
> "*Unlike countries such as Switzerland, Sweden and Finland, the UK has a vast array of various types of radioactive waste, a legacy of its early lead in military and civil power generation nuclear programmes. Higher activity wastes currently being stored (Defra/NDA 2008a and 2008b) include vitrified high level waste (HLW) in over 4300 1.34m high x 0.43m diameter steel canisters in a specialist store at Sellafield and about 40,000 packages of conditioned intermediate level waste (ILW)*"

**** it may be seen that these two pieces of text – from June 2009 – and from July 2009 – are exactly the same ****

**** furthermore – these texts make no reference to the technical difficulties experienced with Liquid HLW Treatment - and thus the resultant problems associated with storing these wastes ****

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[94] Consultation Draft – "CoRWM Report to Government – Report on National **Research** and Development for Interim Storage and Geological Disposal of Higher Activity Radioactive Wastes, and Management of Nuclear Materials" (**July 2009**)
http://www.corwm.org.uk/Pages/Current%20Publications/2543%20-%20CoRWM%20RD%20Report%20Consultation%20Draft%2027%20July%2009.pdf

[95] CoRWM – "Position Paper on Research and Development for Conditioning, Packaging and Interim **Storage** of Higher Activity Wastes and the Management of Spent Fuels, Plutonium and Uranium FINAL (Doc 2389) **16th June 2009**
http://www.corwm.org.uk/Pages/Current%20Publications/2389%20-%20CoRWM%20RD%20Storage%20Position%20Paper%20Final%2016%20June.pdf

CoRWM ref to HLW Problems – in Footnote on Page 87

Research Consultation Doc (July 2009) – page 87 – footnote 5

It is not until page 87 – and then in a footnote [96]– that CoRWM make reference to the fact that:

> "*CoRWM understands that NDA work on the oxide fuels reference strategy is being accelerated because of* ***problems with the Sellafield evaporators for liquid HLW*** *and the consequent effects on THORP throughput. This section of the report will be updated prior to publication to reflect developments*"

In fact rather than updating the CoRWM text wrt to problems with liquid HLW treatment – CoRWM removed the text

E-mail Exchange - Re: Liquid HLW

18th Sept '09 – CoRWM to Rachel

Reasons that Sellafield Liquid HLW not relevant to CoRWM
a) interim
b) Sellafield (cf NDA)

From: Tarsam Bains [CoRWM (ii) Secretariat] to Rachel Western
Re: Page 87 - footnote 5 - NII info source

Hi Rachel

It is not appropriate to include the information in the NII Newsletter in the R&D report. The report is about national R&D for the long-term management of all the UK's higher activity wastes and materials that may be declared to be wastes.

The Newsletter section is about short-term operational matters on a particular site. Furthermore, para 6.27 in the report and the associated footnote are about NDA work, which is not even mentioned in the NII Newsletter as far as we can see.

Thanks
Sam

[96] (Footnote Five)

Immediate Comments on this E-mail

- CoRWM is not just concerned with long –term management of wastes – it is also concerned with interim storage

- the Sellafield site holds the majority of the nuclear waste inventory with which CoRWM are concerned

- the NDA are responsible for the Sellafield site

16th Sept 2009 - Rachel Western to CoRWM

- indicating NII Newsletter reference to Sellafield HLW facilities (cf lack of info from NDA)

E-mail 16th Sept '09

From: Rachel Western to Tarsam Bains [CoRWM (ii) Secretariat]
Re: Page 87 - footnote 5 - NII info source

Hi Sam,

Please could you refer Marion Hill and Bill Lee to the March 2009 NII Newsletter which has just been published.

(pp 15-16)

Please could you let me know if they do not feel that it is appropriate to include this information.

Thanks

Rachel

16th Sept 2009 – Rachel Western to CoRWM

- there would be no consultation on update to HLW note
- plus - as NDA have provided no information on the issue of liquid HLW, the reference may be removed – rather than updated.

16th Sept 2009 – CoRWM to Rachel Western

E-mail - 16th September 2009

From: Tarsam Bains [CoRWM (ii) Secretariat] to Rachel Western
Re: Page 87 - footnote 5

Hi Rachel

I have spoken to Marion Hill and Bill Lee, if there is an update, it will simply be a factual update and revised text will not be sent out for comment. However, there is nothing in the NDA comments received on the report on which to base an update so it may be necessary to leave the text as it is and remove the footnote.

Thanks

Sam

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15th Sept 2009 – Rachel Western to CoRWM

Please confirm that 'update' to footnote will not be consulted on

E-mail - 15th Sept '09

From: Rachel Western to Tarsam Bains [CoRWM (ii) Secretariat]
Re: Subject: Page 87 - footnote 5

Hi Sam,

Please can you confirm that the 'update' referred to in this footnote will not be consulted on.

Thanks

Rachel

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Sellafield + Funding (to Nov 2009)

June '09

Keith Case, Sellafield's commercial director, said [97]

"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 warned [98] that the risks at Sellafield were:

"*far too high*."

Nov '09

The Times report that the Government was drawing up plans for large spending cuts at Sellafield.. [99]

It may be seen that CoRWM abjectly failed to indicate to Government the key issue of concern at the Sellafield site.

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[97] '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

[98] '*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

[99] **'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 Emergencies (During 2009)

During 2009 serious failures including two emergencies are reported:

- Emergency due to Tank Cooling Failure [100, 101,102]
- "Evaporator" – shut-down in an emergency [103]
- Serious Problem with "Vitrification" Plant[104]

CoRWM (2009) + Sellafield Hazard - Conclusion

It can be seen that CoRWM has failed to appraise Government of the true nature of the hazard associated with the Sellafield site. This has important implications for both the public purse and for public safety.

Moreover, the rationale put forward for this omission is either a startling example of mendacity or a startling example of ignorance.

Whichever explanation is correct, both are wholly unacceptable.

CoRWM + Plutonium

The NDA holds a stock of 100 tonnes of plutonium for which no credible technical or economic long term management exists.

In October 2009 CoRWM made the following statement concerning plutonium [105]

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[100] "Cooling Water Supplies" - Note from Sellafield Press Office – 14th April 2009
[101] 'Sellafield News' Wednesday 8th April 2009 – Issue 1101 (page 2)
http://www.sellafieldsites.com/UserFiles/File/Sellafield%20News/Sellafield%20News%2008_4_09.pdf
[102] See also "*Nuclear Installations Inspectorate – March 2009 Newsletter*"page 15
http://www.hse.gov.uk/nuclear/nn45.pdf
[103] Whitehaven News - Weds 20th May 2009
http://www.whitehaven-news.co.uk/news/thorp_threats_1_557207?referrerPath=home
[104] "*Nuclear Installations Inspectorate – March 2009 Newsletter*"page 15
http://www.hse.gov.uk/nuclear/nn45.pdf
[105] CoRWM "*Report on National Research and Development for Interim Storage and Geological Disposal of Higher Activity Radioactive Wastes, and Management of Nuclear Materials*" (October 2009)
http://www.corwm.org.uk/Pages/Current%20Publications/2543%20CoRWM%20Report%20on%20RD%20Final%2030%20October%202009.pdf

> "*R&D into management of the UK's civil plutonium stockpile has been an NDA priority since its inception and has, CoRWM believes, been an example of good practice which could be used as a model for future R&D programmes*." [para A.37 – page 107]

This statement is quite extraordinary.

In fact the NDA is experiencing severe difficulties working out what should be done with the plutonium stocks. The extent of the problem may be seen by the fact that the current NDA Draft Business Plan (2010 –2013) [106] section on (2010 – 2011) Key Activities for the NDA (pp 40 – 41) ; the

> '*manage nuclear materials*' [ie plutonium and uranium]

part of the Table

…refers only to Uranium. Plutonium is simply '*air-brushed*' out of consideration.

Plutonium as Fuel - Failure of Sellafield Plutonium Fuel (MOX) Plant

In April 1994 the construction of the 'Sellafield MOX Plant' was started. [107] 'MOX' is 'mixed-oxide' fuel that is meant to be used in ordinary reactors, rather than 'fast reactors'.

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. [108]

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*" [109]

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

As was shown above the NDA are experiencing severe problems manufacturing plutonium based fuel. However – there are also problems with storage and disposal.

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[106] http://www.nda.gov.uk/documents/upload/NDA-Draft-Business-Plan-2010-2013.pdf
[107] "*MOX Case Between Ireland and the UK*" (2003) http://www.pca-cpa.org/upload/files/MOX-Day%20One.pdf (page 42, line 13)
[108] Paul Brown "Voodoo Economics" (Published by Friends of the Earth) May 2008, http://www.foe.co.uk/resource/reports/voodoo_economics.pdf
[109] http://www.nda.gov.uk/documents/upload/NDA-Plutonium-Topic-Strategy-Credible-Options-Technical-Analysis-January-2009.pdf

Lack of Work on Storage Beyond 50 Years

The NDA (Jan '09 Options Document) 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.

Disposal of Plutonium not Proven

Although the end-point for each of the various plutonium proposals put forward in the NDA options document is '*disposal*' [110] – 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 – Storage, Cheaper & 'No Regrets' - cf Use as Fuel

It has been proposed that the separated Plutonium stocks currently held at Sellafield should be fabricated into fuel rods and utilised in plutonium-based reactors.

However, even the NDA's own documentation recommends against this. Thus Appendix 'B' [111] of the NDA's (Jan 2009 'Plutonium Options' Document) which is an 'Economic External Review ' - carried out by John Brook, (who had previously carried out work for the NDA on the Sellafield MOX fuel fabrication plant – 'SMP') [112] - concludes that storage is the cheaper option and probably the '*no regrets option*' (page 139)

CoRWM + Plutonium - Conclusion

The UK has plutonium stocks sufficient for 7,500 bombs. Sellafield is adding to these stocks. The NDA have no idea what to do with this plutonium – yet CoRWM have stated as recently as October 2009 that NDA work on plutonium: [113]

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[110] See for example page 26 – para 5.4.2

[111] 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)

[112] page 136

[113] CoRWM "*Report on National Research and Development for Interim Storage and Geological Disposal of Higher Activity Radioactive Wastes, and Management of Nuclear Materials*" (October 2009)
http://www.corwm.org.uk/Pages/Current%20Publications/2543%20CoRWM%20Report%20on%20RD%20Final%2030%20October%202009.pdf

is

> "*an example of good practice which could be used as a model for future R&D programmes.*" [para A.37 – page 107]

Once again CoRWM is telling the Government and the nuclear industry what it wants to hear.

This is not the same as what it needs to hear.

NII - Re: Veracity wrt Sellafield Liquid HLW Hazard

The reason that this text is included in this document on the performance of CoRWM is because, at a critical moment in the 'discourse' over the issues involved;

CoRWM saw fit to re-draft their note of a meeting such that it became less accurate

This section addresses the issue raised above – wrt to:

the Sellafield hazard; and
the lack of adequate funding to deal with this hazard

Primarily the text addresses:

not only NII's failure to ensure that the problems are dealt with; but also
the NII's 'lack of veracity' concerning the matter

The 'lack of veracity' is of particular importance in this context as the original issue arose during a Planning Hearing.

Due to the revision of Planning Law – and the need for the public to rely on officialdom to - the lack of rigour displayed by the NII is a matter of great concern.

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Unfortunately the following pages are extremely tortuous.

They are concerned with the evidence that I gave to a CCC Waste Planning Framework meeting in November 2008.

At this meeting I quoted a (July 2008) NII Newsletter to indicate that, not only were the NII concerned about the state of critical safety equipment at the Sellafield site; they were also concerned that the NDA might not be allocated sufficient funds by Government to carry out the necessary refurbishments.

Despite the fact that I was directly quoting NII documentation, the NII representative at the Hearing indicated that my evidence was false.

When a formal minute of this statement was available – in the form of a note prepared by a CoRWM observer – I immediately wrote to the Head of the Health and Safety Executive (HSE), who are responsible for the NII, to make a complaint.

Mike Weightman – the NII Head - responded to my (30th Dec '08) letter on (22nd Jan '09). The further 'misrepresentations in Mike Weightman's letter only served to compound the original problem of the misrepresentation at the CCC Planning Hearing. I therefore almost immediately sent a response (on 27th Jan '09).
~~~~~~~~~~~~

On 5th March 2009 Mike Weightman sent a response to this (27th Jan '09) letter. I was quite astonished to find that this letter had 10 "*fibs*" in just one side of A4. I spent a great deal of time compiling a 36 page document outlining the basis of my assertion that the (5th Mar '09) letter had 10 "*fibs*" in it.

On the 8th July 2009 I had a meeting with Mike Weightman in which I provided him with a copy of my analysis of his (5th Mar '09) letter. He said that he would get back to me to demonstrate that I was in fact misinformed.

Four months later, and less than a week before the (9th Nov '09) nuclear announcement, Mike Weightman wrote to me to say that the issues that I raised had been reviewed. He supplied no documentary support.

Dr Weightman invited me to a meeting, **however at the same time – for whatever reason – the Committee on Radioactive Waste Management (CoRWM) had seen fit to alter their original note of the CCC Planning Hearing such that it no longer provided an accurate report of the meeting.**

I requested that the NII resolve this situation – but they did not deem it appropriate.

Things had quite clearly moved from the sublime to the ridiculous. Given that the very basis of my original complaint was now a bone of contention I felt that a meeting with the NII would be problematic.

Sue Brett (CCC Planning Officer) had taken hand-written notes at the Planning Hearing which match the original CoRWM note (ie that the NII had '*negated*' my evidence.

The fact that my evidence was correct, was confirmed by an article in the Times in (Nov '09) – and its subsequent confirmation by the NDA.

This issue is not a matter of pedantry. At the Sellafield site there is an ever-present risk of a radionuclide that would be generate radioactive fallout that could result in two million fatal cancers. During 2009 there were two emergencies on the site and the NII Inspector Mark Foy stated in October that the risks at Sellafield were '*far to high*'.

The fact that the NII saw fit to misrepresent their views at a Planning Hearing is a matter of very serious concern. The fact that this initial problem has been exacerbated by a serious of highly misleading letters – plus the extraordinary decision by CoRWM to revise a meeting note – such that it no longer provides an accurate account of what was actually said – is truly bizarre.

10 July 2009 – Letter to HSE outlining problems with veracity of NII + implications that this has for the Planning Process

Letter from Rachel Western

To: Geoffrey Podger

Chief Executive of HSE
Health and Safety Executive

CC: Mike Weightman, HM Chief Inspector of Nuclear Installations and Director (Nuclear Directorate)

Mick Bacon (NII), Dick Howarth (NII)
Sue Brett (CCC) Nuclear Issues Officer
FAO: The Planning Inspectors

Diane Abbott (MP for Hackney North and Stoke Newington)
Pete Wilkinson

10th July 2009

Dear Sir,

Re: NII Evidence at CCC Planning Inquiry
(Tue 18th- Wed 19th November 2008)

Adequacy of Dr Mike Weightman's
Further Letter (of 5th March 2009)

Thank you very much for forwarding my letter of the 27th January 2009 to Dr Mike Weightman, [HM Chief Inspector of Nuclear Installations and Director (Nuclear Directorate)] for response.

My letter to you of the 27th January 2009 concerned the Cumbria County Council Planning Hearing of November 2008 – at which an NII representative was present.

Unfortunately, as you know, I felt the need to make a Complaint (see my original letter of 30th December 2008) concerning the way that the NII representative participated in the Hearing.

Specifically, the summary of my complaint (copied from my 30th December 2008 letter) is set out in the box below.

Summary of Complaint

That the NII representative at the Cumbria County Council Planning Inquiry, misrepresented the position of the NII, with respect to the NII's concerns over the difficulties associated with the liquid high level (radioactive) wastes) at the Sellafield site.

I apologise for the delay in my response to Dr Weightman's letter of 5th March; however, Dr Weightman's letter to me posed something of a conundrum.

This is due to the fact that Dr Weightman's correspondence in response to my letters has only served to exacerbate my concerns over the veracity of NII statements.

At the risk that you find my continued correspondence tiresome, I have chosen to pursue this matter further due to the imperative for a robust:

Regulator / Planning interface

ie - the Planning System **must** be able to rely on the factual accuracy of input from regulators.

The box below sets out two quotes from the CCC Inspectors report (February 2009).

These quotes clearly indicate that the Inspectors who presided over the Planning Hearing in question (Nov 2008 – CCC) made the decision to delegate matters concerning detailed issues associated with radioactive waste management to the regulators.

The Critical Role of Regulators in Planning

The CCC Planning Inspectors Report [114] (of 3rd February 2009) states:

"*Detailed technical issues and uncertainties relating to the management, storage and disposal of radioactive wastes are subject to other controls and legislation, and are outside the scope of this strategic planning document*." page 29 (para 8.119)

and more specifically:

"*Issues about possible problems associated with the vitrification* [the process of turning the liquid wastes into a solid glass form] *of liquid HLW are covered by other*

[114] S J Pratt & E Simpson "Report on the Examination into the Cumbria Minerals and Waste Core Strategy and Generic Development Control Policies Development Plan Documents" (Published 3rd February 2009)

regulatory processes and do not, in our view, justify a more restrictive policy towards the existing or future storage and disposal of HLW at Sellafield."

page 27 (para 8.103)

Thus the Inspectors clearly felt that they could rely on the NII evidence that was put before them. However, as is demonstrated below this assumption was inappropriate.

Clearly this is a matter of deep concern.

The majority of this document comprises an analysis of Dr Weightman's March letter. My analysis of the letter is combined with my analysis of the evidence base. – thus, as far as possible, my presentation of a contrasting perspective is sourced to a reference.

On Wednesday 8th July 2009 at a meeting with Dr Weightman, I drew his attention to my concerns over his March letter and gave him a copy of the analysis that I had produced.

This document is set out in subsequent pages.

In addition to discussing the March letter, our conversation ranged across a number of primarily Sellafield related issues. I said that I would very much like to develop a constructive relationship with the NII and Dr Weightman said that he would be happy to meet with me again – for which I am grateful.

Dr Weightman also said that he would provide a response to my analysis of the March letter.

The NII / Planning Issue is not only pertinent to Cumbria County Council and the wastes at Sellafield – it is also highly relevant to the proposals for reactor new build and plans for a new nuclear warhead factory (at Burghfield in Berkshire – just West of London).

Such decisions are of great import. Nuclear projects have the potential for causing extraordinary harm – it is therefore absolutely essential that those who have been tasked with protecting public and worker safety apply the highest standards of rigour and integrity.

Yours sincerely

Dr Rachel E J Western BA (Oxon) PhD MRSC

Nuclear Researcher for Friends of the Earth Cumbrian Groups
Member of Nuclear Waste Advisory Associates

Analysis of Mike Weightman's

5th March Letter

SUMMARY

Context

In November 2008, Dr Rachel Western [115] gave evidence at a Planning Hearing in Cumbria concerning the safety of nuclear waste at Sellafield. She argued that:

i) urgent measures were needed to address safety problems; and

ii) the government regulator – the '*Nuclear Installations Inspectorate*' (or 'NII') were concerned that the necessary funds would not be available to carry out this work.

Her evidence was based on the July 2008 edition of the NII Newsletter – which she quoted verbatim. Thus,

<u>Urgent Measures Needed</u>

> "*Replacement HASTs* [Highly Active Storage Tanks [116]] *should be progressed with the utmost urgency."* (page 16)

Funding

The funding issue was also referred to extensively in the NII Newsletter referred to above.

For example:

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

[115] Nuclear Researcher for Friends of the Earth (Cumbria Groups)
[116] At the Sellafield nuclear plant, nuclear waste is liquidised in order to extract its plutonium content. After the plutonium extraction has been carried out the waste remains in tanks until it is re-solidified. Whilst the waste remains as a liquid it is incredibly dangerous (see Appendix Four).

Web Link for NII July 2008 Newsletter

http://www.hse.gov.uk/nuclear/nsn4308.pdf

Evidence provided by NII Representative

The NII were formally invited to attend the Hearing (see Appendix Two). However, in his evidence to the Hearing the NII Representative stated that the concerns that Dr Western had expressed were without foundation. This was despite the fact that Dr Western had directly quoted an NII document.

The note of the Hearing prepared by the representative from the Committee on Radioactive Waste Management (CoRWM), John Rennilson, who was present as an Observer, formally shows that the NII dismissed Dr Western's concerns. Thus,

> "*Dr Western … felt that funding problems at Sellafield were undermining its safety. This was heard, received a negative response from the regulators and I cannot see being taken forward in a planning document.* " [117] (page 4)

Subsequent Correspondence

Following receipt of the formal CoRWM note of the Hearing, Dr Western wrote to the Chief Executive of the Health and Safety Executive (HSE) [118, 119] to complain that the NII representative had '*misrepresented*' the NII's position.

On 22nd January 2009, Dr Western received a response to her letter to the HSE from the Head of the NII. Unfortunately, this response letter significantly compounded the original problem – as it contained a number of misrepresentations. Thus, Dr Western immediately sent a response to this letter (on the 27th Jan).

On the 5th March 2009, the NII responded to this second letter. This letter has **ten** 'misrepresentations'.

It is this letter which is the subject of this document.

Accident at Sellafield on 1st April

Just a month after the NII's 5th March letter, there was a 'near-miss ' accident in which Sellafield was just hours from disaster.

This accident occurred within the facilities [120] that had been the subject of Dr Western's evidence at the original November 2008 Hearing – and thus vindicated her concerns.

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[117] See CoRWM document 2506 - attached to my original complaint of the 30th December 2008.
[118] Who are responsible for the NII
[119] on 30th December 2008
[120] the Liquid High Level Waste tanks (Liquid HLW tanks)

Dr Mike Weightman
HM Chief Inspector of Nuclear Installations

Letter of 5th March 2009

Ten Misrepresentations

Context

In November 2008 Cumbria County Council (CCC) held a Planning Hearing at which Dr Rachel Western expressed concerns over:

- the fact that due to lack of funds urgent safety requirements laid out by the Nuclear Installations Inspectorate (NII) to the nuclear industry [121] concerning Sellafield [122] may not be implemented; and that

- this has very serious implications for hazard presented by 'Liquid High Level Waste' (Liquid HLW) – one of the most dangerous forms of nuclear waste in existence.

Dr Western's evidence largely consisted of direct quotations from the NII Newsletter.[123] However, at the Hearing, the NII representative stated that Dr Western's evidence was without foundation.

Subsequently, Dr Western wrote to the Head of the Health and Safety Executive [124] (which is responsible for the NII) to complain about this misrepresentation.

The letter of 5th March 2009, [125] from Dr Mike Weightman (Head of the NII), was received by Dr Western as a result of this correspondence.

As is shown below, the 5th March, letter compounds the initial dilemma of one misrepresentation by magnifying the number of misrepresentations to ten. [126]

[121] Specifically the NDA – or 'Nuclear Decommissioning Authority'
[122] The plutonium complex in Cumbria on the coast of the Irish Sea.
[123] of July 2008
[124] Geoffrey Podger – Letter of 30th December 2008
[125] See Appendix One
[126] in just one side of A4

The Ten Misrepresentations
Made in Dr Weightman's 5 March 2009 Letter [127]

SUMMARY

1. **Disposal not Management**
2. **NII Rep Present as Observer not Participant**
3. **Mr Haworth (NII Rep) Views Not Sought**
4. **Sellafield is Safely Managed at Present**
5. **Sellafield Not Focus for Funding Concerns**
6. **Work at Sellafield is Not Constrained by Funding**
7. **Sellafield Insurance Arrangements 'Commercial'**
8. **Even High Hazards can be Managed Safely**
9. **NII Newsletter now More 'Accessible'**
10. **Delayed November 2008 Newsletter now available**

[127] The letter was one side A4 long – and can be found at Appendix One

The Ten Misrepresentations
In Dr Weightman's Letter

Below the ten misrepresentations are set out in the order that they appear in the letter. The full text of the letter is set out in Appendix One.

1. Disposal not Management

Dr Weightman states in his letter:

> "*[t]he hearing was concerned with a proposal for an underground repository in Cumbria. Although operational and safety issues at Sellafield might have some bearing on the practicability of implementing any disposal policy they did not appear to be directly relevant to the Hearing.*" [128]

Thus Dr. Weightman indicates that '*operational*' issues were not '*directly relevant*' to the November Hearing. This is incorrect.

However, the Cumbria County Council (CCC) planning documents that were under consideration at the Hearing did in fact specifically refer to operational issues associated with the management of Liquid High Level Waste. This was considered quite separately from the issue of nuclear waste disposal.

Consideration of Management Issues

The November CCC Planning Hearing was concerned with the Council's Draft '*Development Plan Documents*' [129] (DPDs) on :

'*Minerals & Waste Core Strategy & Generic Development Control Policies*'. [130]

- or, put more simply' Waste Framework' documents. [131]

The 'Core' document addresses nuclear waste at Chapter 8. [132]

In this chapter:

[128] Dr Weightman's Letter of 5th March 2009. page 1
[129] Under the terms of Section 20(5) of the Planning & Compulsory Purchase Act 2004
[130] S J Pratt & E Simpson "Report on the Examination into the Cumbria Minerals and Waste Core Strategy and Generic Development Control Policies Development Plan Documents" (Published 3rd February 2009) - page 1
http://www.cumbria.gov.uk/elibrary/Content/Internet/538/755/1929/1982/39850162227.pdf
[131] Although the document also considered minerals, that was not relevant to the hearing at which Mr Haworth and I attended
[132][132] "*Draft Core Strategy of the Cumbria Minerals and Waste Development Framework* - (pp 45 – 51) "http://www.cumbria.gov.uk/elibrary/Content/Internet/538/755/1929/3951815533.pdf

- Policy 11 (page 48) considers waste **Disposal**; and
- Policy 10 (page 47) considers waste **Storage**

The overall context of these two Policies is set out on pages 45 to 47.

An important technical point to be aware of is that High Level Waste (HLW) – which essentially comprises concentrated '*fission products*' (the most fiercely radioactive form of nuclear wastes) comes in different forms – some liquid, and some solid. This is set out in more detail in the footnote.[133]

At Sellafield the HLW is changed from a solid to a liquid and then back to a solid.

There are two things that it is critically important to realise:

i) Firstly, that during the in-between stage, whilst the HLW is in a **Liquid** form, it is **far more dangerous** (see Appendix Four) - this is because it is liable to boil dry and so escape from the site. [134] Alternatively, were a plane or a bomb to hit Sellafield – being a liquid, again the HLW would readily escape.

ii) The nuclear industry and the government refer to this:

Solid / Liquid/ Solid Process

using the word '**Storage**' – which is obviously highly misleading.

Processing materials is obviously different than storing them.

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[133] '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 break 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 they 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 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 in Appendix Four. 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 the form of a type of glass.

[134] Where it might contaminate the local people

On page 45 of the draft Core document, reference [135] is very clearly made to the process of returning the Liquid HLW to Solid HLW. The method used to achieve this is known as '*vitrification*', in which the HLW is turned into a sort of glass. Thus,

"*Liquid high level waste, mostly from reprocessing, is stored to cool at Sellafield and is then subject to a process of vitrification*"

The solid glass form of HLW is still dangerous - in the sense that if you were near to it, it would kill you very quickly. However it does not possess the same potential for catastrophe (see Appendix Four) that the Liquid HLW poses. This is because it will not boil dry, and because if it were to be hit by a bomb or a plane it would not be released directly into the sky.

Unfortunately Sellafield is currently experiencing problems with the 'Re-Solidification' process, and this is what Dr Western's evidence to the Hearing was concerned with.

The crux of Dr Western's evidence to the (November 2008) Hearing, was that the process of 'Re-Solidiying' (or '*vitrifying*') HLW was not going smoothly.

In particular she referred to the July 2008 NII Newsletter, to show that the NII

1. required '**urgent**' measures to be carried out by the nuclear industry to address problems with the Liquid HLW treatment facilities,

2. feared that these measures may not be carried out – due to lack of funding

2. NII Rep Present as Observer not Participant

Dr Weightman states:

> "*Mr Haworth's* [the NII representative] *role was primarily as an observer"* [136]

This is incorrect.

At Appendix Two (which is a letter from Mr Tony Bishop of the Planning Inspectorate sent to Dr Western 17 April 2009) it is shown that Mr Haworth was present as an official participant at the Hearing – in fact he had been invited by the Inspectors at the suggestion of Cumbria County Council.

Thus, Mr Bishop states that the role of Mr Haworth:

[135] para 8.2 – '*Where are we now*'
[136] Dr Weightman's Letter of 5th March 2009. page 1

"was as an official participant at the hearing representing the NII"

3. Mr Haworth (NII Rep) Views Not Sought

Dr Weightman states that Mr Haworth:

> *"was neither asked nor prepared to comment on the generality of the evidence presented and in particular the detailed regulatory position on Sellafield projects."*

This in incorrect.

The letter from Mr Tony Bishop of the Planning Inspectorate to Dr Western (as discussed above) clearly states that the role of Mr Haworth at the Hearing was:

> *"to assist the Inspectors in understanding the role of the NII and its views on the issues discussed, rather than as an observer."*

This is of particular importance due to the fact that a key function of the Hearing was to establish whether Cumbria County Council's draft 'Waste Framework' was '*sound*.' [137]

Dr Western's Evidence and the 'Soundness' Issue

The word '*sound*' has a very particular definition within the context of Planning Regulations. Thus, the response form, which was sent out along with Cumbria County Council's draft 'Waste Framework' in March 2008, sets out nine 'tests of soundness' which a Policy must pass in order to be deemed: '*sound*'.[138]

In Dr Western's October Submission to the Consultation (which was immediately before the November Hearing) [139] she argued that the draft 'Waste Framework' document

> did not meet 'Soundness Test 7'

ie

> *"policies that fail to represent the most appropriate in all the circumstances."*

[137] Inspectors' Report (February 2009) – page one
http://www.cumbria.gov.uk/elibrary/Content/Internet/538/755/1929/1982/39850162227.pdf
[138] See the Annex on page 4.

139 'Second Submission to Cumbria County Council's Minerals and Waste Development Framework' Dr Rachel Western (21st October 2008) page one

…. the relevant 'circumstances' being the failing of the funding base necessary to ensure that the NII's requirements would be met.

Although Dr Western's evidence was based direct quotes from an NII document, the NII rep dismissed her points out of hand. Thus, the CoRWM representative commented

> *"Dr Western … felt that funding problems at Sellafield were undermining its safety. This was heard, received a negative response from the regulators and I cannot see being taken forward in a planning document.* " [140] (page 4)

Therefore, it can clearly be seen, both from the letter of Mr Bishop of the Planning Inspectorate, and also, from the CoRWM minute of Mr Rennilson – that Mr Hawarth (the NII rep's) function was to act as a the source of official NII views - in order to inform the Planning Inspectors.

Furthermore, it can be seen that Mr Hawarth played a key role in determining the opinion that was formed by the Inspectors that there was no need for them to take note of Dr Western's evidence.

Thus – Mr Hawarth of the NII stated that the NII had no significant concerns over the matters that Dr Western had raised – and therefore that there was no need for the Inspectors to conclude that the Council should take a more proactive approach to the safety of Sellafield.

4. Sellafield is Safely Managed at Present

Dr Weightman states:

> *"we have had a number of issues regarding Sellafield and its facilities over the years, which we have reported in our newsletters and the Site Stakeholder group reports . … we continuously press Sellafield to accelerate the rate at which it places its most hazardous materials into safer forms. It would be wrong however to conclude from this that we believe the safety of this material is not being adequately managed at present."* [141]

Thus, on 5th March 2009, Dr Weightman clearly indicates that he believed that the Liquid HLW at Sellafield is being safely managed.

This is not the case.

Just a month after Dr Weightman's statement, on 1st April 2009 an incident that took place at Sellafield that was so serious that the site emergency arrangements had to be brought into play.

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[140] See CoRWM document 2506 - attached to my original complaint of the 30th December 2008.
[141] Dr Weightman's Letter of 5th March 2009. page 1

This incident involved the Liquid HLW facilities at Sellafield that had been the subject of Dr Western's evidence at the November 2008 Hearing.

Appendix Three sets out the background and details of this accident.

The fact that this incident involved the Liquid HLW facilites that had been the subject of Dr Western's evidence at the November Hearing vindicates Dr Western's concerns.

The incident was caused by failure in the system that pipes cold running water through the HLW tanks. Without this cold running water the HLW would get hotter and hotter. (This is because it is so radioactive - and therefore self-heating).

BNFL [142] analysis has indicated that such failure of this cooling system would lead to:

- boiling of the liquid HLW after 12 hours, and
- the HLW tanks drying out after three days. [143]

The Sellafield Newsletter (April 8th 2009 – Issue 1101, page 2) reports that during the accident the Site Emergency Arrangements were brought into play for four hours. [144]

Gordon Thompson of the '*Institute for Resource and Security Studies*' (IRSS) – who has provided key analysis of the Liquid HLW issue for over thirty years has reported that once the HLW starts to boil, radioactivity will begin to be released. The NII have stated that the consequences of prolonged cooling failure could be '*very severe*'. [145]

Although Appendix Four looks at the possible dangers presented by HLW release in terms of 'possible numbers of fatalities' – and also comparison with Chernobyl; the fact is that precise predictions are very difficult.

What it is possible to say reliably, is that an accident that led to a release of HLW could easily lead to a very significant loss of life.

The operation of the Emergency System for four hours (during the April 1st incident) is comparable to the12 hour period (that would lead to the start of boiling). Clearly this margin is unacceptable.

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[142] BNFL – 'British Nuclear Fuels' the predecessor to the 'NDA' – the Nuclear Decommissioning Authority

[143] "High Level Radioactive Liquid Waste at Sellafield - Risks, Alternative Options and Lessons for Policy" Gordon Thompson (June 1998) - Section 4.1 (as above) [http://www.irss-usa.org/pages/documents/Completew-oapp.pdf]

[144] 'Sellafield News' Wednesday 8th April 2009 – Issue 1101 (page 2) http://www.sellafieldsites.com/UserFiles/File/Sellafield%20News/Sellafield%20News%2008_4_09.pdf

[145] "High Level Radioactive Liquid Waste at Sellafield - Risks, Alternative Options and Lessons for Policy" Gordon Thompson (June 1998) - Section 4.1 [http://www.irss-usa.org/pages/documents/Completew-oapp.pdf]

The difficulty associated with the tightness of the margin may be appreciated when it is remembered that in 2005 Sellafield staff failed to detect a leak of Liquid HLW [146] for nine months. [147] The leak was so serious that the nuclear industry pleaded guilty to criminal charges. [148]

Similarly on 20th May 2009, the Whitehaven News [149] reported that a more recent leak at Sellafield had gone undetected for 14 months, and was only discovered on the day that Gordon Brown was visiting. [150]

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[146] still containing plutonium

[147] "New plant culture" *Nuclear Engineering International* - 27th July 2005 http://www.neimagazine.com/story.asp?storyCode=2029958

[148] "BNG pleads guilty over Thorp leak" *Nuclear Engineering International* - 13 June 2006 http://www.neimagazine.com/story.asp?storyCode=2036700

[149] The local paper in the Sellafield area

[150] Whitehaven News, Weds 20th May 2009 http://www.whitehaven-news.co.uk/news/sellafield_braces_for_fall_out_over_undetected_pipe_leak_1_557205?referrerPath=news

The fact that the April 2009 accident took place just one month after Dr Weightman stated that Sellafield was safely handling nuclear wastes demonstrates that his statement was incorrect.

5. Sellafield Not Focus for Funding Concerns

In an earlier letter to the Health and Safety Executive (HSE) [151] of 27th January 2009, Dr Western made reference to a story in the Guardian [152] which reported a "*call for 'innovativ' ways of raising money"* that had been made by the NII.

Specifically the story referred to widespread concern over a shortage of Public Funds

> "*with the vast bulk being spent at Sellafield in Cumbria and Dounreay in Scotland.*"

However, in his letter of 5th March, Dr Weightman makes the statement that his:

> "*recent comments on funding were not focussed on Sellafield*"

This statement is not correct.

The NDA (2009 – 2012) Business Plan [153] indicates (page 34) that the total expenditure expected for Sellafield in the year (2009/ 2010) is approximately £1.2 Billion. For the whole of the NDA, the expected expenditure for this period is £2.8 Billion. (see page 28) From these figures it may be calculated that Sellafield represents 40% of NDA expenditure. As indicated above, the Sellafield site presents extremely dangerous hazards.

On 10th June 2009, Contract Journal reported (see Appendix Seven) [154] that Sellafield had 'cornered' almost 70% of the Nuclear Decommissioning Authorities [155] budget.

Given the large degree of required expenditure it must be the case that Sellafield represents an extreme funding problem.

6. Work at Sellafield is Not Constrained by Funding

Dr Weightman states in his letter of 5th March:

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[151] Who are responsible for the NII
[152] Tuesday 27th January see Appendix Two of that letter
[153] Nuclear Decommissioning Authority (NDA) Business Plan [2009/2012] Published by the Nuclear Decommissioning Authority 2009 – [ISBN 978-1-905985 13 5]
http://www.nda.gov.uk/documents/loader.cfm?url=/commonspot/security/getfile.cfm&pageid=28874
[154] Contract Journal 'Contractors warm up for £1.3bn Sellafield clean-up' Weds 10 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
[155] NDA

"*As I noted in my previous letter, work at Sellafield is not currently constrained by funding*"

This is incorrect.

Correspondence between the NII and the NDA that has been forwarded to me by Dr Weightman's office [156] clearly indicates that the NII are in fact extremely concerned by the NDA's failure to fund key Liquid HLW projects. [157]

Specifically, in a letter to the NDA dated (26th September 2008) the NII state:

"*Sellafield Limited: High Level Waste Plants Projects*

"We write to say how surprised and concerned we are about recent funding decisions for the evaporator E and replacement Highly Active Storage Tank (HAST) project on High Level Waste Plants (HLWP). The more so, since we thought you were aware of the safety drivers and critical importance of timely delivery"

……

as a matter of urgency we wish you to present:

…..

c) how you plan to have your contractors regain the lost time and momentum for the evaporators and replacement HASTS " [Highly Active Storage Tanks]"

From this is may be seen that the NII are clearly concerned about the degree of funding being made available by the NDA to address the HLW problems at Sellafield.

In response the NDA wrote (on 1st October 2008):

"**<u>High Level Waste Plants Projects</u>**

"*To underwrite the financial sanction and case to Government we are undertaking a strategic review …..*

….

"*we accept that the decision to halt long lead work on [Evaporator E and] replacement HASTs (Highly Active Storage Tanks) were premature*" [158]

[156] (This was originally meant to be an Enclosure with the 5th March letter – but was kindly E-mailed to me on the 9th March)
[157] Letter from P Woodhouse and G A Trimble (NII) to Richard Waite (NDA) - 26th September 2008
[158] Letter from Richard Waite (NDA Acting Chief Executive) to Kevin Allars (NII – Head of NII Division 2) - 1st October 2008

Thus it can be seen that the NII, in fact, are extremely concerned about the degree to which the NDA is funding safety critical HLW work on the Sellafield site.

Appendix Three reports more recent reference to these funding shortfalls.[159] The issue is also discussed in the 10 June 2009 issue of Contract Journal (See Appendix Seven).

7. Sellafield Insurance Arrangements 'Commercial'

Dr Weightman states [160] that:

> "*the new management company* [Nuclear Management Partners] *for Sellafield required alternative insurance arrangements for commercial accounting reasons*"

Clearly, it would suit every business and individual that required insurance, if this financial responsibility were to be taken on by the Treasury. Thus, Dr Weightman's statement here that this is a 'commercial' arrangement amounts only to word-play.

8. Even High Hazards can be Managed Safely

Dr Weightman states: [161]

> "*even high hazards can be managed safely* "

Although this statement may be correct in an academic sense – it is not correct in terms of the attitude of Nuclear Management Partners [162] to their capability to achieve safe management of Sellafield. This is demonstrated by the fact that they did not deem it appropriate to be responsible for their own insurance.

9. NII Newsletter now More 'Accessible'

Dr Weightman states (wrt the NII Newsletter) that the delay in publication [163] of the most recent Newsletter was due to:

> "*our desire to put information in a more accessible form*" [164]

However, there does not appear to be any actual change in the nature of the terminology used, nor the degree of explanation that is given.

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[159] (In a February 2009 on the disbanding of the Nuclear Safety Committee 'NuSAC')
[160] Letter of 5th March 2009 (page 2)
[161] (In his letter of 5th March – page 2
[162] The managers of the Sellafield site
[163] NB – The NII Website stated in January that the November 2008 Newsletter would be published at the end of January 2009. However, three months later, this has still not taken place.
[164] Letter of 5th March 2009 (page 2)

For example the text on page 13, which considers the possible use of nitrates as means of avoiding corrosion in the cooling coils within the Liquid HLW tanks, gives no explanation of how this was meant to work, and furthermore gives no technical explanation of why this approach will not now be pursued.

Of more concern is the fact that the sentence from the July 2008 NII Newsletter, which indicates that replacement Liquid HLW tanks should be built as a matter of '*utmost urgency*' (see below) has simply been deleted from the September text. [165]

This has been done for no apparent reason.

NII - July 2008 Newsletter

> "*Replacement HASTs* [Highly Active Storage Tanks [166]] *should be progressed with the utmost urgency."* (page 16)
>
> http://www.hse.gov.uk/nuclear/nsn4308.pdf

Appendix Six sets out the relevant September (NII Newslettre text) text in full – and thus an appraisal of accessibility may be made. In addition, the text may be analysed in order to demonstrate that the critical sentence "*Replacement HASTs* [Highly Active Storage Tanks] s*hould be progressed with the utmost urgency*." (from the July text) has been deleted.

10. Delayed November 2008 Newsletter now available

Finally, Dr Weightman states:

> *[You] "request [ed] .. an explanation for the delay in the publication of the November 2008 NII newsletter on the web. Please find attached a copy of this edition of the Newsletter."* [167]

In fact the edition that was enclosed was the September 2008 edition. The November version – which was due to go on-line at the end of January 2009 has still not been made available.

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[165] (See Appendix Four)

[166] At the Sellafield nuclear plant, nuclear waste is liquidised in order to extract its plutonium content. After the plutonium extraction has been carried out the waste remains in tanks until it is re-solidified. Whilst the waste remains as a liquid it is incredibly dangerous (see Appendix Four).

[167] (on page 2 of the 5 March letter)

NII - MISREPRESENTATION

Annex ONE – Text of 5 March 2009 NII Letter

Letter from Dr Weightman to Dr Western
5th March 2009 (Re-typed) [168]

From: Health and Safety Executive
Nuclear Directorate
HM Nuclear Installations Inspectorate

MIKE WEIGHTMAN

HM Chief Inspector
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Bootle
Merseyside
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Great Britain

Direct Dial: 0151 951 4168
Fax: 0151 951 4821

http://www.hse.gov.uk/

To:
Dr R Western
53E Norcott Road
Stoke Newington
Hackney
London
Hackney

N16 7EJ

5th March 2009

Dear Dr Western

I have been asked to reply to your further letter dated 27 January 2009 reiterating your complaint that 'the NII representative at the Cumbria County Council Planning

[168] The original is available on request . The document is included here – in as a 're-typed' version due to problems associated with E-mailing scanned documents.

Inquiry, misrepresented the position of the NII, with respect to the NII's concerns over difficulties associated with the liquid high level (radioactive) wastes at the Sellafield site". Thank you for providing more information with this letter but having reviewed it, I remain of the view that Mr Haworth did not misrepresent our position for the reasons I explain below.

The hearing was concerned with a proposal for an underground repository in Cumbria. Although operational and safety issues at Sellafield might have a bearing on the practicability of implementing any disposal policy, they did not appear to be directly relevant to the hearing. Mr Haworth's role was primarily as an observer and he was neither asked nor prepared to comment on the generality of the evidence presented and in particular the detailed regulatory position on sellafiend projects.

As you have noted, we have had a number of issues regarding Sellafield and its facilities over the years, which we have reported in our newsletters and Site Stakeholder Group reports. UK health & safety law requires all employers to reduce the risks to their workers and the public "so far as is reasonably practicable", (SFAIRP), and so we continuously press Sellafield to accelerate the rate at which it places its most hazardous materials into safer forms. It would be wrong to conclude from this that we believe that safety of this material is not being adequately managed at present. What we have been doing, however, is seeking to ensure that strategi and long term issues are addressed as well present day risks are managed SFAIRP.

My recent comments on funding were not focused on Sellafield, but applied to the whole of the NDA estate. As I noted in my previous letter, work at Sellafield is not currently constrained by funding. There are a number of low priority decommissioning projects across the UK that could be accelerated, and in my comments I wished to draw attention to possible alternative funding mechanisms that could enable such acceleration. Let me assure you, however, that we consider any delays to progress with remediation of high hazard plant as a serious matter regardless of the reasons for this.

Finally, in relation to your three particular points the new management company for Sellafield required alternative insurance arrangements for commercial accounting reasons and there is no contradiction between this and my view that even high hazards can be managed safely. Indeed, this is true for other high hazard sectors of the British industry as it is for the nuclear industry.

You also had two specific queries. First a request for a copy of the NII letter to NDA of 26th September 2008 and their reply of 1st October 2008, please find copies enclosed.

Second a request for an explanation for the delay in the publication of the November 2008 NII newsletter on the web. Please find attached a copy of this edition of the Newsletter that is just about to go on HSE's website. The preface explains the delay, it relates to the curtailment of the Nuclear Safety Advisory Committee for whom the basic report is produced and our desire to put information in a more accessible form.

I hope that this helps you to understand our position better and that this letter provides the information you seek.

Yours sincerely

Mike Weightman
HM Chief Inspector of Nuclear Installations
And Director, Nuclear Directorate

APPENDIX TWO

Letter from the Tony Bishop
of the Planning Inspectorate
To Dr Rachel Western

(17th April 2009)

ctorate
411/Eagle Wing
Temple Quay House
2 The Square
Temple Quay
Bristol BS1 6PN

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GTN 1371-6278
e-mail: tony.bishop@pins.gsi.gov.uk
http://www.planning-inspectorate.gov.uk

Dr Rachel Western

By email

Your Ref:

Our Ref: PINS/H0900/429/9

Date: 17 April 2009

Dear Dr Western

CUMBRIA COUNTY COUNCIL – CORE STRATEGY

Thank you for your telephone call of 8 April and your email of 9th asking about the status of Mr Howarth of the Nuclear Installations Inspectorate.

It may be helpful if I explain that the Nuclear Installations Inspectorate (NII) was formally invited to attend the hearing session on radioactive waste by the Inspectors, at the suggestion of Cumbria County Council. The Inspectors have the discretion to invite parties who have not made formal representations or indicated an intention to attend an oral hearing if they feel it would help to assist the discussion. Consequently, the role of Mr Howarth was as an official participant at the hearing representing the NII, to assist the Inspectors in understanding the role of the NII and its view on the issues discussed, rather than as an observer.

With regard to your question about minuting there is no formal requirement for notes or records of sessions at Development Plan Document hearings to be made. However, I understand that the Inspectors asked for notes to be taken, outlining the gist of the discussions at the hearings, principally for their use. Although these notes are not formal examination documents, they are available for public inspection, if necessary, at the offices of Cumbria County Council. Although these notes outline the main topics discussed, they are not intended to record all comments made during the hearing session. Notes were produced for the pre hearing meeting, principally because this set out the procedures to be adopted for the hearing sessions of the examination, and because not all those attending the hearings were present at the prehearing meeting. However, these were not intended to be formal minutes of the prehearing meeting, but to outline the main matters discussed.

I hope that these comments are useful.

Yours sincerely
TONY BISHOP

Quality Assurance Unit

APPENDIX THREE

Sellafield
Loss of Coolant Incident
In Liquid High Level Waste Tanks

1st April 2009

Introduction – What Sellafield Does

The main process carried out at the Sellafield nuclear site is the separation of plutonium from used nuclear fuel rods. This procedure is carried out using a liquid based chemical technique known as '*solvent extraction*'. Following the plutonium separation, the majority of the radioactive wastes are to be found in a hot nitric acid mixture known as 'Liquid High Level Wastes.[169]

The Importance of Constant Cooling

This High Level Waste stream at Sellafield is fiercely radioactive – so much so that it is self-heating and needs to be constantly cooled. This is achieved by a system of pipework inside the tanks which carry cold water.

It is important that the cooling system in the high level waste tanks is kept running constantly – otherwise the high level wastes in the tank could get so hot that they boiled. If the cooling problem remained unresolved, the tank would eventually boil dry.

It is very important to prevent this happening - because if the wastes were allowed to start boiling then radioactivity would escape and contaminate the surroundings.

Precise estimates of how much radioactivity would escape – and how many people would be affected – have not been carried out. However the Nuclear Installations Inspectorate (NII) have stated that the consequences of prolonged cooling failure could be 'very severe'. [170]

In December 2008, the Department of Energy and Climate Change (DECC) defined a severe accident as one that would kill at least 100 people. [171] (This is based on a

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[169] Prior to re-solidification (vitrification).

[170] "High Level Radioactive Liquid Waste at Sellafield - Risks, Alternative Options and Lessons for Policy" Gordon Thompson (June 1998) - Section 4.1
[http://www.irss-usa.org/pages/documents/Completew-oapp.pdf]

[171] 'The Justification of Practices involving ionising Radiation Regulations (2004) '"*Consultation on the Nuclear Industry Association's Application to Justify New Nuclear Power Stations* " – Volume Two (Appendix B) – Copy of the Application.- Published by the Department of Energy and Climate Change (December 2008)
http://www.berr.gov.uk/files/file49231.pdf (page 47)

Nuclear Industry Association document (NIA) document of (June 2008) – which is itself based on a Nuclear Installations Inspectorate (NII) Document (of 2006). [172]

The timings involved for the initiation of a severe accident are very short. BNFL [173] analysis has indicated that cooling failure would lead to boiling after 12 hours, and to the tank drying out after three days. [174]

Estimated Probabilities of Cooling Failure

Although the time it would take for radioactivity to start escaping is short, it has been argued that the probability of a failure in the cooling system is extremely low. For example the NII have argued that the probability of a failure continuing for 24 hours is less than one in one million years – and the possibility of 3 day failure (that would lead to the tanks drying out) is less than one in a 100 million years.

However on Thursday 9th April, Cumbrians Opposed to a Radioactive Environment (CORE) revealed that at the beginning of April (2009) a cooling failure had in fact taken place.[175] The incident was on Wednesday 1st April [176] and the Sellafield Site Newsletter '*Sellafield News*' [177] indicates that that the problem was so serious that the Site Emergency Control Centre arrangements had to be called on.

Comparison with Chernobyl

This happened just a week after the Norwegian Radiation Protection Authority published a report comparing the effects of an accidental release of radioactivity from the Sellafield high level waste tanks to the effects of the Chernobyl accident. [178]

This clearly indicates that the probabilities of cooling failure that are used by the NII to regulate the Sellafield site are extremely unrealistic. It is important to realise that although the Norwegian report refers to the implications of an accident at Sellafield being up to 50 times worse than Chernobyl (see page 5) – obviously, because Sellafield is in Cumbria, the effects on Cumbria and the UK would be much worse.

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[172] See 'DECC' December (2008) 'Justification' document Volume Two (Appendix B) – http://www.berr.gov.uk/files/file49231.pdf (pp 46,47)

[173] BNFL – 'British Nuclear Fuels' the predecessor to the 'NDA' – the Nuclear Decommissioning Authority

[174] "High Level Radioactive Liquid Waste at Sellafield - Risks, Alternative Options and Lessons for Policy" Gordon Thompson (June 1998) - Section 4.1 (as above) [http://www.irss-usa.org/pages/documents/Completew-oapp.pdf]

[175] 'Near Miss' at Sellafield's High Level Waste (HLW) Storage Tank Complex.' Thur 9 April 2009 http://www.corecumbria.co.uk/newsapp/pressreleases/pressmain.asp?StrNewsID=256

[176] "Cooling Water Supplies" - Note from Sellafield Press Office – 14th April 2009

[177] 'Sellafield News' Wednesday 8th April 2009 – Issue 1101 (page 2) http://www.sellafieldsites.com/UserFiles/File/Sellafield%20News/Sellafield%20News%2008_4_09.pdf

[178] 'Norwegian Radiation Protection Authority, P.O. box 55, No-1332 Østerås, Norge.
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E-mail: nrpa@nrpa.no
www.nrpa.no
ISSN 0804-4910

Conclusion

At the beginning of this month, there was an accident at the Sellafield nuclear facility that was only supposed to happen of the order of once in one million years. Due to the fact that radioactivity could have escaped from the site, emergency arrangement needed to be brought into play.

The reality of the Sellafield incident – as compared to the abstract calculation of the probability of future accidents – clearly indicates that basis of the NII regulation of the Sellafield site is seriously flawed.

APPENDIX FOUR

Sellafield and
The Hazard Presented by
Liquid High Level Wastes

The Military Origin of the Sellafield Site

The techniques applied to spent fuel waste management at the Sellafield site have changed little since the military origins of the site. Sellafield was first set up immediately following the Second World War to provide plutonium for nuclear weapons. In order to achieve this a chemical extraction process was developed.

Thus at Sellafield spent nuclear fuel rods are dissolved in hot nitric acid and then subjected to a 'solvent extraction' process to separate the uranium and the plutonium, and concentrate the intensely radioactive 'fission products' in the nitric acid.

When the decision to subject nuclear fuel rods from the non-military nuclear power stations was made it was confidently argued that the fission product stream could readily be turned into glass (vitrified) – and also that the plutonium and uranium product streams would prove to be a valuable resource.

However, in fact it has proven to be very difficult to achieve the vitrification of the nitric acid/HLW stream, and also – rather than bringing in funds, the reprocessed uranium and separated plutonium stocks are going to require funds in order to develop a long term approach to their management.

The Hazard Presented by Liquid HLW

A significant contribution to the hazard presented by the Sellafield site arises from the liquid wastes – thus in a June 2006 an NDA (Nuclear Decommissioning Authority) document on 'Radiological Hazard Potential', the NDA Engineering Directorate[179] wrote:

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

In the year 2000, British Nuclear Fuels (BNFL) estimated that the likelihood of a plane crashing into the liquid high level waste tanks on the Sellafield site was:

one in 100 million a year.[180]

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[179] 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

[180] '*Assessing the risk of terrorist attacks on nuclear facilities*' Parliamentary Office of Science and Technology Report - Report 222, July 2004 (page 79)

In the following following year, the 9/11 plane crash took place – and thus BNFL's one in a 100 million estimate of a plane crash is demonstrably far too low. However, given that BNFL had argued that the risk of such a plane crash was so low, they had not designed the tanks that hold the liquid high level wastes to be able to be able to withstand aircraft impact.[181]

Thus – if there were to be a 9/11 at Sellafield the radioactive contents of the tanks would be released.

In the following Boxes, some attempt is made to give an indication of the hazard presented by the liquid HLW at Sellafield. The first calculation is based on a report for the European Parliament carried out in 2001; and the second calculation is based on a report by the US High Level waste expert, Gordon Thompson.

Caveat

- Calculations – 'Order of Magnitude Only

The figures in the two boxes below are meant to give an order of magnitude indication of the degree of hazard only – as there are many variables that would affect the harm that would be caused by a release from the liquid waste tanks.

In addition to factors such as wind direction; another very important consideration is the actual quantity of radio-nuclides in the tanks. The quantity of radionuclides is dependent not only on the balance between:

(a) how much has been generated as a bi-product of the plutonium separation operation, and

(b) the amount vitrified (turned into glass blocks)

but also on how much has decayed away to non-radioactive isotopes

[181] POST (2004) page 79.

Sellafield + Possible Fatalities

Source: **European** "**STOA**" **Report** – (**<u>August 2001</u>**)
[STOA = 'Scientific and Technological Option Assessment']

"*Possible Toxic Effects from the Nuclear Reprocessing Plants at Sellafield (UK) and Cap de la Hague (France')*" [182]

Some indication of the possible number of fatalities that would result from a Plane Crash into Sellafield may be given by the STOA Report (August 2001).

On page 38, this report considers a possible '*atmospheric release*' from the Sellafield Liquid High Level Waste tanks of the radioactive atom:

'3.5 million Tera Bequerels of Caesium-137'.

It calculates that this could result in a '*collective dose*' over the affected population of:

' 47 million Person – Sieverts [183] '

According to the Health Protection Agency (HPA), the International Commission of Radiological Protection (the ICRP) has recommended an 'overall total cancer risk coefficient': of:

5% per Sievert. [184. 185]

Thus, the number of fatalities that may be expected from such a release would be:

47, 000 000 x 0.05

= 2, 350 000

or - approximately **Two Million Fatalities**.

[182] Mycle Schneider et al - Commissioned by the European Parliament, (Directory General for Research) Contract No EP/IV/A/STOA/2000/17/0 (August 2001)
[183] Sv – stands for 'Sievert' – which is the unit used for the health effects of radiation,
[184] E-mail from Shelly Mobbs (Health Protection Agency) to Rachel Western - 26 Nov 2008
[185] see also e-mail from Ian Fairlie (Consultant on Radioactivity in the Environment) to Rachel Western - 24th January 2009

Sellafield + Chernobyl

Source:

"*Civilian Nuclear Facilities as Weapons for an Enemy*" [186]
Submission by Gordon Thompson
to Defence Select Committee (January 2002)

"A notable example of a potential radiological weapon for an enemy of the UK is the B215 facility at Sellafield. This facility houses 21 steel tanks and associated equipment in above-ground concrete cells. The tanks contain high-level radioactive waste (HLW) in the form of a self-heating, acidic liquid that requires continuous cooling and agitation. This liquid HLW is a product of nuclear fuel reprocessing at Sellafield. At present, the tanks contain about 1,550 cubic metres of liquid HLW. The radioactive isotopes in this liquid include:

about ***8 million*** [187] *TBq (2,400 kilograms) of caesium-137*

For comparison,

the 1986 Chernobyl reactor accident released to the atmosphere about **90,000** *TBq (27 kilograms) of caesium-137, representing 40 percent of the inventory of caesium-137 in the reactor core. Most of the offsite radiation exposure from the Chernobyl accident can be attributed to caesium-137, which has a half-life of 30 years."*
(page 2)

Using these figures, the hazard associated with Sellafield, can be calculated as follows:

$$= \frac{8{,}000{,}000}{90{,}000}$$

" 90 Chernobyls "

[186] http://www.irss-usa.org/pages/documents/UKDefCttee01_02_000.pdf, p2
[187] a TBq is a unit of radioactivity

APPENDIX FIVE

UK nuclear advisory group scrapped after warning of safety risks, insiders claim

Monday 16 February 2009 16.16 GMT

Summary

An expert advisory committee has been quietly scrapped after it warned the future safety of Britain's ageing nuclear plants was being put at risk by poor performance, delays and budget cuts. The Nuclear Safety Advisory Committee (NuSAC), which has been offering critical advice to Britain's health and safety watchdog for nearly 50 years, was disbanded without any public announcement. Former members of NuSAC are now worried about the lack of independent safety advice at a time when the government is embarking on a major expansion and clean-up of nuclear power

http://www.guardian.co.uk/environment/2009/feb/16/nuclear-safety

• Nuclear Safety Advisory Committee disbanded without any announcement
• Experts alarmed there is no immediate successor to provide independent nuclear advice

Rob Edwards and **Terry Macalister**
Monday 16 February 2009 16.16 GMT

An expert advisory committee has been quietly scrapped after it warned the future safety of Britain's ageing nuclear plants was being put at risk by poor performance, delays and budget cuts.

The Nuclear Safety Advisory Committee (NuSAC), which has been offering critical advice to Britain's health and safety watchdog for nearly 50 years, was disbanded without any public announcement.

Former members of NuSAC are now worried about the lack of independent safety advice at a time when the government is embarking on a major expansion and clean-up of nuclear power.

Some former members privately suspect that NuSAC was shut down in October because it could have hampered government plans for a new programme of nuclear reactors. "This was just the time to get rid of a potential pest and spanner in the works of the brave new world of nuclear regulation and build," said one.

Some of NuSAC's recent criticisms — particularly on potential shortfalls in the future funding of nuclear decommissioning and radioactive waste management — were forthright. "Maybe that was enough to rock the boat," added the former NuSAC member.

Some committee members are also angry at suddenly being told in September that their next meeting was cancelled. "The way we were treated was shabby, to be honest," said another former NuSAC member.

NuSAC consisted of 19 safety experts, including scientists, academics, trade unionists and business executives, none of whom were paid. It reported to the Health and Safety Executive (HSE) and was chaired for the past four years by Dr Stephen Vranch, a chemical engineer from Jacobs Engineering.

"We are anxious to ensure that a successor body to NuSAC is set up as soon as possible," he said. "It is essential that nuclear safety regulators continue to receive good, independent advice, particularly at a time of great change in the nuclear industry."

NuSAC had been "passionate" about safety and spoke with "tremendous authority", Vranch argued. "I believe we did good work and raised important

concerns on the future funding of nuclear decommissioning and waste management, on skills shortages, on the siting of new nuclear power stations and on other issues."

NuSAC's demise followed the launch of a major review of nuclear regulatory arrangements by the government's nuclear adviser, economist Dr Tim Stone. In a report last month, he recommended more staff and a major shake-up for the HSE, but made no mention of an advisory committee.

Marion Hill, a radiation scientist and former NuSAC member, thought it was unclear why the committee had not been allowed to carry on until a replacement could be set up. "It is a very busy time for the nuclear industry and I would have thought that HSE needed access to independent safety advice," she said.

The absence of NuSAC made it more difficult to find out about the regulation of nuclear plants. She argued: "Without NuSAC there is less information in the public domain about nuclear safety."

In an unpublicised report last July, NuSAC warned that programmes to deal with radioactive wastes from decommissioning the Sellafield nuclear complex in Cumbria and other old nuclear plants had suffered "substantial slippages".

The slippages were caused by the "poor performance" of nuclear plants, delays in developing waste processing and budget restrictions, the report concluded. "There remains a lack of confidence that the high hazards are being tackled to a robust programme."

NuSAC has also expressed concerns about the likely impact on safety of the shortage of skilled staff. And it has identified shortfalls in the siting criteria for new nuclear stations.

But the HSE denied that NuSAC had been shut down because it raised inconvenient issues. According to an HSE spokeswoman, it was because of the review by Tim Stone. "The HSE board decided to defer on reconstitution of this committee until it knows what sort of advisory body will be best suited to the changing circumstances in the nuclear field," she said. "It will be reconstituted in some form in due course."

The spokeswoman claimed that HSE nuclear inspectors had access to independent advice on nuclear safety from other sources. And she promised that information on nuclear regulation would continue to be published.

Some nuclear industry experts argued that NuSAC was a relatively ineffectual committee that had failed to live up to what had been expected of it. But they too expressed grave concern that there was no immediate successor to the organisation at such a vital time, when nuclear newbuild and waste issues were high on the public agenda.

APPENDIX SIX

Comparison of NII Newsletter Text on 'Highly Active Storage Tanks'

July 2008 – need for replacement '***with utmost urgency***'

"***Replacement HASTs*** **[Highly Active Storage Tanks]** ***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)

NII - July 2008 Newsletter
http://www.hse.gov.uk/nuclear/nsn4308.pdf
(page 16)

Compare the Sept 2008 Newsletter (the most recent that is on the web) – which makes no reference to the need for the urgent replacement of tanks.

NII – Sept 2008

Highly active storage tanks (HASTs) integrity

The following two paragraphs comprise the full text of this section. It can be seen the the previous (July 2008) reference to the need for replacement tanks to be built '***with the utmost urgency***' does not appear within this text.

"*Our previous reports have indicated that HAST cooling components have suffered over the years from corrosion. A number of cooling coils have been declared failed. A failure causes a breakthrough of activity into the cooling water circuits which can lead to a radioactive release if not properly managed. HAST cooling coil failure rates, and (specifically) the location of the most 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. If the HASTs start to deteriorate more quickly, then the ability of HALES to receive raffinates will be prejudiced (with important knock-on consequences). The rates of failure of cooling coils will determine the volumetric capacity of HASTs to store HAL and has the potential to constrain raffinate receipt.*

Sellafield Limited's contingency plans had until recently placed considerable reliance upon a project to dose the cooling water circuits with nitrates as a way of stopping, or at least reducing the rate of, corrosion failures. Following our review

of the technical information relating to nitrate dosing, and consideration by the licensee and internationally-recognised independent corrosion experts, Sellafield Limited has decided not to pursue this strategy further. In the light of this significant development, we have written requesting a revised statement of Sellafield Limited's strategy for the future safe storage of HAL." (page 13)

Source

http://www.hse.gov.uk/nuclear/nn44-040309.pdf

NII Newsletter
Issue 44 - Reporting period June-September 2008

(Most recent that is publicly available)

APPENDIX SEVEN

Sellafield and Funding Problems

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.

nuclear

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.

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

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.

CoRWM + Re-Write of Note on Planning Hearing

Nov 2009 – Request to CoRWM to Correct 2nd Version of (Nov '08) CCC Note

Rachel Western – E-mail to CoRWM (3rd Nov 2009)
Sent to Adam Scott (CoRWM Secretariat)

Re: CoRWM Note of (Nov 2008) CCC Hearing + Regulatory Views on my Evidence

~~~~~~

Hi Adam,

Thank you for your E-mail. I am grateful for the progress in the redrafting of the CoRWM note of the CCC (Nov 2008) Planning Hearing.concerning the regulator's view on my comments - as follows:

2nd Draft

> "*Dr Western expressed particular concerns about escape of gases which she considered had not been given the same weight as liquids reaching acquifers or the atmosphere. She also felt that funding problems at Sellafield were undermining its safety. The former is a matter which the Environment Agency acknowledges will require more work whilst the latter is not appropriate judgement for a Town and Country Planning Act document.*"

However, I am afraid that this 2nd draft still does not convey accurately the Regulatory responses to my comments at the Hearing:

I therefore propose an amended draft - as set out below.

The reasons for these proposed further amendments are also set out.

Given that the CoRWM note is the only Public Record of this Hearing, I am sure you will agree that it is very important that the record of the meeting is accurate.

I**************************************

Summary of Requested 3rd Draft
~~~~~~

In order to capture the three central points made in the text below, I propose the following third draft for the CoRWM note:

> "*Dr Western expressed particular concerns about the implications of gases within a disposal system. She also felt that funding problems at Sellafield were undermining its safety. Both of these matters are delegated by the Planning system to the respective regulator. The former issue is a matter for the Environment Agency - who acknowledge that more work is required - and that this work may or may not indicate that an acceptable safety case can be made.*
>
> *The issue concerning Sellafield safety was 'negated' by the NII representative at the Hearing.*"

****

(i) Environment Agency + Gas

In Clive Williams E-mail to myself and to you (of 16th Oct) Dr Williams referred to work that the Environment Agency were undertaking on the Gas issue.

In this E-mail Dr Williams stated that:

" *I would add that, as a regulatory body, the Environment Agency is not presuming any particular outcome from the Managing Radioactive Waste Safely process.*"

Thus the CoRWM draft statement that the gas issue is one that:

> " *the Environment Agency acknowledges will require more work* "

does not adequately capture the Environment Agency's true position.

ie. - the Environment Agency do not presume any particular outcome from the current process - thus the result of further research into the Gas issue could go one way or could go the other way.

Therefore, there is a possible outcome in which, after further work, the Environment Agency do not feel that disposal should be given the go-ahead. It is important to convey that the Environment Agency feel that this is a possible outcome - however the CoRWM note does not convey this.

(ii) NII + Sellafield

CoRWM commented that I:

> *"felt that funding problems at Sellafield were undermining its safety"*

... [- and that this was -] ...

not appropriate judgement for a Town and Country Planning Act document."

This may be compared to the first draft of the CoRWM note:

"*Dr Western ... felt that funding problems at Sellafield were undermining its safety. This was heard, received a negative response from the regulators and I cannot see being taken forward in a planning document.* " (page 4)

It is interesting that CoRWM have chosen to amend the NII aspect of the CoRWM note - even though that was not the subject of the exchange that Clive Williams and I have been pursuing with CoRWM. [Emphasis added]

There is a clear change in meaning from the first draft to the second.

Unfortunately, whilst the 2nd draft allows for the fact that my concerns may be well founded - it still fails to convey the true position.

This is

- firstly because the NII rep **did** in fact '*negate*' my comments; and

- secondly because the statement made in the 2nd draft wrt the relevance of my concerns to the Planning process does not convey the actual context of the NII at the Hearing

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NII Concerns Over the Safety of the Sellafield Site

In October 2008 I submitted a document to the Planning process which quoted the July NII Newsletter. (see attached)

This NII Newsletter reported that the NII were extremely concerned over the poor state of key safety equipment at Sellafield. (see pp 3-4 of attachment)

At the November Hearing I read from my October Submission;

- however even though this document comprised direct quotes from NII documentation, the NII representative dismissed my concerns.
(See page 33 of Sue Brett's (CCC Planning Officer) hand written notes)

Thus, the CoRWM 2nd draft - which does not state that the NII "*negated*" my evidence - is wrong. [Emphasis added]
~~~~~~~~~~~~~~~~~~~~~~~~~

It should be noted that in October 2009, the Whitehaven News reported that the NII stated that they regarded

> *"the risk of a major event caused by further degradation of legacy plants, or increased time at risk due to deferrals,*[as] ***far too high***."

Source:

Whitehaven News 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

It may therefore be seen that the NII (Nov 2008) "*negation*" of the concerns that I expressed at the CCC Planning Hearing

(which were based on NII documentation)

was inappropriate.

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The Regulators + the Planning Process

The attached letter to me from the Planning Inspectorate (17th April 2009) demonstrates that the NII were official participants at the Planning Hearing.

The text below comprises two quotes taken from the Inspectors report [1] produced following the Hearing:

> *" Detailed technical issues and uncertainties relating to the management, storage and disposal of radioactive wastes are* ***subject to other controls*** *and legislation, and are outside the scope of this strategic planning document."* page 29 (para 8.119)

and more specifically:

> *" Issues about possible problems associated with the vitrification [the process of turning the liquid wastes into a solid glass form] of liquid HLW are* ***covered by other regulatory processes*** *and do not, in our view, justify a more restrictive policy towards the existing or future storage and disposal of HLW at Sellafield."*
>
> page 27 (para 8.103)
~~~~~~~~~~~~~~~~~~~~~~~~~~

[1] S J Pratt & E Simpson "Report on the Examination into the Cumbria Minerals and Waste Core Strategy and Generic Development Control Policies Development Plan Documents" (Published 3rd February 2009) "

In the 2nd **CoRWM** draft, it is stated that the issue of Sellafield site safety was*:*

"not appropriate judgement for a Town and Country Planning Act document."

ie - that my evidence on the safety of the Sellafield site was not relevant to the Cumbrian Planning process

This representation of the situation is not correct.

The key Town and Country Planning Act document in this process - ie the Inspector's Report (as quoted above) - indicates:

i) that the Inspectors did **not** decide that the issue was inappropriate for judgement - rather that they

ii) decided that the process of judgement could be **delegated** by the Planning Regime to Regulator

~~~~~~~~~~~~~~~~

As the CoRWM note appears to be the only official minute of the meeting I would be grateful if CoRWM could further amend the document in order that an accurate minute will stand.

My request for a more accurate further drafting is not merely a matter of pedantry.

As discussed above it is possible that the Gas issue could lead to the rejection of the disposal option – certainly as currently envisaged. It is important that both the public and decision makers are aware of this.

Furthermore – due to my reliance on the CoRWM note of the meeting I was under a false impression that the Environment Agency had not stated their actual opinion at the Hearing. As a result I incorrectly accused them of 'misrepresentation' in a number of Consultation responses – and I would now like to put the record straight. However it would be inappropriate to do so until the CoRWM note is no longer misleading. Unfortunately, this is not currently the case.

The Sellafield site risks - which are the subject of NII regulation - are much more immediate than the disposal risks under consideration by the Environment Agency.
~~~~~~~~~~~~~~~~

An incident at Sellafield could release a cloud of nuclear contamination whose fall-out could spread as far afield as Glasgow and Liverpool [1] and result in a fatal dose of radioactivity that would affect over two million people. [2]

In addition to my Oct 2008 Submission to the CCC Planning process (which I referred to above) that cites the NII's July 2008 Newsletter in order to indicate their documented concern over the safety of Sellafield site;

I have also attached a letter of complaint from me to to the HSE (who are responsible for the NII) setting out my concerns that the NII had misrepresented their position at the Planning Hearing by dismissing ("*negating*") my citation of their published document

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The issue of the interface between the Regulatory Regime and the Planning Regime is not only pertinent to Cumbria County Council and the wastes at Sellafield – it is also highly relevant to the proposals for reactor new build and plans for a new nuclear warhead factory (at Burghfield in Berkshire – just West of London).

Such decisions are of great import. Nuclear projects have the potential for causing extraordinary harm.

It is therefore absolutely essential that those who have been tasked with protecting public and worker safety apply the highest standards of rigour and integrity.

This is of all the more importance in the context of the revised Planning System in which the opportunities for public input are being seriously eroded in favour of an approach much more based on officialdom.

[Emphasis added]

****

Summary of Requested 3rd Draft

In order to capture the three central points made above, I propose the following third draft for the CoRWM note:

> "*Dr Western expressed particular concerns about the implications of gases within a disposal system. She also felt that funding problems at Sellafield were undermining its safety. Both of these matters are delegated by the Planning system to the respective regulator. The former issue is a matter for the Environment Agency - who acknowledge that more work is required - and that this work may or may not indicate that an acceptable safety case can be made.*
~~~~~~~~~~~~~~~~~~~~~~~~~

The issue concerning Sellafield safety was 'negated' by the NII representative at the Hearing."

****

I would be very grateful if you could clarify if - for any reason CoRWM does not accept this suggested draft

- why this is the case

~~~~~~

best wishes Adam

Rachel
Dr Rachel Western BA (Oxon) PhD MRSC

Nuclear Researcher for Friends of the Earth (Cumbria Groups)

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

[2] See STOA Report ["STOA Study Project" on the "*Possible Toxic Effects from the Nucler Reprocessing Plants at Sellafield (UK) and Cap de la Hague (France')*"
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: - Conversion form 'man-Sieverts' to number of fatalities.

Attachments

(i) Dr Rachel Western - Second Submission to Cumbria County Council's Minerals and Waste Development Framework (21st Oct '08)
[Available on Request]

(ii) July 2009 – Complaint Letter from Dr Rachel Western to HSE (see above)

(iii) April 2009 – Letter from Planning Inspectorate to Rachel Western (see above)
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9 Nov 2009 – CoRWM Refusal to Produce Accurate Note of (Nov '08) CCC Hearing

Adam Scott – E-mail to Rachel Western (9th Nov 2009)
[Adam Scott (CoRWM Secretariat)]

Re: CoRWM Note of (Nov 2008) CCC Hearing + Regulatory Views on my Evidence

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Dear Rachel,

Thanks for your comments, which I have shown to John Rennilson.
There are no further plans to amend his summary note to Members. It was never intended to be the record of the meeting, which is a matter for the organisers.

Best wishes,

Adam

18 Nov 2009 – Request to NII to Resolve Problem with Accuracy of CoRWM Note of (Nov '08) CCC Hearing

E-mail from Rachel Western to Chris Snaith

Chris Snaith – Health and Safety Executive (HSE)
Head of International and FOI Unit
Nuclear Policy and International Relations Division

Re: .Matter That Requires Resolution..

~~~~~~

Dear Christine,

For reasons best known to themselves, **CoRWM** (ii) have chosen to amend their note of the (Nov '08) Cumbria County Council (CCC) Waste Planning Hearing such that it is no longer accurate wrt to the participation by the Representative from the NII

You will be aware that it was the NII participation at this Meeting that precipitated my initial letter of Complaint to Geoffrey Podger (Head of HSE) at the end of 2008.

On Tues 3rd November ('09), I e-mailed the CoRWM (ii) Secretariat (see attached) seeking a further redraft in order to correct the erroneous nature of their revised note

However, on Mon 9th November ('09) **CoRWM** (ii) contacted me to say that they were unwilling to make such a Correction.

The Cumbria County Council (CCC) Waste Planning Framework is a particularly important document - and thus it was vital that when the Inspector's wrote up their February ('09) report they were appropriately informed by **reliable** evidence from the NII.

This was not the Case.

This is all the more important in the context of the present changes to the the Planning System (which include the removal of the right of the Public and NGOs to participate in such a way that projects are subject to **Thorough Democratic Scrutiny**)
[Emphaisis added]

Given that the CoRWM (ii) Note is the only official note of the Hearing it is vital that it is an accurate record of what was said.

On Mon 9th Nov ('09) - the day that CoRWM (ii) refused to amend their erroneous redrafting of the (CCC) minute; the Government published their Draft Consultation document concerning the Proposed Nuclear New Build Programme.

It is **ABSOLUTELY ESSENTIAL** that the forthcoming Discourse that will comprise the to-ings and fro-ings of the different sides of the Nuclear Debate has as it's basis a **Solid Foundation** in both:

Truth,

and also more specifically

in Scientific Accuracy

[Emphasis added]

As indicated in the attachment that details my 3rd Nov e-mail to the CoRWM (ii) Secretariat; the hand-written notes of the CCC Planning Officer Sue Brett, support my contention that the CoRWM (ii) note is incorrect.

Furthermore, the attached October ('09) article from the Whitehaven News which reports the NII Spokesman as saying that the Risks at Sellafield are:

"*far too high*"

also supports the evidence that I gave at the (Nov '08) Hearing - evidence which was based on the (July '08) NII Newsletter.

~~~~~~

The Government's Nuclear Waste Advisory Committee CoRWM (ii) appear to be quite happy to **'Re-write History' over a matter of such great importance as the Risks associated with the Sellafield site.** [Emphasis added]

An accident at Sellafield could result in over two million people receiving a fatal dose of radioactivity - and **there have already been two Emergencies at the site this year.**

(see attachment for References)

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The notes of Ms Brett (CCC Planning Officer) indicate that the NII participant at the Hearing stated that the:

"*NII made good progress on HAL [Highly Active Liquid] at Sellafield so review good* "

This evidence was quite simply untrue.

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CoRWM (ii) had originally written that the NII had '*negated*' my evidence at the Hearing

which the NII representative had indeed done

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CoRWM's recent **'*negation*' of that '*negation*'** is the Harbinger of a contempt for democracy and due process - which could be catastrophic in the context of the intrinsic potential harm of Sellafield's nuclear inventory [Emphasis added]

- furthermore in the context of the **vital need for Public and Political Decision Makers be able to source Reliable Official Information** on nuclear issues whilst the topic is a matter of current debate [Emphasis added]

I would be grateful if you could resolve this matter.

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wrt to the proposed Meeting with Dr Weightman, I feel that it would be unfortunate to go ahead with such a meeting whilst the facts pertaining to the particular matter that initiated my Correspondence with Geoffrey Podger - the Head of HSE (ie the NII Evidence to the CCC Nov '08 Hearing)

are a matter of Contention.

It was this original letter that led subsequently to Dr Weightman's letter of 5th March '09 (which was discussed at out Meeting of 8th July '09).

Clearly if even the matter of what was said at the original (Nov '08) Hearing which precipitated my initial Correspondence is a matter of dispute,

then a meeting with Dr Weightman would be Problematic.

yours

Rachel

Dr Rachel Western BA (Oxon) PhD MRSC
(Nuclear Researcher for Friends of the Earth - Cumbria Groups)

Attachments

(i) 3 Nov E-mail from Rachel Western to Adam Scott (CoRWM Secretariat) Requesting Correction of 2nd Version of (Nov '08) CCC Hearing

(ii) Dr Rachel Western - Second Submission to Cumbria County Council's Minerals and Waste Development Framework (21st Oct '08) [Available on Request]

(iii) July 2009 – Complaint Letter from Dr Rachel Western to HSE (see above)

(iv) April 2009 – Letter from Planning Inspectorate to Rachel Western (see above)

(v) 9 Nov 2009 – E-mail from Adam Scott (CoRWM Secretariat) to Rachel Western – indicating CoRWM' refusal to Correct the (Nov '08) CCC Meeting Note

(vi) 7 Oct 2009 – Whitehaven News article – indicating NII View that 'Risks at Sellafield are far too high' (Quoting NII Inspector Mark Foy)

26 Nov 2009 – HSE indicating that they do not feel that they should pursue the accuracy of the CoRWM Note of the (Nov '08) Meeting

E-mail from Chris Snaith (HSE) to Rachel Western – 26 Nov 2009
[NB – HSE are responsible for NII]

RE: ..Matter That Requires Resolution..

~~~~~~

Dear Rachel,

Thank you for your email. We appreciate that you were trying to clarify matters via the CoRWM note of the Planning Hearing, but we do not feel it is appropriate for us to pursue this.

Despite your reservations, we would still be happy to meet with you to discuss the matters you raised in July; we feel it is important to discuss any of your underlying concerns about the regulation of Sellafield and to address the points you raised and indeed your more recent comments about the Whitehaven News article of 7 October.

We presume the 27 November is not convenient, but please do let us know when you would like to meet and we can offer dates/times.

Best regards

Chris

Chris Snaith
Health and Safety Executive (HSE)
Head of International and FOI Unit
Nuclear Policy and International Relations Division
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25 Nov 2009 - Times article Confirms my Original (Nov ’08) Evidence to CCC

“*Cuts loom over UK’s nuclear clean-up budget*”

Robin Pagnamenta, Energy Editor

The Times
Nov 25th ‘09

http://business.timesonline.co.uk/tol/business/industry_sectors/natural_resources/article6930592.ece

The Government is sharpening the axe for Britain’s £4 billion nuclear clean-up budget and drawing up plans for big spending cuts at contaminated sites including Sellafield and Dounreay, *The Times* has learnt.

The Treasury has begun a sweeping review of spending by the Nuclear Decommissioning Authority (NDA), the quango that over the past four years is understood to have spent about £1 billion of taxpayers’ money annually on cleaning up at Britain’s 20 contaminated nuclear sites.

An NDA spokesman said that it was in talks with the Treasury and the Department for Energy and Climate Change about options to cut costs.

These include the acceleration of some pieces of work as well as scrapping or deferring others.

He said that a final shortlist of options would be agreed in February. A Treasury spokesman said that it was “reviewing arm’s length bodies, which could include the NDA”, but no plans had been published and he declined to give further details.

One area of concern is understood to be the fact that almost a third of the NDA’s budget — or £800 million per year — is not spent directly on clean-up operations but on “support”, including administration and other costs.

The bulk of the NDA’s budget is used to pay engineering subcontractor firms involved in clean-up, which employed 18,467 staff on its sites last year. Most work at Sellafield, Europe’s most contaminated industrial site.

The cuts could affect future revenues of companies such as Areva, of France, AMEC and Washington Group, of the United States, which won the main Sellafield decommissioning contract last year, worth an estimated £1.3 billion per year. The NDA’s budget for the four years to 2011 is £8.5 billion.

NDA - Statement in response to Times article on Budget Cuts

25 Nov ‘09

[http://www.nda.gov.uk/news/responsetotimesarticlenov09.cfm]

The NDA is totally focused on achieving its clean-up mission while providing value for money for
the UK taxpayer. This is even more crucial **given the wider economic situation.**

As part of its financial and budgetary planning processes the NDA, along with other agencies, is taking part in a Government-wide review to identify options for transformational value for **money savings** called the Public Value Programme (PVP). The aim is to drive efficiency and effectiveness, and options identified through the PVP process will be used to inform the next spending review, currently expected in the first half of 2010.

The NDA Board will consider a range of options that will be submitted to a review panel of senior Government officials, including representation from the nuclear regulators which is essential to ensure safety considerations are taken fully into account. The range of scenarios to be considered includes:

- Bringing forward some work, subject to affordability, where there are strong value for money business cases
- **Deferral** of some non-essential work to later years
- **Deletion** of scope where alternative plans can be formed
- Increasing income generation from our remaining assets
- Opportunities for further **efficiency savings** across the estate

This work has begun and is due to be completed by February. We will ensure that stakeholders are kept informed at all stages of this process.

Within a **constrained funding environment,** it is critical that we are able to direct every available pound towards core activity. Therefore, it is a priority for the whole NDA estate, including our Site Licence Companies which carry out the work on our sites and the NDA itself, to reduce the proportion of our budget spent on support costs so that we can deliver more decommissioning and clean-up work.

[Emphasis added]

NDA – Lack of Credibility of its 'RadWaste' Evidence Base

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.*" [188]

(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.[189]

188

189 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.

E-mails – Re: NDA 'Lack of Credible Evidence Base

----- Forwarded Message ----
From: phil davies <phil_davies_2000@yahoo.co.uk>
To: Enquiries @nda.gov.uk
Sent: Tuesday, 22 September, 2009 22:14:58
Subject: Error in NDA document at Cumbria MWDF Hearings
Dear Judith,

I attended a meeting for NGO stakeholders today at the NDA Offices in Buckingham Gate, hosted by Bill Hamilton. Towards the end of the meeting I requested clarification of an NDA document submitted to the Cumbria Waste and Minerals Framework Hearings, the document ED 19, reference NDA/WNM/G/009, since the answer to the first question appeared incoherent. Mr. Hamilton agreed that the NDA had made a mistake, and that their answer referred solely to LLW, whereas the question required answers about the policies and evidence basis for HLW/ILW storage and disposal.

I attach a letter to Bill Hamilton, quoting the relevant paragraphs in full, and asking him to confirm in writing that this mistake was made, as he agreed he could be quoted, plus any steps he will be taking to rectify the position. Would you therefore please forward the letter to him for his reply.

Thanks,

Yours sincerely,

Phil Davies

ATTACHED LETTER:

22 September 2009

Dear Bill Hamilton,

I am writing to confirm in writing your answer to the question I put to you at the meeting for NGO stakeholders held at NDA Offices in Buckingham Gate today, about the NDA Document ED19, Reference NDA/WNM/G/009 submitted to the Cumbria Waste and Minerals Development Framework Hearings, which is a public document.

The first part of the document reads as follows:

Section 5 – Radioactive Wastes of the Examination of Minerals & Waste Core Strategy & Generic Development Control Policies DPD's [sic]

Schedule of Matters & Issues to Examination [sic]

NDA submission of further statements.

Key Issue:

3. **"*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?*"**

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.*"
>
> (Emphasis in original)

I questioned whether the "NDA Comment" represented a coherent and appropriate response to the question, and you confirmed that the answer applied to Low-level radioactive waste only, and that the NDA had made an error in the way it had commented on this question. You thereby agreed that the question, as it applies to HLW/ILW, remains unaddressed: "What is the basis and justification for the approach to radioactive wastes (other than low-level wastes), including the specific policies for storage/disposal of high/intermediate-level wastes, and is the strategy for these wastes based on a robust and credible evidence base?"

I asked whether you could be quoted on this matter and you stated that you could. I am therefore writing to you to confirm this position in writing.

I will also ask whether you will be taking any other steps now that this error has been pointed out to you.

Yours sincerely

Phil Davies

From: phil davies [mailto:phil_davies_2000@yahoo.co.uk]
Sent: 26 October 2009 17:01
To: Enquiries
Subject: Fw: Error in NDA document at Cumbria MWDF Hearings

Dear Judith,

It's been over a month since I sent this request, and I've had no reply as yet. Would you be good enough to chase it for me?

Thanks

Phil Davies

From: Enquiries <Enquiries@nda.gov.uk>
To: phil davies <phil_davies_2000@yahoo.co.uk>
Sent: Tue, 27 October, 2009 8:44:53
Subject: RE: Error in NDA document at Cumbria MWDF Hearings

Dear Phil

Just heard back from Bill Hamilton. He says that you can quote him as agreeing that a mistake has been made and that the answer is incomplete. He is following up the matter with the originators of the document.

Regards

Judith Hollands
Information Access Manager
NDA, Herdus House, Westlakes Science and Technology Park , Moor Row , Cumbria , CA24 3HU
T: 01925 80 2077
W: http://www.nda.gov.uk

From: phil davies [mailto:phil_davies_2000@yahoo.co.uk]
Sent: 30 December 2009 12:00
To: Enquiries
Cc: rachel western
Subject: Re: Error in NDA document at Cumbria MWDF Hearings

Dear Judith,

I haven't heard back from Bill Hamilton about this matter which he agreed to follow up. Would it be possible for you to request a progress report?

Thanks,

Phil

From: Enquiries <Enquiries@nda.gov.uk>
To: phil davies <phil_davies_2000@yahoo.co.uk>
Sent: Mon, 4 January, 2010 11:34:46
Subject: FW: Error in NDA document at Cumbria MWDF Hearings

Dear Phil

The response I sent (appended below) on the 27th October was the update from Bill Hamilton – that is his response to you.

Regards

Judith Hollands
Information Access Manager
NDA, Herdus House, Westlakes Science and Technology Park , Moor Row , Cumbria , CA24 3HU
T: 01925 80 2077
W: http://www.nda.gov.uk

From: phil davies [mailto:phil_davies_2000@yahoo.co.uk]
Sent: 04 January 2010 18:11
To: Enquiries
Subject: Re: Error in NDA document at Cumbria MWDF Hearings: New FoI/EIR Request

Dear Judith,

It appears from your response that I will have to make a new Freedom of Information/ Environmental Information Regulations request.

On October 27th Bill Hamilton sent me a response to a query I sent initially on 22nd September 2009 about an NDA document EH 19 sent to the Cumbria County Council Minerals and Waste Development Framework hearings:

Dear Phil

Just heard back from Bill Hamilton. He says that you can quote him as agreeing that a mistake has been made and that the answer is incomplete. He is following up the matter with the originators of the document.

Regards

Judith Hollands

The mistake he admitted to was as follows. The extract below is from my letter to Bill Hamilton and includes the verbatim text of the NDA document from Document EH 19 (Highlighted). 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**.

[extract begins]

"***Section 5 – Radioactive Wastes of the Examination of Minerals & Waste Core Strategy & Generic Development Control Policies DPD's*** ***[sic]***

Schedule of Matters & Issues to Examination ***[sic]***

NDA submission of further statements.

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?"

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."

(Emphasis in original)

I questioned whether the "NDA Comment" represented a coherent and appropriate response to the question, and you confirmed that the answer applied to Low-level radioactive waste only, and that the NDA had made an error in the way it had commented on this question. You thereby agreed that the question, as it applies to HLW/ILW, remains unaddressed: "What is the basis and justification for the approach to radioactive wastes (other than low-level wastes), including the specific policies for storage/disposal of high/intermediate-level wastes, and is the strategy for these wastes based on a robust and credible evidence base?"

I asked whether you could be quoted on this matter and you stated that you could. I am therefore writing to you to confirm this position in writing.

I will also ask whether you will be taking any other steps now that this error has been pointed out to you."

[end of extract from my letter to Bill Hamilton]

My New Request is therefore:

In the light of Bill Hamilton's 27th October response to my letter of 22 September, in which he has agreed that a mistake has been made in this text, that the answer is "incomplete" , and that he would follow up this matter with the authors of the original document, (which was a publically available document for the public MWDF Hearings),
1) can he now inform me if the original authors of the document have reported to him what the nature of the mistake was, including in what ways it was "incomplete", and how the document should have read?

2) will a corrected version therefore be issued?

3) will a copy of the corrected version be sent to Cumbria County Council and to the Planning Inspectorate, to whom the original document was addressed, drawing attention to the nature of the mistake?

Yours sincerely,

Phil Davies

Enquiries <Enquiries@nda.gov.uk>
From: ...
View Contact
To: phil davies <phil_davies_2000@yahoo.co.uk>
Cc: "Hamilton, Bill" <Bill.Hamilton@nda.gov.uk>

5th January 2010

Dear Phil

I have read your email and in my view this is not a FOI or EIR request – you have had a response to your original question. That is the end of the matter as far as I am concerned.

Regards

Judith Hollands
Information Access Manager
NDA, Herdus House, Westlakes Science and Technology Park , Moor Row , Cumbria , CA24 3HU
T: 01925 80 2077
W: http://www.nda.gov.uk

CoRWM – Failure of Consultation Body

DEFRA – (Sept 2001) – The Launch of a 'National Debate'

In September 2001 in the '*Managing Radioactive Waste Safely*' launch document: [190]

DEFRA stated:

> *"In this paper, the UK Government and the Devolved Administrations for Scotland, Wales and Northern Ireland are launching* ***a national debate*** *which will lead up to that decision, and beyond it. The aim is to develop, and*

[190] *"Managing Radioactive Waste Safely - Proposals for developing a policy for managing solid radioactive waste in the UK"* - Department for Environment Food and Rural Affairs (DEFRA) (September 2001)

implement, a UK nuclear waste management programme which ***inspires public support and confidence***." [para 4 (page 7)]

(Emphasis Added)

CoRWM + Funding for Participants

This section addresses the failure of CoRWM to pay for participants time – as compared to the fact that the Govt are prepared to pay for Consultants.

At the extreme, the failure for CoRWM to pay for tickets in advance (even though the cost of these would be reimbursed) meant that one key figure that CoRWM had invited to a workshop was unable to attend.

Invite to Workshop

- on CoRWM's Draft Interim Storage Report

Thurs 19th February (Reading)

CoRWM would like to invite you to attend the workshop on its report to Government on its interim storage tasks.

The report will cover the conditioning, packaging, storage and transport of higher activity wastes, and the management of spent fuels, plutonium and uranium.

The workshop will provide opportunity to input views on the emerging conclusions and recommendations and shape the final report to Government, which will be submitted in March 2009.

David Lowry's Message to
CoRWM (Feb '09)
Workshop on Storage (at Reading)

(Dr Lowry specifically raises the issue of travel costs)

I am deeply disappointed at not being able to attend the meeting with you in Reading, and sharing my thirty years expertise in nuclear policy making. As a self-employed consultant, I am unable to afford the upfront cost of attending this meeting, as **I have no institutional base to cover my transport costs.** I asked CoRWM's secretariat and chairperson through the secretariat, if they would exceptionally arrange for my tickets in advance, but they claimed it was "best value" for invitees to pay up and claim back. It is zero value for me, as it has meant I cannot attend at all. I am requesting, in my personal absence, that those who value the kind of independent

critical assessment I am able to offer are faciltated in future, **so they can attend on a fair footing with those whose organizations** (nuclear industry organizations, regulators, NGOs, trades unions etc) have the resources to pay for their travel and time in attending such meetings.

thank you.

David Lowry + CoRWM / DECC
E-mail exchange – Re: Participant Funding

(edited)

20th Feb – David Lowry to CoRWM

- consultants are in fact hired – but this is wrt how to execute policy; rather than the merits of policy

E-mail : - 20th Feb 2009
From: - David Lowry to Adam Scott – CoRWM Secretariate

Subject: - CoRWM workshop on Interim Storage: 19 February 2009 in Reading

Adam

I understand you were not in Reading yesterday either for theCoRWM meeting on management/interim storage of spent nuclear fuel, plutonium and enriched uranium. I am informed **my message to you was read out, and some discussion ensued over the merits of paying for independent policy input**.

When I enquired of **DECC** about payment for my expertise in radioactive waste management policy, **I was told DECC/CoRWM did not pay for consultants. I now find from the message below, received yesterday, that this is not an accurate statement.**

It seems consultants are contracted to advise/ develop ways of executing policy, but not on the merits of policy, which has long been the failing of nuclear decisions in the UK, certainly in my thirty years watching poorly founded decisions (eg SMP, Thorp), and my academic research on nuclear decision-making for my Phd (AGR, SGHWR, FBR, etc).

I would request you review why it is that lavishly funded consultants (such as the Assessment of BNFL's Business Case for the Sellafield MOX plant, Public domain version of the report prepared by Arthur D. Little Ltd, [191] (15 June 2001) get decisions so badly wrong, but underfunded or non-funded experts get the analysis so right.

I would be grateful if you were to consider engaging my own services, especially on the security dimension of radioactive waste management policy, on which the current NDA position is so manifestly deficient.

sincerely

Dr David Lowry

[191] http://www.berr.gov.uk/files/file19285.pdf

environmental policy and research consultant

19th Feb – DECC to David Lowry

Freedom of Information Response
Govt Engages Paid Consultants

E-mail: Thur 19th Feb 2009
From: Lewis.Mortimer (DECC) to David Lowry

Subject: Action required: Invitation to CoRWM workshop on Interim Storage: 19 February 2009 in Reading

Dear David,

Thank you for your email of 27 January to the CoRWM Secretariat asking about consultants contracted to BERR in the past, and to DECC currently , who have advised on nuclear waste policy. As the Secretariat let you know, they were unable to answer your question but passed it to the DECC Radioactive Waste Policy team for consideration. Your request has been considered under the Environmental Information Regulations 2004.

Since BERR's creation in June 2007 Slaughter and May, Deloitte, and Ernst and Young have provided advice on the development of the new waste and decommissioning financing arrangements for new nuclear power stations.

Consultants currently contracted by DECC are Serco, in respect of the Funded Decommissioning Programme, and WS Atkins for general technical support on nuclear waste policy.

All contracts were entered into following a competitive tender process and **the organisations were/are paid for their work.**

I hope that this answers your question. If you have any queries about this, please contact me again. I also attach an annex giving contact details should you be unhappy with the services you have received.

Lewis Mortimer
Radioactive waste team (DECC)

27th Jan – DECC to David Lowry

DECC unable to pay Consultants Fees

Tue 27th Jan 2009
E-mail from Nicola Martin (DECC) to David Lowry

Subject: Action required: Invitation to CoRWM workshop on Interim Storage: 19 February 2009 in Reading

Hi David

We will cover standard train fares and overnight accommodation (inc breakfast) if essential. **We are unable to pay a daily rate or fee.**

Hope this helps

Nicola

Folder 1.1 Process planning for engagement, option assessment and deliberation

CoRWM modus operandi

Options for managing the CoRWM programme, secretariat paper to the November 2003 plenary meeting, reference CoRWM(03)1/1, document 12

CoRWM's Key Guiding Principles, document 5

CoRWM objectives, document 16

CoRWM Publications scheme, document 34(1)

CoRWM Transparency policy, document 34(2)

Team decision making for complex problems, document 60; and addendum, document 131

Proposal to conduct a Multi-Criteria Mapping (MCM) exercise, document 124

Report by the Principles working group on a proposal for a "Supporting Programme" to the April 2004 CoRWM plenary meeting, document 349

How to achieve consensus on consensus, May 2004, document 350

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THE CoRWM ELECTRONIC DOCUMENTS ARCHIVE

The Archive is a term (although "Guide to Key CoRWM documents" might be a better one) for about 750 numbered documents (out of a total of about 2200 registered by CoRWM as part of its policy on transparency) that:

- particularly influenced its decision making;

- recorded key decisions.

It follows that documents that solely describe process (such as Programme Manager and secretariat reports to plenary meetings) or administration, or did not influence CoRWM's work significantly, are not included.

The Archive is not an "audit trail" since the rationale for CoRWM's recommendations is set out in its Final Report. However, the Archive facilitates the location of numbered documents that are associated with other related documents, for example groups of documents describing short-listing or quality assurance, or referenced together in the Final Report, in order to provide a fuller idea of the context of CoRWM deliberations.

Structure

All documents created by CoRWM and substantive documents provided by others to CoRWM are numbered and registered in the CoRWM Documents Register. This is simply a (broadly) chronological list that does not permit the reader to look at further documents covering the same topic area.

The structure of the Archive reflects the main steps and themes of the CoRWM programme: 1. Planning; 2. Information gathering and reviewing; 3. Engagement, including early bilateral meetings; 4.

Making decisions; 5. Outcomes; 6. Reporting; 7. Implementation; 8. Quality Assurance

Hence, the archive is arranged as eight "Tier 2" electronic folders containing 35 "Tier 3" sub-folders and 6 "Tier 4" (sub) sub-folders. The four tiers are consistent with the arrangement of CoRWM files on the Defra/RAS Accredited Shared Drive.

Tier 2 folders

1. Planning

CoRWM modus operandi (21 documents); PSE (25); Shortlisting (7); Specialist and technical input (10); Methodologies (16)

2. Information gathering and reviewing

Nirex documents (121); Nirex peer reviews (16); Work packages for shortlisting: Work commissioned by CoRWM to facilitate shortlisting (33); Peer review of shortlisting work packages: Peer review reports (37); Information for detailed option assessment: Commissioned background reports on assessment criteria (11); BNG reports (17); Work packages for option assessment (40); Other key reports (2)

3. Engagement

Bilateral meetings (39); PSE 1-3 (67); PSE4 (10)

4. Making decisions

Ethics (5); Holistic assessment (14); Briefing on key issues (27); Reports on the specialist option assessment workshops (7); Scoring options (7); Sensitivity testing (7); The UK and overseas experience (8); Vetting (4)

5. Outcomes

Shortlisting (15); Forming the recommendations (6)

6. Reporting

Annual reports (3); CoRWM Inventory (8); Final Report (1); Other reporting (13); Phase 1 and 2 reports (2); Plenary meeting minutes (40); Quarterly reports (7); Reporting to sponsors (9)

7. Implementation

Advice on implementation (19); bilateral meetings and PSE (17)

8. Quality Assurance

Quality Assurance (16); CoRWM External evaluator reports (9)

Use

Each of the eight Tier 2 folders has a WORD file alongside it that lists the documents contained in the folder by sub-folder and, where relevant, (sub) sub-folder, detailing its title, date, author (in some cases) and registered number. (A future job is to order these lists chronologically.) This serves as a means of locating a relevant document in the absence of its number, e.g., if you want to understand the decisions behind the short-listing of options, Tier 2 folder 4 covers decision making, and – within it - a Tier 3 sub-folder is dedicated to the short-listing process.

If you know the number of a registered document, you can search the whole electronic file and then see what other documents are associated with it in the same sub-folder.

DISPOSING OF BRITAIN'S NUCLEAR WASTE: THE CORWM PROCESS

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ABSTRACT
The Committee on Radioactive Waste Management (CoRWM) set up in 2003 was tasked to oversee a review of options for managing UK radioactive waste and to engage the public in choosing a long-term solution with the objective of inspiring public confidence. This paper reviews the Committee's processes against their remit and guidance on public engagement. It shows that CoRWM assumed proof-of-concept for geological disposal, despite the contrary verdict of the Sellafield inquiry, and biased the framing of options against 'interim storage plus ongoing R&D' (Netherlands option). CoRWM also failed to propose technical criteria comparable to those used internationally, and to resolve the deep disagreement on timescale between key stakeholders. The paper points out vested interests operated via CoRWM's programme manager (AMEC-NNC) and sees the checking role of Defra's chief scientist as also undermining the proclaimed independence of the Committee.

CoRWM did recognise their need to range much wider than scientific and technical issues, introducing concepts of institutional breakdown, volunteerism, and socio-cultural timescales. However, these concepts were not subjected to stakeholder consultation and public judgement. The audit of public and stakeholder engagement omitted questions of procedural norms, imbalance of power, and lack of consultation on novel judgements. Two late 'show stoppers' were ignored in a desire to complete the task, resulting in a fudged compromise papering over deep divisions between members.

Their final choice of 'Phased Deep Geological Disposal' expressed qualified confidence in the concept, yet favoured keeping the repository open while continuing R&D into other options. The substantial scientific uncertainties associated with this choice, the problematic process by which this decision was reached, and the concerns associated with the modes of public engagement, mean that their 'solution' is more rhetorical than real. The technical problems and requirements for public confidence remain obscured and unresolved. The reasons for this problematic outcome are located in the current UK policy push for substantial new nuclear power plants and in a culture tolerant of vested interest in nuclear policy-making and civil service warping of the science process.

Key Words: nuclear waste; geological disposal; deliberative discourse; public engagement.

1. INTRODUCTION

The Committee on Radioactive Waste Management (CoRWM) was established in 2003. The two most significant 'Terms of Reference' (ToR) asked the Committee to:

1. Oversee a review of options for managing solid radioactive waste in the UK and to recommend the option, or combination of options, that can provide a long-term solution, providing protection for people and the environment.
2. Ensure that this review of options is carried out in an open, transparent and inclusive manner. The process of review must engage members of the UK public, and provide them with the opportunity to express their views. Other key stakeholder groups with interests in radioactive waste management, must also be provided with opportunity to participate. The objective of CoRWM's programme is to arrive at recommendations which can inspire public confidence and are practicable in securing the long-term safety of the UK's radioactive wastes. It must therefore listen to what people say during the course of its work, and address the concerns that they raise[1].

The radioactive waste issue had earlier been posed by the Royal Commission on Environmental Pollution report of 1976 (known as the 'Flowers Report') as:

> "... it would be morally wrong to commit future generations to the consequences of fission power on a massive scale unless it has been demonstrated beyond reasonable doubt that at least one method exists for the safe isolation of these wastes for the indefinite future."

This toughly-worded condition had become accepted as a constraint on any new nuclear reactor programme (the CoRWM Report's 'Overview' omits the first half of the quotation). When re-opening the search for a solution in 2000, under Michael Meacher as Environment Minister, the UK Government laid emphasis on genuine consultation and declined to "endorse any particular management option until after they have carefully considered the views of respondents." [2] As long as nuclear energy remained on the back burner as in the 2002 Energy Policy review, there was little pressure to retract on this position. However, once Tony Blair and his government switched into wanting a new nuclear programme, the CoRWM process inevitably became politically charged.

CoRWM's full *Report* to government (Doc. 700) is a clever piece of writing. The mid-term public row over the deficit in science that led to Defra's intervention in January 2005 is smoothed over as "some criticism" (Report 8:4), the dismissal of

[1] Annex 1 to the final Report at http://www.corwm.org.uk/content-1092. In the text, we refer simply to the *Report* with Chapter numbers and sections. Other CoRWM documents we denote here simply as Doc.123 and they should be available via the document-vault search on the website www.corwm.org.uk.

[2] For a historical summary post-1976 see http://www.no2nuclearpower.org.uk/reports/waste_disposal.php or the CoRWM Report's *Overview* (http://www.corwm.org.uk/pdf/Overview.pdf). The Government began consultation in Sept. 2001 on how to develop its policy with *Managing Radioactive Waste Safely*, leading in July 2002 to the decision to establish the independent committee CoRWM (which took over 12 months because of wrangling in government and then resignation of the first-announced chair).

Baverstock and resignation of Ball are just a note within Annex 2, and phrases like 'scientifically and technically robust', 'peer review' and 'latest relevant scientific opinion' give plausibility to the government claim that CoRWM's work had a sound scientific basis[3]. The public involvement is said *(Report* Ch.7:1) "to ensure the robustness of programme outcomes" and (Ch.7:3) "to enable the public and stakeholders to participate in key stages", though these were declared aims and much frustration was expressed over both. The rhetoric was sufficient to allow Defra (Department for Environment, Food and Rural Affairs, 2006a) to have the Minister, David Miliband, say that CoRWM's report had provided a strong basis for moving forward with clarity and consensus:

> "CoRWM has set the standards for open and transparent advice that not only takes into account the best available expert input, but also the views of the public and stakeholders."

Just two weeks later, parliament's report (House of Commons 2006) on *Scientific Advice, Risk and Evidence Based Policy Making* came out critical of Civil Service rhetoric and 'spin', in commonly saying policies are 'science-based' when they are not.

CoRWM's external assessors have appraised the Committee processes and reporting (Faulkland 2005a,b, 2006a,b) and some of their criticisms are developed here. But this paper approaches the Committee's performance more fundamentally, asking how genuine it appeared to NGO participants (environmental non-government organisations), NGOers for short. It reviews CoRWM's deployment of technical knowledge (ToR 1) and the reality of engagement with the public and stakeholder groups[4] (ToR 2) which led to the choice of 'Phased Deep Geological Disposal' as the solution to the UK's rad-waste problem, while nevertheless failing the Flowers condition.

2. PUBLIC DIALOGUE OVER NUCLEAR RISK

Public dialogue concerning environmental risk, and the models of engagement to enable a deliberative dialogue, are critical to the relationship between science and governance. In the area of radiation exposure, the determination of risk is particularly problematic for reasons that include the complexity of the processes under investigation; difficulties resulting from uncertainty in data; little-understood genetic mechanisms relating to radiological harm; spatial and temporal spread of impacts on

[3] Responding to criticism in the House of Commons that science was being manipulated for political ends, the Minister wrote that CoRWM had taken the "best available existing scientific knowledge" into account. He added: "I believe it is possible to conclude that the scientific basis for CoRWM's work has been sound." (*The Independent*, 19 January 2007, http://news.independent.co.uk/uk/politics/article2165451.ece).

[4] 'Key' stakeholders given a major role were NIREX (the UK nuclear waste executive, now absorbed by the Nuclear Decommissioning Authority, NDA) and the Environment Agency (England & Wales, denote as EA). The stakeholder group known as the regulators includes as well as the EA, the Scottish Environment Protection Agency (SEPA) and the Health and Safety Executive (HSE Nuclear Safety Directorate, formerly the Nuclear Installations Inspectorate). The anti-nuclear and community NGOs formed a 'green' stakeholder grouping and generated the critique (Annex 6).

health; the dynamic nature of human and environmental systems; and the species and intra-species (genetic) variability of cause-effect relationships (CERRIE 2004). A corollary to this list is the questioning of reliance or focus on expert scientific risk assessment. As the CERRIE[5] process revealed, there are not only large irreducible uncertainties but also strong disagreements between scientists. These have led to the setting up of an alternative to the longstanding ICRP[6]. Applying a model derived from radiation exposure of adults (and animals) to the foetus and child presents particular difficulties (Busby and Fučic 2006). There is moreover, a body of human knowledge – values and cultural norms – that are not founded in science, but are still employed for reaching judgments of risk. To some extent, the science-based community denigrates this as "perceived risk", but in the late '90s, it was accorded validity by the UK government (Sect.6.3 below), also in the EU and other institutions of the developed world.

This new approach was given a firm basis from the Royal Society 1997 conference on *Science, Trust and Social Change*, which called for new mechanisms of involvement where there's strong mismatch between technical experts and lay-perceptions. In the nuclear and radiation area, this requires the decision-making process to:

- negotiate acceptable ways forward and agree framings of issues
- recognise divergent knowledge-bases and
- correct the imbalance in power between the nuclear industry and NGOs (Section 6.3)

The approach was taken forward by government in their guidance on risk appraisal (Defra, 2000).

Implicit within this analysis is the need to broaden and extend the decision-making community to incorporate the diversity of knowledge. So in both the UK and Europe, there has been a clear move towards the integration of community participation into environmental and health risk communication processes –a move reflected in CoRWM's terms of reference. As the CoRWM Report *Overview* put it, technical and social considerations had to be brought together.

The Select Committee *Inquiry into radioactive waste management* (EFRA 2002) gave CoRWM further help:

[5] CERRIE, the *Committee Examining Radiation Risk from Internal Emitters* (http://cerrie.org.uk), was an expert committee set up with nuclear critics and establishment members, with the remit to set out areas of uncertainty and disagreement where consensus could not be reached and recommend research aimed at resolving them.

[6] ICRP, the International Committee on Radiological Protection, has been long dominated by nuclear power and weapons interests. The alternative centre, ECRR (European Committee on Radiation Risk) (http://www.euradcom.org) was established in 1997 and issued an alternative basis for radiation risk assessment in 2003. Despite the ICRP being independent of governments and of cross-government bodies, it is serviced by leading figures in nuclear regulation and its recommendations are often adopted for government purposes.

> 'following the Sellafield planning inquiry, with NIREX in particular undertaking a fundamental reappraisal of its purpose and approach... there is now a widespread recognition that gaining public trust and confidence is a prerequisite to securing public acceptance of policies. Consequently, there is an emphasis on the need for transparency and openness and for engagement in dialogue with stakeholders and the public as the basis of policy-making.'

However, to gain public trust and confidence, more is required than the ToR and the EFRA watchwords "open, transparent and inclusive". Also required are:

- accountability, not just to participants and stakeholder groups, but also to procedural norms
- recognition of and accommodation to divergent knowledge-bases
- compensation for the imbalance in power in the presence of a strong and well-resourced nuclear establishment.

The ToR 2 seems to place other stakeholder interests second to the public, but still implies criteria securing long-term safety (timescales and radiological impact) should be defined and inevitably involves regulatory and industry interests. CoRWM's task also required respecting overarching concepts of sustainable development, international law and the plurality of ethical systems (Hunt and Wynne 2000). To do that coherently (and in accord with policy on nuclear waste) these authors argue for full public involvement, including public access to expert reviews covering the overarching topics.

Genuine public involvement requires a process now known as deliberation, or deliberative discourse - a form of a dialogue, in which all parties present claims and test their validity in a free and open forum. Through deliberation, consensus may be forged between the public and stakeholder groups, integrating the knowledge and views of both communities and scientific experts. Consensus emerges when all relevant stakeholders trust that their views and experience are genuinely taken into consideration. The *Overview* says CoRWM chose a deliberative approach and claims to democratic and 'holistic' integration. Unfortunately CoRWM was set up without expertise in this area. Faulkland Associates were brought in from mid-2004 to constructively assess process quality, starting with the website and a trial of Deliberative Mapping that CoRWM had started. Faulkland were taken on to work under the NNC from January 2005 (starting in December), reporting on the Website and CoRWM's Phase 2 work in April 2005 and the Inventory in May 2005. They found the initial public-stakeholder engagement processes (PSE1) to be innovative (Faulkland 2005a) but to fall short over the deeper democratic requirement.

3. ASSESSMENT OF OPTIONS FOR CONSULTATION

3.1 Appraisal of rad-waste issues

The first tasks the Committee undertook were to consider all options and to draw up an inventory of UK intermediate and high-level radioactive wastes (rad-waste, for short). Subsequently, late in 2004, they moved on to defining the criteria for selecting

options. Despite the Committee's requirement of 'openness and transparency', these criteria were developed by working groups meeting informally, with no published records, no dates and lists of members present (Faulkland 2005a).

The first technical choice of the Committee arose in compiling the 'Inventory of Nuclear Wastes' in terms of waste volumes. This choice was strongly criticised, since the simple use of 'volume' as the descriptor conceals the fact that the most problematic and highly radioactive "high level waste" derives from spent nuclear fuel. Apart from the radioactivity level, important characteristics ignored by choosing 'volume' include: decay lifetime, bio-accumulative potential, security from bomb diversion, chemical mobility and biological effectiveness. Compiling the inventory primarily in terms of 'volume' illustrates the influence of the nuclear industry on the Committee.[7]

The engagement of NNC (formerly National Nuclear Corporation) as project managers for CoRWM manifested this too. This is because the NNC were the leading UK private sector supplier of nuclear engineering, technical and safety services when they took on the CoRWM contract in 2004.[8] Subsequently, in July 2005, NNC were acquired by AMEC - a company with an acknowledged and overt agenda for new-build nuclear power in the UK.[9] In January 2006, AMEC joined UKAEA and CH2M HILL to form a new alliance to *target opportunities in the UK's £56 billion nuclear clean-up market* (UKAEA, 2006). Thus it came about that AMEC were tendering for government contracts on decommissioning and waste at the same time as running the programme for CoRWM. Annex 1 gives further detail on the NNC conflict of interest.

3.2 Technical options emerge

With NNC's engagement in July 2004, the technical assessments needed by CoRWM had to be rushed through. Technical work packages were allocated by NNC internally, or subcontracted on the basis of sometimes poor specifications and rapid responses. The assessor's evaluation of sixteen key reports concluded that they were fairly basic and the quality was variable (Faulkland 2006a). Judgments about the authority of scientific input were required for short-listing, but in areas in which no CoRWM Member was competent. Of the external reviews, many were critical pointing out significant omissions[10]. Specialists including the regulators heard of this, but not the wider stakeholders. CoRWM defended their rough-and-ready methods as appropriate for short-listing, but Faulkland (2006a) still considered that external specialists should have been used to help frame questions.

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[7] CoRWM's Inventory Working Group was chaired by Wynn Davies, ex-Amersham International, a radiochemicals company.

[8] While working for CoRWM, NNC was promoting its GeoMelt technology for rad-waste management, presenting it at CoRWM's 22 February 2005 meeting (Annex 1).

[9] Sam Usher, who managed the CoRWM contract for AMEC-NNC, wrote in the in-house magazine: *This is a high profile contract that puts AMEC at the leading edge of developing nuclear strategy – not only in the waste management industry, but to have an influence on new build* (Annex 1).

[10] Large (2006) noted that the work package on risk of terrorism seemed naïve, in that it required the frequency of incident to be assessed in terms of principles based on pre 9/11 attack rationale, and omitted to identify the vulnerability of nuclear waste during the transport phase. The terrorism work package report itself (Doc. 619) comprises a single page summary and six pages of text which, because of the security issues involved, admits that *"it is not comprehensive"*.

From this problematic start, CoRWM proceeded to form a long-list of potential rad-waste options. Their Terms of Reference (their *Report Annex 1*) said they should:

> "take the earliest possible opportunity to identify those options which have no realistic prospect of being implemented within the reasonably foreseeable future, so that the main effort during the assessment stage can be focussed on those which are practicable."

For this purpose CoRWM formulated short-listing criteria, which included 'legality' and existence of 'proof-of-concept'. The former was applied unnecessarily strictly (laws change within the foreseeable future) and the second loosely (disposal in UK geology is unproven). How the criteria were formulated is unclear, with no Minutes or schedule of meetings and working group members unlisted (Faulkland 2005).

Though certain members favoured sub-seabed disposal, the short-listing process was used to sideline that option on the weak criterion that discharge of nuclear waste to the sea is unlawful, as radioactivity might be accidentally released during emplacement. Working from an island or shore would of course, avoid this objection. Also accidental release is not clearly unlawful and the law may well be changed or clarified, so the option could be viewed as potentially available within the reasonably foreseeable future.

3.3 Problematic framing of options

While certain options are clear from the bare description (e.g. launching nuclear waste into the sun) others need careful specification, in particular the timescale for an interim 'Radioactive Storage Facility.' CoRWM specified the timescale for this option as 300 years. Yet saying a store had to be viable for 300 years could not be justified on practical grounds (buildings and rad-waste packaging tend to last up to 100 years) and looks like leaving the problem to future generations. The 300 year scale was related to ideas of major changes in society (NIREX 2005). The Working Group paper that justifies it (Doc.1257: s.3.4 3) said "the option is characterised by the need to maintain institutional control" and then explained (s.3.11.4) that 300 yrs was the maximum any regulator could accept. Its only example was the Netherlands, who envisage their present 100 years storage might be extended to 300 years. The US specifies 100 years maximum for assuming institutional control. CoRWM's specification had, it seems, significant influence on the public consultation and contributed to the eventual outcome of the Committee's deliberations.

Further bias in framing options for public consultation entered in framing deep disposal options ('Geological Disposal') without mention of the need for prior storage over decades – and inescapable investment in building new stores.[11] A fairer presentation between the two principal options would have been:

[11] Citizens' Panels did indeed see that all options required a storage component, if only whilst the hole is being dug. But this point did not enter into the general popular consciousness. The misconception has persisted to this day that it is proposed to simply dig a hole and place the waste in it. The government is now expecting to persuade communities to volunteer (Annex 3) to host the repository, but without explaining it is a huge decade-long construction project needing a big area for site works, large numbers of employees living locally and major transport links. There is no mention of the landscape being highly impacted and a rural community being swamped.

a) build stores lasting for up to 50 years plus developing a deep disposal site for 40-50 years hence, or
b) build stores lasting up to 100 years plus pursuing research and development of options

The latter "Netherlands option" was excluded by CoRWM. They just included the single 300-year option for interim rad-waste storage on the short-list, along with three variations of geological disposal.

Another issue CoRWM glossed over concerned reactor compartments and reactor cores from obsolete military nuclear submarines. These required particular consideration, in that a volunteer site was being sought for storage and/or dismantling and is needed within years. The 'Isolus' project consulting on the way forward had been completed under the Ministry of Defence (MOD) who had proceeded to obtain proposals from industry, but frozen decisions pending CoRWM's conclusions. The umbrella NGO[12] had informed CoRWM that the defunct reactors and the huge reactor compartments should be covered in the waste inventory, particularly their large size. But CoRWM disregarded such detail in reporting them only as containing ILW (*Report* Ch.3:6) with the assumption of readily handled metre-sized packages, and passed the buck to Government (Ch.18:10). CoRWM similarly dismissed the proposal for a decay store for short-lived ILW, particularly tritium wastes[13].

Further significant bias was introduced when the Committee presented deep geological disposal as internationally agreed, while ignoring the UK's 1997 decision (Sellafield Inquiry) which found proof-of-concept was lacking (Section 5.1). Public acceptability of deep disposal remains an issue in Japan, Switzerland and France, as well as Nevada.[14] In fact, few countries are currently attempting to proceed with deep disposal and the technology remains both experimental and unproven. Alternative neutral presentation would have brought out the Netherlands' storage plus research/watching option, whereby the UK would watch what happens in those few cases and learns from them before proceeding. Since CoRWM members knew well this is what anti-nuclear groups advocated, the bias against it implies naïvity as well as manipulation.

3.4 Assessment of PSE

For the first phase of Public and Stakeholder Engagement (PSE1), the assessors judged the Consultation Document of November 2004 as "adequate" and the PSE1

[12] NSubF a network set up through ISOLUS and covering local and national anti-nuclear groups, representing them in the Ministry of Defence consultations (http://www.nuclearinfo.org)

[13] Quantities of tritium wastes are accumulating at the Cardiff radiochemicals works, in which the radioactivity decays away in decades (half-life 12 yrs). The local NGO (Community Concern) reminded CoRWM that the House of Lords report (1999) had recommended that Amersham plc produce proposals for a decay store. CoRWM ignored this (though their Wynn Davies, ex-Amersham, was doubtless well aware of it) and left Cardiff with a 'temporary' nuclear ILW store within the city that would stay for decades awaiting the geological repository.

[14] *Radioactive Nimby: No One Wants Nuclear Waste: the Swiss Example*, New York Times, Nov. 2007 http://www.nytimes.com/2007/11/07/business/.

programme as "only just adequate,"[15] but it is unclear why they couldn't write "inadequate and flawed." There are many inadequacies (Annexes 2, 6), in particular the failure to negotiate with stakeholders over framing the options and the criteria for selecting the short-list and long-list (see Section 6.3). Because of the time schedule, the short-listing was reviewed and finalised prior to a report or summary of the public consultation responses. This was despite some discord on the Committee at the Cardiff plenary in July 2005. Just one member had read through the main responses and reported on his interim summary that was later written as the CoRWM paper (Barker 2005). That Faulkland (2005a,b) did not recognise the limited participation[16] and biases in the short-listed options as described above is surprising.

After the participative process known as Deliberative Mapping was dropped in mid 2004 in favour of a Cooperative Discourse model (CDM), the four *Citizens' Panels* became the representative intensively-engaged fraction of the public that is required in a properly deliberative process (Section 6.1). The *Panels* were facilitated by Lancaster University and one of their tasks was to elicit public values for the CDM, yet Lancaster's reports do not refer to the CDM (or MCDA hybrid as chosen). Nor did the *Panels* follow the CDM discourse principles with set standards for participants and with equal rights and duties on parties to present claims (Section 6.1 and footnote). While CoRWM's Report implies the *Panels'* output was of high quality, our Annex 2 shows amateurish and largely parochial views in the records. Participants had been pressed to take positions on the short-listed options before getting the necessary specialist information (Doc.1750). While CoRWM's *Report* (Ch.7:36) says the ethical dimensions were discussed, the views as summarised do not show structured deliberation. Half the panellists could hardly think beyond the 300 years of CoRWM's formulation (Doc.1532). Safety and quality of life for far future generations was of paramount importance to only a quarter, and none showed knowledge of the scientific-geological timescales (10,000 to million years). In considering the fairness of a disposal site to the local community, no-one saw the geological repository as a decade-long huge construction project. Insofar as the *Panels* were to assess the MCDA swing-weightings, the facilitators reported disaffection and even hostility to the exercise (Doc.1532, 4.3.1).

The assessors concur that the ethical and societal considerations were poorly programmed and unintegrated into the PSE processes. They considered the "time and resource – particularly management and planning resources - dedicated to the ethics programme were disproportionately low" (Faulkland (2006b, p.40). This was a very significant deficiency in the CoRWM process – it was both known from the outset that

[15] Faulkland (2005a) says PSE1 development was a troubled process and agreement took too long to reach. Under this they include: time pressures; the Consultation Document was adequate, though some earlier events were not well organised; short listing was completed before some key PSE reports and there was little time to debate issues arising; an impression that at least some Members would have had to formulate their positions and take their decisions without adequate consideration of the views expressed. "We have concluded that CoRWM's PSE1 programme was adequate, but it was only just adequate. Improvements are needed in future."

[16] Large (2006) reports few from the public attended the CoRWM PSE1 road-shows, with an average of 14 and 8 individual stakeholders attending each of the open meetings and discussion groups respectively (a high proportion of these being interested professionals from Nirex, the DTI, local press and local authorities).

ethics must play a large part and then CoRWM introduced novel concepts with important ethical considerations (originating from the nuclear industry), namely volunteerism; socio-cultural timescale (as opposed to geo-scientific timescale); providing for institutional breakdown; acceptable burdens on future generations; tacit disregard of the non-human biosphere. The challenge of the ethicist Barbara Adam that the nuclear industry's (IAEA) approach is "a present-oriented, utilitarian perspective based on moral assumptions that are no longer appropriate" (Doc.1334) could and should have been put into the PSE processes.

4. BEST AVAILABLE SCIENCE?

4.1 Open approach

In claiming to start with completely open minds, CoRWM may have hoped to avoid the scientific establishment's commitment to "geological disposal". They did, however, find difficulty in deciding whether any alternatives were technically sound or might be feasible within decades. In the event, they came back to the well-worn short-list, parking a few others in a "watching brief" for no further consideration. At the same time (July 2005) two Committee members with significant scientific-technical experience (Dr. Keith Baverstock and Prof. David Ball) became critical over a number of issues including the back seat given to technical assessments, and both quit the Committee after pressing the issue of using scientific expertise.

Their stance stimulated well-publicised criticisms from the science and engineering establishment, including the House of Lords Science & Technology Committee,[17] so the government had to intervene. CoRWM's response was to create a QA group with external assessors and Defra sent in their Chief Scientific Advisor, the late Prof. Howard Dalton, with a further review team to oversee the scientific work. The Committee made a rhetorical commitment to adopting the best available science, as inserted on the website and later in the header to Ch.8 of CoRWM's report:

> "CoRWM recognised from the outset that its recommendations have to be scientifically and technically robust if they are to withstand challenge during implementation. The science strategy adopted was to use the best available scientific knowledge at appropriate stages of the CoRWM process."

Criticisms came not just from the establishment. The internationally recognised expert and independent consultant (Dr John Large, an early favourite for chairing CoRWM) was excluded by the NNC for preliminary work and later declined to act as reviewer, being very critical of the quality and time allowed (Large 2006). His expert critiques of NNC's information base and of NIREX's restricted scientific/technical assumptions for the deep-disposal repository - ignoring heat generation, long term chemistry and long term microbiology – have effectively been excluded from the CoRWM process. He (Large 2006) considered a selection of the work packages

17 House of Lords Science & Technology Committee (5th Report, Dec. 2004) was highly critical of CoRWM's diverse membership discussing fringe options, and expressed *"no confidence in the technical ability within CoRWM itself to understand the science"* of radioactive waste management.

undertaken by consultants identified by NNC, suggesting the programme was overly managed and constrained and noting that:

> "Limiting the scientific and technological input to the leanly sponsored 'work packages' runs the risk of introducing shallow if not 'junk' science which an 'unintelligent' receptor could not be expected to differentiate, let alone use to arrive at a rational scientific and/or technological outcome. The excuse proffered by CoRWM for restraining the science input is that it is not necessary to commission any new, fundamental work but, quite contrary to this, the 9-11 terrorism risk assessment, which runs counter to the established PRA assessments universally adopted by the nuclear industry, is entirely new."

CoRWM's Quality Assurance group was slow in getting going (formed January 2005) and its Minutes show it was quite inadequate as a check on the nuclear biases of the NNC. Of the two independent members (three had been intended) Brian Wynne repeatedly gave apologies (meetings of 22 July, 30 Sept, 31 Oct.; Docs.1269, 1333) and Geoffrey Bolton missed the 30 Sept. meeting. However, the latter made some significant criticisms of the process at his first (3 May; Doc.1135) meeting, saying:

- CoRWM's QA processes are not very innovative
- a "charmed circle" is utilised, neglecting the potential independence of those not traditionally associated with the nuclear waste issue
- access to engineering expertise looked particularly weak
- CoRWM's working group structure appeared obscure

The assessors found (Faulkland 2005a) that for PSE1, key technical/specialist reports plus peer reviews were unavailable to stakeholders, unlisted on the website document register and not showing up in searches. They noted in a later report (Faulkland 2006a) a deficit in "counter-experts" (from outside the nuclear industry mainstream), but overlooked the need to rebalance the information base. NGO participants pointed out this need at CoRWM's Stakeholder round-table sessions and referred to experience in the Magnox dialogue.[18] They argued the absence of any rebalancing of the information base badly detracts from the product as well as undermining trust and confidence in the process (Section 6.3).

The EA pointed out (EA 2005c) the huge uncertainties in technical documents provided by CoRWM, noting that the information supplied was of very limited use to stakeholders in the specialist MCDA[19] workshops. This regulator's critique of CoRWM was leaked to NGO participants at the 19 January 2006 Bristol round-table

[18] The NGO critique (2006) refers to experience in BNFL's Magnox decommissioning dialogue. It was recognised that there is a substantial body of non-establishment technical and scientific information that is largely disparate from official information (Section 2). Independent advisors (Mike Sadnicki and John Large) were therefore engaged to assist the anti-nuclear/green sector, and this helped to rebalance the inequality in power. The CoRWM process did nothing similar - yet it is an essential component of fair participation. Participants in CoRWM's *Round-Tables* were given selected, edited and limited information, quite insufficient to base stakeholder decisions upon.

[19] MCDA, Multi-Criteria Decision Analysis, see Section 6 and Annex 5.

(ahead of posting on CoRWM's website), where support for the EA's views was voiced. CoRWM's QA process should surely have pulled up the NNC for such omissions and failures prior to the MCDA workshops (in November to January). The same weakness was observed in the post-MCDA assessment (Faulkland 2006a).

4.2 Failure to Consider Siting

CoRWM's decision to exclude questions of where a geological dump might be sited, even issues generic to many sites like coastal erosion, raised many NGO objections. That the geological establishment subsequently claimed 30% of the UK to be "suitable" shows this exclusion was a mistake. The list of possible sites disclosed during CoRWM's process under Freedom of Information (FoI) showed many to be off-shore islands. Off-shore disposal under the seabed has potential advantages but also many problems and costs in construction that could have been addressed.

Most existing nuclear sites are vulnerable to the sea under the increasing storm surges and sea-level rise expected from climate change. Reports commissioned by nuclear and anti-nuclear interests post-CoRWM have made contrary claims on the significance of this problem. The nuclear industry and Environment Agency maintain they can meet safety case requirements without knowing the characteristics of a site. But underlying that is an assumption of a few hundred years for groundwater movement and corrosive processes, not the tens of millennia through ice-ages and build-up of microbial gas pressures.

Another generic question is whether deep disposal is 'socially' siteable; would people object so strongly, using legal rights to object, that it would be politically impossible to proceed? The social problems with the Yucca mountain dump show attitudes to "disposal" and to nuclear waste stores (on existing sites) differ hugely. In Sweden, community volunteerism was abandoned because of the ethical-social difficulties of committing future generations and of 'compensation.' CoRWM deferred the volunteerism proposal until too late for critical examination and public consultation (Annex 3).

4.3 Failure to specify Time-scales

While NIREX say their Viability Report was to cover the 1 million year time-scale, in practice they and the EA argue over the few hundred years when they are reasonably confident of their science. The EA (2005b) was sceptical whether the containers will resist corrosion as long as NIREX claim. Two of the Review's three authors previously worked for NIREX, which explains their focus on this kind of time-scale, rather than e.g. the 10,000 years specified by the Swedish regulators and one million years for less specific 'scenario' assessment for longer times when radioactivity levels would be formally predicted to approach background levels. CoRWM's failure to fix on determining UK timescales and assessment criteria shows an unscientific approach. The EA were complicit in this as their review (EA 2005b) shows. It is a case of the 'magic circle' (or 'epistemic community') at work, a UK failing that underlines the need for independent critical review.

At their 13 January 2006 meeting with CoRWM's InfWG subgroup (Doc.1541[20]), the EA expressed concern at truncating at 300 yrs. They had considered coastal erosion and inundation by seawater but not the 1:1000 year tsunami event. Here it became clear that the EA was not following US or international practice:

> "the UK's environmental regulatory regime... unlike in the USA, did not require demonstration of compliance... because of the absence of experience of performance... EA proposed to develop environment principles for regulation which were similar in intent to SAPs" (of the US NII).

Clearly this declared departure from international practice was an issue that CoRWM should have probed and properly reported to the Plenary meeting. The 13 January sub-group did nothing. If they had probed, they should have discovered that government policy for waste store planning (Defra 2006b) specifies design for climate change that covers both rising sea-level and glaciation. That implies a timescale over 10,000 years – Defra's reason is "to ensure the necessary safety standards are maintained". The EA's concern over 300 years doubtless reflected Defra's new policy statement. The EA were developing new environment regulatory principles (Doc.1612) to cover situations where there is no experience of performance (now expected for April 2008). However, at the time, both CoRWM and the regulators in effect fell back to the outdated BPM (Best Practical Means) concept that virtually dismisses highly uncertain long-term risks.

4.4 Science authentication of 13th March 2006

In claiming CoRWM's report to be soundly-based in science, the UK government put emphasis on the checking and review of Professor Dalton's panel, which was formed, following pressure and some outcry, mid-process in January 2005 (Section 4.1). CoRWM's *Report* (Ch.8:30) describes senior external scientists and engineers, including the panel, attending the 13 March 2006 one-day meeting to review CoRWM's use of science. The summary note (Doc.1700) gives the purpose as:

> "To provide advice on technological and scientific coverage," but extends this to:
> "check that coverage and referencing of final report are scientifically robust and will meet the expectations of the science community. The report has to be fit for purpose - essentially a support for policy."

The extra-scientific motivation implied in the last phrase came out in statements in Doc.1700:

[20] The current version of Doc.1541 on the website is only the InfWG's own report of the meeting, not the EA's "comments on a note" mentioned there. The Secretariat's Doc.1693v3 quotes from it, but not the specific points above. The old version of Doc.1541 is one of the critical documents that no longer turn up in Search on the Document Vault in CoRWM's website.

- "the way this is described in the report will have to be carefully phrased according to the various constituencies of CoRWM's audience"
- "the main advantage (of phased geological disposal) may be one of societal perception"

The Panel also rejected the idea of watching briefs for ice sheets and subduction zones as "hostages to fortune," but added that "the watching briefs issue could help expose the issue of maintenance of the nuclear skills base."

The one-day meeting with science 'heavyweights' must have given quite detailed criticisms, so the summary Note is strikingly bare. Defra refused disclosure of the full meeting record under FoI[21] - a blatant departure from transparency - offering Howard Dalton's public reassurance letter instead (Section 8.2). As excuse they say (as Ch.8:30) the review was conducted on a non-attributable basis and although a full note was taken, this is not a public document. No such exemption exists under Freedom of Information; if necessary, such a document can be released with names blanked out. The refusal implies Defra is hiding criticisms - disagreement on the suitability of UK geology is evident from use of the double negative (Section 5.2). Without disclosure, the Report's conclusion (Ch.8:30) "that the work carried out by CoRWM *appeared to be fit for the purpose* of the recommendations and the accompanying Report" cannot be validated.

The parliamentary Select Committee reported in November 2006 on *Scientific Advice, Risk and Evidence Based Policy Making*, condemning the Civil Service for claiming policies and proposals are science-based when they are not.[22] The Committee chair, Phil Willis MP, said in a lecture on their report (Willis 2006):

> 'successful policy development requires both an effective scientific advisory system, an appropriate use of evidence and an effective way of dealing with risk by Government... (it is) unacceptable to claim that policies are evidence based "when clearly that is not the case, or where evidence is commissioned, published or cited in a biased way simply to affirm a policy decision."'

This sets very apposite tests for CoRWM's Report (Ch.8; see below Section 5.1).

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[21] 28 August 2007 e-letter M. Wallis to Defra's Robert Jackson, requested the full record of 13 March. Despite one of his staff attending (Malcolm Wakerley - Research Manager, RAS Division, Defra) and after prompting over the 20 working days allowed for response, he passed the request to CoRWM on 10 October. S J Mansfield, CoRWM secretariat wrote on 1st Nov 2007:

"The information you requested is being withheld as it falls under the exception in Regulation 12.5(f) of the Environmental Information Regulations 2004. This exception relates to the interests of people supplying information voluntarily to a public authority:

...participants at the Science Review were asked to provide their views in as frank and free a way as possible. To help them in this, it was made clear at the start of the meeting that their comments would be regarded as confidential and would not be made public."

Yet this was an official review for which expenses and fees were probably paid, so the claimed exception is invalid. Second, whatever the promise of confidentiality, the staff who gave or agreed it were not complying with the ToR's requirement of openness (Section 1).

[22] This was headlined in *Nature* **444**, 252 (Nov.2006) as "UK civil servants accused of warping science".

5. 'PROOF OF CONCEPT' OF DEEP DISPOSAL IN THE UK

5.1 Post-1997 Sellafield Inquiry

Proof-of-concept was tested and failed in the 1995-6 Sellafield public inquiry,[23] at least for that location. The NIREX/Sellafield rejection evidently required CoRWM to consider what might have changed to supersede the 1997 legal verdict. However, CoRWM's review of the science of radioactive waste management (*Report* Ch. 8: 7-11) makes no mention of the unresolved scientific issues that contributed to the rejection of the NIREX case. Rather, this section quotes the view of the Nuclear Energy Agency (NEA), whose responsibility is promoting nuclear energy.

CoRWM in fact assumed proof-of-concept for deep geological disposal in the UK at the short-listing stage. Indeed, the Committee seemed to struggle to come to terms with the deep repository concept. Early in their programme Committee members visited the site of the off-shore storage repository in Sweden, and learned of the stringent technical criteria set by the Swedish regulator for a disposal site and of the R&D programme trying to meet them. These include a legal requirement on maximum future dose from the repository and implied timescales (over 10,000 years; perhaps 1 million years) for which they expect quantitative and scenario modelling (SSI 1998, 2004). However, the Committee failed to use or refer to any similar criteria for disposal facilities in the UK. Obvious differences between UK and Swedish geology would have pointed to questions – would the UK's be stable over the million year timescale given our situation on the edge of the continental shelf and subject to likely recurrence of km-deep ice coverage? What of the UK's far stronger coastal erosion? Would it be acceptable to design a repository that would leak into the sea under plausible million-year scenarios.

UK geologists and engineers have persisted with the belief in geological disposal, voiced through the Geological Society and Royal Society, despite the Sellafield verdict. The EA also made an early policy declaration: *"the only sustainable solution to the long-term management of these wastes entails a clear commitment to developing a deep geological disposal facility"* (Environment Agency 2005a). But CoRWM failed to ask if the Swedish criteria were appropriate and force these bodies to address problems of meeting these or similar criteria. They let pass geologists' claims that 30% of UK geology is suitable without a challenge on the Sellafield Inquiry criteria of

[23] Ending on 1 February 1996, the public Inquiry into the Nirex proposal for a deep disposal Rock Characterisation Facility concluded that not even a trial 'rock laboratory' should be permitted at the Sellafield location, a decision accepted by government. The then Secretary of State for the Environment, John Gummer, announced his rejection of Nirex's planning application in March 1997, explaining that he remained:

"...concerned about the scientific uncertainties and technical deficiencies in the proposals presented by Nirex [and] about the process of site selection and the broader issue of the scope and adequacy of the environmental statement". The decision letter to Nirex said: *"your company does not understand the regional hydrogeological system well enough."*

low groundwater flow, readily characterisable and predictable geology, and an overlying barrier layer.[24]

5.2 Environment Agency critique of NIREX's Viability Report

By the end of 2005, weaknesses began to show in the claim to proof-of-concept. NIREX's *Viability Report* (NIREX 2005) emerged (but not to the Committee and the public domain till March 2006) entitled: *The Viability of a Phased Geological Concept for the Long-term Management of the UK's Radioactive Waste*. The EA review of this (Environment Agency 2005b) tore into NIREX's use of the word "viability":

"We agree with NIREX that deep geological disposal is viable, in the sense that, in the medium term, it is feasible that a safety case could be generated that would meet regulatory requirements, provided a publicly and technically suitable site were available". However NIREX should provide a "clearer explanation of the criteria that it believes are appropriate to judge viability. We are concerned that plans for a long period of storage, which is envisaged as part of the Phased Geological Repository Concept, are not sufficiently underpinned technically."

"We agree that no major issues have been identified that make deep geological disposal non viable. However, the report has not provided a good technical overview of many remaining key technical challenges and how they will be resolved." The EA outlined twelve *key technical challenges* "...where further work is needed before an acceptable repository safety case could be generated."

The EA's key technical challenges are paralleled in the Austrian ministerial review of 2007, which refers to the IAEA listing 13 subject areas requiring further work on the scientific and technological basis for final disposal. The Austrian review goes further,[25] pointing out the very criteria for longer timescales are debated internationally and asking if additional long-term safety indicators are needed to

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[24] Chris McDonald, the lead inspector (now retired) of the 1995-96 public inquiry wrote in *The Guardian* of 28 June 2007 that "10 years ago the nuclear industry had not found a way of maintaining the stability of (the Sellafield) geology when physically exploring the underground site. The imperfection (claimed by Nirex) consists of simply failing to meet the internationally agreed criteria on the suitability of rocks for nuclear waste deposit. The site should be in a region of low groundwater flow, and the geology should be readily characterisable and predictable, whereas the rocks there are actually of a complex volcanic nature, with significant faulting. Also, the industry was relying on an overlying layer of sedimentary strata to dilute and disperse any groundwater leakage, when the international criteria require such a layer to act instead as a barrier. The comprehensive assessment that reports the deficiencies in detail is at www.jpb.co.uk/nirexinquiry/nirex.htm".

[25] The chapter on Radioactive Waste in *Nuclear Power, Climate Policy and Sustainability An Assessment* (Austrian Nuclear Advisory Board, Ministry of Environment, Vienna, 2007) gives an up-to-date international assessment: though geologic disposal is favoured worldwide and has first priority in most EU-countries, the fact that a reliable safety assessment is not possible for the required time periods (millions of years) presents a major problem. The very criteria for longer timescales than a few hundred years are debated internationally. Is the maximum individual dose for humans useful as the central criterion, or do we need additional long-term safety indicators to protect the living environment and the environmental media generally? Moreover, unsolved phenomena render any predictions very problematic, eg. gases generated in a geological repository, or colloids transporting nuclides in groundwater. The IAEA's 2003 technical report on geologic disposal listed 13 subject areas where there were deficits, requiring further work in order to enlarge the scientific and technological basis for final disposal.

protect ecosystems. Moreover, it says, unsolved phenomena render any predictions very problematic. The EA's review states that "significant gas-generating components may challenge the bentonite buffer" - an issue from the Sellafield Inquiry that keeps resurfacing (Annex 4). Like the geology-engineering community, the EA authors assume this could be resolved through "pre-treatment" and "alternative encapsulants to cement," though anaerobic bacteria generating gases over the millennial timescale are a largely unknown (and unknowable) agent.

NIREX supplied answers to CoRWM questions in February 2006 (Doc.1609), explaining why they assumed a one million year timescale, talking of probabilistic calculations of realisations (the reply over "worst case scenarios") and justifying stability through ice ages. But by that time, the sessions with the geologists of January 2006 were past and CoRWM was already accepting that geological disposal was top choice. They left it to the Science review meeting of 13 March 2006 with heavyweight scientist reviewers, whose conclusion (Doc.1700) gave the go-ahead:

> "Nothing has been identified that need cause CoRWM to take a completely different course and no significant gaps in scientific or technical coverage have been identified."

CoRWM could also take comfort from the final sentence of the EA's (2005b) summary:

> "In all, whilst we have reservations about certain aspects of the report, we agree that it provides satisfactory support to the conclusion that deep geological disposal is a viable solution."

Not only are these statements at odds with other assessments (eg. in Austria – footnote 25), but they also both look like 'political' statements, appended to rather critical assessments with significant reservations. Thus, under geological disposal, the summary Note (Doc.1700) said:

> "Dealing with uncertainties is an important issue. A lot of sites overseas are highly characterised for disposal; the UK has a uniquely varied geology and there is no reason to believe that sites which cannot be characterised to the same standard do not exist in the UK. But the way this is described in the report will have to be carefully phrased."

Defra refused disclosure under FoI of the full report of the Science Review (footnote 21). From the summary Note we cannot tell if it considered stability over the 1-million year timescale or the likely significant gas-generating components (Annex 4), or the NIREX simulations that include dose levels an order of magnitude above the current legal limit. We do not know if they considered the EA's strong reservations on viability, with 12 key technical challenges to meet (Section 5.2). However, the double negative in "no reason to believe... do not exist in the UK" (as written there was a triple negative, but the intermediate "cannot" should, in logic, have read "can") implies some disagreement on the suitability of the UK geology. It would not bear out the anodyne conclusion of "no significant gaps."

5.3 Two potential 'show stoppers'

CoRWM's Plenary meeting was only updated on this in April 2006, after their conclusions had been sent out. The Secretariat's summary[26] informed them geological disposal could impose doses on the public ten times the international dose limit. This meant 10mSv/yr, far above the legal limit of 1mSv/yr. The Swedes require their disposal site to meet the limit 0.015mSv/yr, while Defra's limit for 'regulatory concern' is still lower, at 0.01mSv/yr.

The Secretariat must have been aware of Defra's principle for long-term storage or disposal of rad-waste, stated in February (Defra 2006b):

> "ensure the necessary safety standards (with) due account of the potential future effects of climate change, in particular from rising sea levels and glaciation."

However, no mention is given to it. Our consultation responses pointed it out, but CoRWM's final report ignores it. Yet on any technical criteria, NIREX's 10 mSv/yr shows there is still no proof-of-concept in UK geology.

The knowledge that the geological repository was far from meeting technical criteria doubtless influenced CoRWM in making their "holistic assessment" in April. At that plenary session of the full Committee (CoRWM 2006), there was no consensus, but:

> " ..... sufficient, although not absolute, confidence among most members on the issue of the long-term safety of geological disposal. Most members also believed that the risks associated with long-term interim storage were smaller than those associated with disposal.... Most members thought that placing waste in a highly stable geological formation did achieve much in terms of burden reduction."

One member who disagreed on the latter point wrote a post-meeting Note[27] and later letter to the Minister (October 2007) which argued that it is contradictory for members to want further R&D while expressing 'sufficient' confidence and that members (and the public) preferring retrievability were in effect choosing storage pending further R&D. He added that NIREX's high dose necessitates further R&D, which the government was ignoring.

The idea of weighing "burden reduction" on near future generations versus burden increase on the far future generations and biosphere is of course debatable. Irrespective of this ethical point, the fact that the majority believed the risks associated with long-term interim storage were smaller than those associated with disposal illustrates uncertainty and lack of clarity in CoRWM's over-hasty drive to a conclusion.

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[26] Doc.1693, April 2006 *Uncertainties Associated With Geological Disposal*; CoRWM's E-Bulletin 6 to the public (April 2006) admitted radioactivity doses to the public could be at the "upper end of the background radiation," likewise meaning 10 mSv/yr

[27] Pete Wilkinson, *A cautionary note*, April 2006; Wilkinson Environmental Consulting Ltd., letter to Hilary Benn, 8 October 2007, www.nuclearwasteadvisory.co.uk/ uploads 1680 and 1724.

On one interpretation, CoRWM performed badly in wrongly accepting proof-of-concept by ignoring the Sellafield Inquiry decision, together with the legal of 1 mSv/yr limit[28] and timescale criteria (including Defra's principle). In the light of these criteria, CoRWM's recommendation of 'geological disposal' as "best available approach" appears perverse. On the other hand, was there manipulation to ensure restricted and late circulation of the October 2005 *Viability Report* and November 2005 critique by the EA? Certainly CoRWM got the information late and complained the wording was "difficult to follow" (Doc.1693), then were caught up in the decision-making rush of April 2006. They were also influenced by arguments of "institutional breakdown" – that they should allow for breakdown of regulatory controls, of society even, on a timescale of a century or two. The 'burden reduction' argument shows a tendency to opt for the "least worse" solution, even sweeping away established standards and legal precedents, in a belief that alternatives have higher short-term risk (because of "terrorist actions, war, loss of institutional control and severe environmental change"). Moreover, the failure to subject these panicky excuses to critical analysis amounts to intellectual failure. In the end, however, CoRWM tacitly admitted their too-hasty assumption of proof-of-concept, in calling[29] for an intensified research programme to resolve the EA's 'key technical challenges.'

6. COOPERATIVE DISCOURSE VERSUS MULTI-CRITERIA SCORING

6.1 Choosing deliberative discourse

Prior to CoRWM's first plenary meeting in November 2003, Defra had run a two-day workshop with a cross-section of stakeholders and academics to discuss alternative engagement programmes and develop criteria to define their effectiveness. Defra then commissioned University College London to prepare an outline PSE programme within a £500k/year budget. CoRWM acknowledged but did not adopt this programme, wishing to take time to consider other models of public and stakeholder engagement (Faulkland 2005a). They started on deliberative mapping (DM) to explore how to integrate public and expert knowledge into their decision-making, engaging consultants to conduct initial trials. However, this was later rejected.[30] At the July 2004 meeting, Baverstock and Ball (2004) proposed consideration of Renn's

[28] Nirex downplayed the results from their worst-case scenario calculations by renaming them 'realisations' and calling on pseudo-probability arguments. This presumably enabled the pro-nuclear influences to persuade scientifically-weak Members to disregard the legal limits and accept levels equal to highest natural background levels (replacing legal limits by Best-Practical-Means arguments)

[29] http://www.no2nuclearpower.org.uk/reports/radwaste_consultations_2.php.

[30] Large (2006) reports that Deliberative Mapping (DM) was introduced to CoRWM in or about February 2004 and some £100,000 spent on trials. In September 2004, it was pointed out by some CoRWM members that DM was not fit for purpose and that a full programme would have to be run several times. The approach was finally abandoned. CoRWM was later lobbied to use another unproven technique referred to as Strategic Action Planning by two CoRWM members familiar with it via a Magnox nuclear industry 'dialogue.'

Cooperative Discourse Model (CDM), [31] along with technical assessment by a specialist sub-committee.

Though not agreeing to a technical sub-committee, CoRWM did eventually opt for a "deliberative" process. Professor Ortwin Renn was engaged to advise on using his Co-operative Discourse Model (CDM); he presented it at the December 2004 plenary, and was then temporarily co-opted onto the Phase 3 Working Group. Renn's CDM incorporates 'cognitive' (expert) and 'participatory' (public) discourse, this being a special form of a dialogue, in which all affected parties have equal rights and duties to present claims and test their validity in a context free of social or political domination. Renn (2004) requires 'rational' discourse that sets standards for participants.[32] He also requires procedures derived from Multiattribute Utility theory (MAU) to elicit values, criteria, and attributes and to assign relative weights. A stakeholder process generates criteria and a value-tree; public participants are free to add new values to the tree, to modify the presented option or to add a new option to the list (but not delete any of the criteria). The rating of options then proceeds on the basis of expert-generated profiles. The numerical results are not used as the final judgment of the participant, but as a structuring aid to improve the participant's holistic, intuitive judgment. Participants reflect upon their opinions and search for potential hidden motives or values that might explain the differences between the numerics and the holistic judgments. This version of the MAU model has been successfully applied by citizen panels (outside the UK) - conclusions are always based on a holistic judgment. It is not clear why CoRWM called Renn's model an "MCA", since this acronym and the term "multi-criteria" are not used in his article (Renn 2004). Baverstock & Ball's paper to the July 2004 meeting called it CDM, but the chair is recorded as saying MCDA (CoRWM 2004).

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[31] The paper had derived from Baverstock's proposal at the May 2004 meeting, over which he and Ball subsequently consulted a large number of external experts. The document is not on CoRWM's website; personal information from Ball is that the paper was effectively 'binned' following the Chair's decision. Doc. 537 identified a number of possible approaches, some tried and tested, eg. in Canada, and argued for CoRWM members to disengage from doing too much work themselves, to appoint a technical sub-committee to evaluate short-listed options in risk/benefit terms, and send the output into a CDM process. The record of the July plenary meeting (CoRWM 2004) notes that CDM involves three steps:

- Identification of objectives and concerns (via public-stakeholder engagement) ;
- Experts judge option performance (cognitive discourse); and finally
- Evaluation of each option profile by citizens in participatory discourse (may be informed by expert input)

[32] In *"Rational discourse"* (Renn 2004) *all participants are obliged to*:

- seek a consensus on the procedure that they want to employ in order to derive the final decision or compromise, such as voting, sorting of positions, consensual decision making or the involvement of a mediator or arbitrator;
- articulate and critique factual claims on the basis of the "state of the art" of scientific knowledge and other forms of problem-adequate knowledge (in the case of dissent all relevant camps have the right to be represented);
- interpret factual evidence in accordance with the laws of formal logic and analytical reasoning;
- disclose their relevant values and preferences, thus avoiding hidden agendas and strategic game playing;
- process data, arguments and evaluations in a structured format (for example a decision-analytic procedure) so that norms of procedural rationality are met and transparency can be created..

6.2 Development of the MCDA hybrid

CoRWM had been very aware of the need to include deliberation, despite dropping their first choice of Deliberative Mapping. The July 2004 Minutes (CoRWM 2004) record the chair stating they needed both a *deliberative* MCDA and high quality scientific/ technical input. Was this confusion over acronyms or a manipulation of the record? Whichever, it led to commissioning a review of MCDA from a nuclear industry person and swallowing a referee's advice that there was 'no alternative' to MCA/MCDA (Annex 5) which in fact failed on the deliberative and high-quality criteria. The briefing information for the specialists was hurriedly assembled and of variable quality (Faulkland 2006a), while none was provided for the public (January 2005 *Round Table*, Bristol). As reported in the NGO critique (2006) we didn't get the rational-discourse criteria, but the facilitators' elementary 'ground rules'. We were not free to add to the value-tree, modify options or add a new option to the list. As a result, the facilitators reduced the exercise to MCDA (Annex 5) and, in effect, opinion counting. It is easy to be wise after the event, but even on its own terms the MCDA quality was very poor.[33] The stakeholder scoring degenerated into a game that no-one trusted, as also reported from the Citizens' Panels.[34]

CoRWM's *Report* (Annex 5:1.8; 1.10) shows their confusion, in aiming for a "bespoke assessment process" with an MCDA based on "key principles from CDM" and claiming a "balance between an MCDA-type approach and a more holistic assessment." The Citizens' Panels judged the listed options on criteria determined by CoRWM; the stakeholder sessions were faced with second phase MCDA with no 'rational discourse' or 'holistic' principles. Public values appear to be a minor input to a value tree (*Report* Annex 5:2.5) used to frame issues. The CDM/MCDA hybrid appears to be an innovation of CoRWM's chair or the NNC, to bridge the chasm between MCDA and deliberative discourse – including the expert-supported deliberative CDM (Baverstock and Ball 2005). The hybrid failed, for CDM models are fundamentally distinct from MCDAs.[35] The NGOs (2006) proposed the NUSAP

[33] Faulkland (2006b) quotes CoRWM's own statement about science input being fundamental to MCDA but: The briefing papers to support the first round of specialist workshops... disappointed... All were key contributions both to the workshops and to the wider evidence base. The intent was appropriate and 'fit for purpose,' but the quality of the reports produced was variable.

[34] The facilitators' summary report (Doc.1532, 4.3.1) details: In some groups citizens who were having trouble following the process became frustrated, withdrawn or even mildly hostile. There were statements made to the effect that the citizens did not have enough information to assess options' performance and that comparisons between options were in some cases conceptually difficult (especially when comparing long and short term option performances, costs, risks, uncertainties etc). The size of the difference in performance was therefore often hard to establish, or was contested, and the assigning of importance was sometimes either seen as an unnecessary further step, or was undertaken before the size of performance difference was established ...resulting weightings were described by one citizen as 'subjective judgements based on subjective judgements based on subjective judgements.'

[35] Multi-criteria decision analysis (MCDA or MCA) is sensitive to the definitions chosen, overlaps in criteria and relative weightings as well as personal interpretations. Its history in nuclear decision-making has been controversial in the UK – the Nirex MCDA at the Sellafield inquiry was rigorously disputed and effectively sidelined. BNFL's in-house MCDA on decommissioning Magnox plants was not accepted by the UK nuclear inspectorate, who both developed their own criteria and required wide stakeholder involvement. MCDA is problematic in allowing people to choose weightings according to unanalysed preconceptions, with limited testing and mutual scrutiny, and quite different interpretations of issues as framed.

system (NUSAP 2003), which, like Renn's model, centres on deliberative discourse but has a stronger academic community and more successful pedigree, especially in EU and Netherlands policy-making. It would have specifically included ethically-motivated discussion among participants (which Renn's holistic assessment stage should have covered), thereby generating better informed interpretations of criteria and reducing the prior prejudices in individual choices.

Bias readily entered the MCDA process, through *"framing the MCDA in the values and needs of society"* (Report Annex4: 5.4). Inevitably the initial framing process depended on huge assumptions and judgements about a range of social values. It was in effect used to force on the process:

- the government mandate to CoRWM to find a 'solution' to the waste problem, and
- the Blair perspective that the UK 'needs' a new generation of nuclear power stations.

The first came from CoRWM's ToR 1, the second from loading the specialist and stakeholder sessions with people who were increasingly taken in by the government's line (and the nuclear lobby winning through). Like many in the Citizens' Panels, the NGOers were also alienated by the 'swing weightings' scoring process (Annex 2).

The framing process needs to encompass the issue of 'social conditions' under which particular decisions can, or cannot, be made. Whether policies have become generally acceptable and enforceable depends not simply on evidence becoming clear, but on the social conditions and climate in which the 'facts' are produced and used (cf. laws restricting smoking). In the case of nuclear waste disposal, the big socially compromising factor is the threat of a new generation of nuclear reactors. Without new-build, the issue of rad-waste management was relatively amenable to resolution. But with new-build a very real possibility, CoRWM's attempt to sideline this raised much distrust. The NGOs boycotted one stakeholder round-table session on this specific account (Helensburgh Round-Table, 2 Feb 2006), while in other cases NGOers just stayed away.

Though CoRWM intended the stakeholder engagement to be genuine, they were a victim of the management by the NNC (having minimal sensitivity to anti-nuclear NGOs) and of heavy loading by nuclear industry people:

- The choice of participants and the framing of issues were manipulated
- No briefing on the timescale for judging 'safety'[36]
- high fraction (30-50%) of nuclear industry people in the 'specialist' events
- high fractions (30%) of officials and nuclear industry people as 'stakeholders' assessing the public's "inherent values"
- the Citizens' Panels did not review the key criteria in the MCDA.

[36] Especially no requirement to consider the 10,000yr and M-year timescales; the Citizen Panels found it difficult to conceive of longer times than 300 yrs and more than a few generations (Doc. 1532).

The facilitators' protestations of good faith, backed up by CoRWM members present at the Bristol round-table of January 2006, did not change the NGO perception and mistrust. This first UK trial of Renn's CDM model was effectively sabotaged via the reduction to the nuclear industry's well-worn MCDA.

6.3 Democratic approach to risk in contested areas of knowledge

The failure to deliver deliberative decision-making backed up by high quality scientific-technical input is not only to be ascribed to the NNC, but also to CoRWM's failure to appreciate the disparate knowledge bases and disparity in power in the nuclear debate. CoRWM's Report (Ch 8:3) states:

"The basic premise was to use the best available existing scientific knowledge."

This "expert view of science" has been long criticised especially in the nuclear field where disparate bodies of knowledge and expertise are recognised. It was effectively rejected in the 1997 Royal Society report *Science, Trust and Social Change,* which comprised seminal contributions to our understanding of risk management, and led to a fundamental shift in government guidance on risk assessment (Defra 2000). This prescribed the need for an inclusive democratic approach in strongly contested situations, characterised by disparate knowledge bases and disparity in power.

In the Royal Society report, John Durant (1997) argues that the 'expert' approach to risk assessment is appropriate for risk communication e.g. for smoking, contraception etc. and can be effective when there is active support from key sections of the community. But in the nuclear field there is mismatch between experts and lay-perceptions. Durant pointed out the widespread distrust of risk assessment by the public and vocal individuals, saying trust is a crucial ingredient and they have little in the government or nuclear scientists. He concluded there is a need to take the public seriously and develop new participatory models. This approach has been developed as the "democratic" approach to risks – the alternative adopted for Health Impact Assessment (WHO 1999). Hunt and Wynne (2000) advised NIREX to use such an approach if they wish to achieve trust and legitimate authority.

Another contributor at the Royal Society, Robin Grove-White (1997), pointed out the *"chronic mismatch between public concern and regulatory issues"* in the nuclear arena. He argued that disparagement of public concerns as irrational and silly just reinforces longstanding mistrust – such disparagement is what the minority from NGOs encountered from the nuclear industry participants. On this analysis, the MCDA technocrat-driven approach to stakeholder engagement works only where differences over framing of issues are limited and straightforward to resolve. Grove-White spotlighted the need for agreed framings of issues and for new mechanisms of involvement. In the nuclear area, the decision-making process should negotiate acceptable ways forward, rather than relying on the industry's old and rejected approach to radiological 'dose' and risk.

The CERRIE committee was an attempt by Defra to fulfil this (Bramhall et al. 2004), but it failed - the resulting majority and minority reports showed continuing deep discord between experts concerning fundamental radiation risk assessment. The uncertainty over long-term nuclear waste is irreducible, with potential harm to nature and to future generations being largely unknown.

7. TIME SCALE AND ETHICAL BASIS

7.1 Regard to long timescales of nuclear hazards

The time over which we pay regard to the interests of future generations is, to a major degree, an ethical question. The idea of Community Volunteerism (first introduced in the UK by CoRWM – Annex 3) implies a forward look for two or three generations. The EA thinks of regulating e.g. landfill sites for a similar time, while for nuclear waste they extended it to a few hundred years. They argued (Environment Agency 2005b) over NIREX's Viability Report whether waste containers would last 300 years or not. The nuclear regulators (and industry) choose to talk of 'dose' to future individuals after a relatively short period (few 100 yrs) rather than 10,000 years hence. 'Collective dose' summed over all humans within the UK or the whole planet is a measure of the total detriment and a legally significant criterion in the Euratom Directive. As it cannot be defined numerically over the long time, regulators have introduced a cut-off at 500 years (Fairlie and Sumner 2000).

Yet sustainable development has no such time limits, but extends to an unlimited number of generations, as is accepted internationally, under the principle that radioactive waste shall be managed in such a way that it will "not impose undue burdens on future generations" (IAEA 1995). The term 'future generations' does not support the 500 year cut-off. Fairlie and Sumner (2000) discuss the moral and ethical questions, particularly the nuclear industry's emphasis on individual doses to the exclusion of societal risks. Setting any time limit had a strong ethical aspect, as came out in CoRWM's workshop on ethics. However, this ethics workshop and discussion occurred late in CoRWM's process (Sept. 2005) with the report on it not available till decision time in March 2006 (Blowers 2006). The Blowers report counter-posed a high concern over societal collapse or loss of institutional control to ethical arguments for an indefinite timescale. Because of the lateness, these concepts were not inputs to the Citizens' Panels and the Stakeholder MCDA consultations (Section 3.4).

7.2 Institutional breakdown and 300 years time horizon

The societal timescale (NIREX 2005b) apparently underlay CoRWM's early choice of 300 years for the lifetime of surface storage of the PSE1 short-list. They subsequently showed interest in the notion of institutional control breaking down, stimulated by a paper commissioned by NNC internally (Hillis 2004). However, this was given two highly critical reviews (by RM Consultants: Doc.620/RMC and by the EA Doc.620/EA, both of June 2005), so a further study was commissioned (Summerling 2005) preparatory to an internal CoRWM workshop in January 2006. They gave no support to the explicit figure of 300 years.

When CoRWM representatives met the EA early in 2006 the EA stated that 300 years is not a radioactive decay timescale (as CoRWM was saying) and CoRWM should plan for longer (below). From their side, the CoRWM participants argued that acute or chronic collapse of institutional control would be likely to take place within 300 years. CoRWM's Plenary meeting of 20 February 2006 showed uncertainty over the 300 year choice, but the issue was again left in the air. The Minutes record "reflections" of Members: a 300 year boundary is driven by radioactivity decay and institutional control; a 100 years boundary is more of a social-societal perception of a

"relevant" timescale; a new store doesn't have to last for 100 years...even if storage will be necessary over that period; technically not too much difference between 100 and 300 years. Note that CoRWM's *Report* (Ch.11:8, also 2:12) passes smoothly over this confusion, by ignoring the 100 years. The Plenary's only reference to the 13 January meeting was implicit: "these represent a much shorter (timescale) than most previous conversations," which suggests that the CoRWM representatives played down the EA's view given at the 13 January meeting.

7.3 International standards

CoRWM did visit Sweden, and should have picked up on the 10 000 year and million year timescales that the Swedish repository is being designed to meet. They were certainly informed of the Court decision over Yucca Mountain store in the USA (July 2005) and knew the 1 M year stemmed from a recommendation of the National Academies of Sciences.[37] The science rationale for a M-year timescale is that the radioactivity levels would be close to natural radioactivity levels in rocks. That may not suffice, as mobile radioactive substances may concentrate via biological or mineralising mechanisms, the former being more liable to be a hazard to life.

The Swedish guidance (SSI 1998) said:

- "The absolutely most important period taking into account the hazard of the waste is the first thousand years after repository closure"
- distinguishes time-periods which can be associated with existing judicial traditions from time-periods associated with an unknown future and
- requires the repository's protective capability (for health and environment) to be also described for very long (M-year) time-scales, even if the biosphere and other conditions cannot be described with reliability.

The later report (SSI 2004) increased the time in the first bullet to at least 10 000 years because of gas pressures. CoRWM had NIREX's responses (Doc.1609) to questions on the "Viability Report":

> "We asked what period of time NIREX would justify as the time period that should be covered by a post-closure safety case and why? Paragraph 6 on Page 52 suggests that NIREX is addressing up to one million years but that predictions up to 50 million years can have little basis."

[37] Following the Court decision, US EPA proposed "a unique two-part standard, with one set of limits for the first 10,000 years of repository operation and a second set for the succeeding years, out to a million years". This was reported in August 2005 as an attempt to set radiation risk controls and limits that will potentially obtain for 25,000 generations (http://www.reviewjournal.com/lvrj_home/2005/Aug-10-Wed-2005/news/ 27026244.html). There remain significant criticism of the actual future dose levels proposed by EPA and challenges again in Court, leaving the Yucca Mountain dump still far from resolved.

NIREX said their answer had been given in Sept. 2005[38]: they "propose that one million years is a reasonable time cut-off for post-closure assessments of quantified annual individual radiological risk." Qualitative arguments covering the period beyond that would be in a post-closure safety case. Thus, CoRWM had been informed that NIREX was sticking to the international M-year standard, but no-one pressed the contradiction with the EA (up to January 2006) concentrating on a few hundred years.

7.4 CoRWM's choice of a utilitarian ethic

At the 28-30 March 2006 Plenary session, Blowers gave a discussion presentation Issues of Time (Doc.1665), when he distinguished *socio-cultural timescales from geo-scientific timescales.* Yet the ethicist Barbara Adam's (August 2005, Doc. 1334) principle that he cited covers both timescales: "responsibility has to extend to the reach of the impact of our actions." She saw no justification for an arbitrary cut-off point after which the burden is externalised. Evidently CoRWM were aware they were out of tune with international standards, whether science-based or ethics-based, and laid weight on their innovation of socio-cultural timescales with "emphasis on the more immediate future and the survival of institutional controls." This might be said to avoid "undue" burdens on future generations and keep within predicted "levels of impact that are acceptable today" (IAEA 1995; also quoted above). However, Barbara Adam (Doc.1334) answered that this approach misses the ethical point altogether: "a present-oriented, utilitarian perspective based on moral assumptions that are no longer appropriate".

The assessors were critical that the ethical discussions were delayed and not well integrated into CoRWM's assessment processes (Faulkland 2006b, p.40). As in PSE, the ethical discussions by CoRWM in Plenary were rather shallow as the:

> "ethics sessions were rather ad-hoc and the debate was not as well informed as it might have been. If Members were to move beyond debating their own views, more attention should have been given to equipping them with the necessary knowledge and frameworks or tools."

As a consequence, in part if not entirely, CoRWM chose the nuclear industry's utilitarian "ethical" stance. They took a static or science-pessimistic view that neglects likely progress via R&D into alternative options and their technical uncertainties. While the 'volunteer community' concept depends on the utilitarian choice, CoRWM never clarified this. Crucially, CoRWM made a further linked ethical choice in ignoring geologically long timescales and ignoring international standards – a choice they are not entitled to make and which they failed to state openly.

8. SUMMARY AND CONCLUSIONS

8.1 Failures in Science

The weakness of CoRWM in science was well aired following the House of Lords and Royal Society criticisms. Defra intervened and took steps to overcome it in January

[38] *Response to CoRWM Questions Concerning The Long-term Safety of Geological Disposal*, NIREX 14 Doc. 1609, Sept. 2005. The *Viability Report* came in Nov. 2005 (NIREX 2005a).

2005. So it is of concern that the final report is not honest over these early-phase shortcomings. It is also of concern that Defra's Chief Scientist both "raised issues as necessary with the Chair" (Faulkland 2006b; p. 47), and had a Panel participating in meetings, thereby exercising a steering or shepherding role. Undoubtedly, this detracted from CoRWM's claimed independence. CoRWM never challenged the 'expert view of science' (supposed free of personal values and of political, commercial and institutional interests) that prevails in the government, despite some members being academics in social science. They proved unable to challenge the geological-dump lobby, yet CoRWM's final report was written ("backfitted" Doc.2071, p.33) to claim their review was scientifically and technically robust, using the best available science. Government may have wanted these sound-bites, but they are readily disputed and were not in CoRWM's terms of reference.

CoRWM made a crucial mistake at the short-listing stage in excluding the "Netherlands strategy," namely: near-surface storage for 50-100 years while pursuing R&D into deep disposal and alternative long-term options. The NGOs saw the choice of 300 years storage as driven by pro-nuclear interests and expected that CoRWM would admit their mistake. Despite cogent criticism during 'consultation,' CoRWM failed to change the 300 years and Members were still debating and sticking to it in February 2006 (section 7.2).

CoRWM's second major failure came through assuming deep geological disposal is "do-able". They took proof-of-concept for granted when short-listing, and presented it as widely agreed internationally with no mention of the problems. They ignored the Sellafield Inquiry, failing to press the nuclear interests to explain what had changed since 1997 that might overturn the decision against geological disposal. Despite the scientific-technical uncertainty - our citations of the IAEA and recent Austrian government assessments, paralleled by EA criticisms of the NIREX *Viability Report* - the assumption that geological disposal is do-able was reified by repetition. CoRWM was faced with statements of high confidence in UK geological disposal, by scientific authorities including the Royal Society. Nevertheless, such over-statement is analogous to that over drug-tests on animals, found to be an abuse of intellectual authority (Matthews 2008[39]).

A further technical failure was on time-scale and dose criteria. CoRWM did not point out the UK's lack of parameters comparable to those used internationally. CoRWM knew of the US Supreme Court decisions over Yucca Mountain and Sweden's stringent legal requirements - their failure to cover this legal criteria-based framework introduced significant bias in the stakeholder discussions. CoRWM's report papered over this gap by quoting the UK HPA's comment on "relevant dose and

[39] Matthews (2008) examined the basis for the statement 'Virtually every medical achievement of the last century has depended directly or indirectly on research with animals', which has been endorsed by leading academic bodies including the Royal Society and over 500 eminent academics in a 2005 public petition supporting the statement, among them three Nobel laureates and over 250 professors. He concluded "the failure – and, in all likelihood, inability – to (substantiate the statement) exposes some of our most respected academic institutions to a charge of abuse of authority."

risk criteria".[40] Defining retention tests (i.e. 'dose') and timescales are important for purposes of short-listing as well as for the second stage PSE. Positing a timescale of millions of years, rather than the hundreds of years of the regulators, forces thinking outside-the-box and faces up to the deeper implications of sustainable development. For fair and genuine consultation, the public would have been informed that few countries are currently attempting to proceed with deep disposal and the technology remains both experimental and unproven.

The hidden reason for this approach was that leading CoRWM members were favouring socio-cultural timescales over geological ones (section 7.2). That the results of the ethics workshop (Blowers 2006) and the geological arguments came out only late in the process in January-March 2006, consequently excluded the public and stakeholders from these vital debates. By omitting to propose and consult on long-term criteria and timescales for deep geological disposal, CoRWM biased their considerations to the short socio-cultural timescale and assumed a utilitarian ethical stance. Adding to the failure to brief the limited Citizens' Panels on the real regulatory position and technical uncertainties internationally (Section 3.4; Annex 2), CoRWM's own utilitarian ethics put a heavy bias on the PSE process.

A vital issue that came through only in 2006, too late for the PSE, concerned NIREX's *Viability Report* on geological disposal (Section 5.2). Though completed in Sept. 2005, it was made public only with the EA critical review in November. CoRWM found the Viability Report "difficult to follow" and received NIREX's explanations in February (Doc. 1693[41]) so they failed to feed the issue into the geology debate. Yet the EA's review severely qualified NIREX's claim to "viability" and counted twelve *key technical challenges* "where further work is needed before an acceptable repository safety case could be generated." The fundamental importance of such a deep disagreement was effectively ignored by CoRWM.

8.2 Inadequate auditing of CoRWM's processes

The science audit was conducted via Defra's chief scientist, Howard Dalton, who wrote 18 May 2006 to the Minister:

> "my Expert Panel have reported - the expertise present was comprehensive, that debates were open and objective and informed by the latest scientific and engineering knowledge".

This letter was used by Defra as 'authority,' in pro-forma reassurance, to respond to critical letters from the public. The main auditing event had been the full-day

[40] *Report Ch7:28 A response to PSE4 from the Health Protection Agency stated*: ' ...any disposal of radioactive waste should meet the radiation protection criteria of optimising exposures below the relevant dose and risk criteria. HPA considers that CoRWM's choice of geological disposal as the long term management option could be implemented to satisfy these radiation protection criteria'.
In fact CoRWM avoided considering "the relevant dose and risk criteria". The HPA were not in a position to know (nor qualified to judge) that Nirex modelling had failed to show the criteria could be met, by factors of 100s.

[41] CoRWM Secretariat's summary, April 2006 'Uncertainties Associated With Geological Disposal' Doc.1693

discussion on 13 March, for which a brief summary is available (Doc.1700). Though the summary is far too brief to confirm what issues were considered, it appears the 'Expert Panel' must have missed the NIREX /EA disagreement over "Viability." Some disagreement on the suitability of the UK geology is evident from the use of a double negative, which casts doubt over the stated conclusion of "no significant gaps." It is not disclosed what documentation the reviewers used, nor what issues were addressed, because of the refusal to disclose the full report even on a Freedom-of-Information demand (footnote 21). This is suspicious when the ToR required openness and transparency (cf. refusal of documents on Public Relations[42]).

Not only did the programme managers NNC have a conflict of interest, but actions[43] giving the impression of taking advantage of their vested interests were tolerated (Annex 1). Other biases within the system showed up in the information supplied to the Citizens' Panels and specialists supplied for briefing and questions, as well as how the CoRWM Report (Ch.7:20) put a conformist spin on their deliberations and diversity of views (Annex 2). Evidently the process failed the Michael Meacher test[44] on rigorous unbiased procedures, set when he was Environment Minister. The CoRWM process is a case for the Science and Technology Committee's strictures (House of Commons 2006) - their chairman Phil Willis MP in his presentation stressed (Willis 2006):

> "Indeed as successive Governments have found to their cost – unless the evidence underpinning policy is robust, capable of rigorous scrutiny – and is communicated convincingly to the public, the consequences can be: grave for public confidence... damaging to scientific progress... or potentially disastrous."

Though engaging the public and stakeholders was a major part of their task, CoRWM lacked expertise in consultation (Faulkland 2006a, p.15). They failed to recognise that the process of framing options is critical and to organise 'upstream' PSE to cover it. Faulkland's (2005a) PSE1 audit suggested external specialists should have helped in framing the questions. The audit details how criteria and option listing was carried out by unspecified subgroups meeting behind doors with no minutes or schedule of meetings. They failed on quality and effectiveness criteria.[45] At formal consultation

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[42] to a request from *Spinwatch*, http://www.nuclearspin.org/index.php/CoRWM. *Nuclear Spin* have chased up documents and assembled much material critical of CoRWM's managers and public relations firms (http://www.nuclearspin.org/index.php/CoRWM).

[43] Faulkland (2006b, p.11-12) reported the "list of contractors... does, to a surprising extent, seem to be made up of nuclear-focussed consultancy teams. It is not surprising that they are there, only that academic teams, other sectors, overseas contractors and 'counter-experts' seem under-represented."

[44] "Science can only be trusted if it is pursued with the most rigorous procedures that guarantee freedom from bias. .. I asked the Members (of CERRIE) to agree where they could and to delineate any areas of disagreement... in accessible language and to propose research that might resolve them." Michael Meacher, Preface to Bramhall et al. (2004).

[45] Officials and nuclear industry people were involved in sessions to judge the public's "inherent values." Options were framed with no consultation, without recognising the significance and biases introduced. Options were excluded on proof-of-concept grounds without unpicking this term.

times, technical/specialist reports plus peer reviews were unavailable to stakeholders; interim short-listing was completed before some key PSE1 reports were finalised and there was little time for plenary debate of the issues arising. CoRWM did not adhere to consultation norms (Better Regulation Executive 2005), e.g. they decided the short-list before the report of responses was ready and dismissed critics of the short-list as "few exceptions" (*Report* Ch8-14), contrary to the requirement to pay regard to the cogency of the arguments. Public consultation was hampered through a poor website (improved later) and a lack of core/summary documents, which is vital when they are numbered in hundreds.

CoRWM's public-stakeholder engagement processes (PSE) were innovative, but poorly directed, while time pressures repeatedly caught them. They unwittingly neglected norms of environmental assessment (SEA – Strategic Environmental Assessment), public engagement in issue-choosing (Health Impact Assessment; WHO 1999) and consultation standards (Better Regulation Executive 2005). CoRWM intended to run the second phase Public-Stakeholder Engagement as a *deliberative* stakeholder process, choosing Renn's Co-operative Discourse Model. Yet they made a crucial error in effectively changing to MCDA[46] (Section 6 and Annex 5) with its charged history. Instead of being rooted in fundamentals, ethical issues were by and large treated via polling individual preferences. The intent of the July 2005 plenary meeting for deliberative decision-making backed up by high quality scientific/ technical input was not delivered. The information base had limited coverage and quality, and did not inform 'rational discourse' at stakeholder round-tables. Faulkland Associates judged that CoRWM Members' accessibility and engagement with the public was exceptional,[47] but didn't address the bias and railroading in the facilitation (cf. Annex 2).

8.3 Unstoppable momentum to adopt the 'solution'

By early 2006, CoRWM was focused on its key conclusion ('solution'), so brushed aside the disparate timescales of NIREX (ie. international) and the EA. The NIREX *Viability Report* was spun as giving radiation doses up to UK background levels, rather than far above legal and regulatory limits. CoRWM adopted two concepts "Loss of Institutional Control" and "Community Volunteerism" that had been fed in from the nuclear industry, had limited analysis, and were never put for public consultation. Implicitly they chose the "socio-cultural timescale" and the nuclear industry's

[46] MCDA, multi-criteria decision analysis, favoured by the nuclear industry. MCDA results presented at the Sellafield and other public inquiries have been taken apart by the HSE-NII and social policy experts.

[47] In evaluating CoRWM's second half PSE, Faulkland report (2005b) finds:
"there have been very few adverse comments about lack of access or willingness to listen. Overall, we consider that Members' accessibility, openness and commitment to meeting and engaging with stakeholders and the public have been exceptional."
But this paper asks more basic questions, relating to the choice of participants and railroading by the facilitators. From an anti-nuclear NGO background, with experience of other stakeholder exercises, we found CoRWM's round-tables to be a biased process, generally hostile to alternative NGO views. They were open to manipulation by nuclear interests and intimidatory, deterring free expression of views. While sharing criticisms of *Nuclear Spin*, ours is an inside view, as NGO-stakeholders.

utilitarian stance. CoRWM's ignoring geologically long timescales and international standards was an ethical choice that they are not entitled to make. All these ethics-based points should have been presented for stakeholder consultation and open determination, but CoRWM kept the 'holistic' assessment internal to the committee – as opposed to "citizen" decision-making of Renn's CDM.

After CoRWM's draft recommendations went out in March 2006, two potential show-stoppers emerged and were disregarded. First the NIREX assessment of 'deep disposal' scenarios was confirmed as showing possible high radiation dose to far future humans, hundreds of times above the current regulatory standard. Second, CoRWM Members' own 'holistic' assessment concluded by majority that storage is safer than disposal (cf. "long-term safety" in the ToR 2). The record of that 'holistic assessment' (CoRWM 2006) shows that key differences between CoRWM members were resolved by 'polling' rather than via consensus on setting out issues for (political or public-deliberative) decision as had been required of CERRIE (footnote 44).

Ignoring the April show-stoppers, CoRWM retained their basic recommendation as:[48]

> "geological disposal is the best available approach for the long-term management... The aim should be to progress to disposal as soon as practicable"

CoRWM did try to 'hedge', by adding recommendations on flexible and staged decision-making and intensified R&D, and on keeping open the possibility that other options could emerge as practical alternatives. Subsequently, CoRWM has publicly expressed annoyance as the government ignored these parts of their 'package' and their specific restriction to 'legacy waste' only.[49] One Member has gone further, arguing effectively that the package was not consistent, with the majority (public and Members) wanting retrievability. He argues[50] that in effect this means storage pending further R&D, which contradicts disposal as meaning finality.

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[48] CoRWM *Report* Overview: http://www.corwm.org.uk/pdf/Overview.pdf.

[49] CoRWM itself meeting Defra, reminded them in Feb 07 of their original caveat (March 2006, Doc. 1593): "The public assessment process that should apply to any future new build proposals... will need to consider a range of issues including the social, political and ethical issues of a deliberate decision to create new nuclear wastes."

They went on to stress (CoRWM 2007):

"Regardless of whether the same technical solutions could be applied to these wastes, the social, political and ethical context is completely different and this necessitates a separate assessment process. Any conflation between the politics and ethics of legacy waste and new build wastes will make it more difficult to inspire public and stakeholder confidence in the MRWS process and, ultimately, will make it less likely that a satisfactory outcome will result. The question of how any new build wastes would be dealt with in the process needs to be dealt with in an open and transparent manner."

[50] P Wilkinson: Note of April 2006. Most CoRWM members were in favour of some form of disposal, but he asks what do we and the public understand by the preference for phased disposal and retrievability. It implies insufficient confidence in disposal. If CoRWM recommend disposal, R&D should be redundant, yet it's necessary (cf. Nirex results of 10-fold dose over the legal limit, 250 times the limit of regulatory concern).

Wilkinson Associates: Letter to the Minister, Sept.2007: "The majority view given at workshops to underpin the support for disposal was that 'disposal removes the burden.' This view contradicts the preference for retrievability, which is in effect a preference for storage."

The critical question is whether in practice, CoRWM's report and recommendations have won public trust and confidence. Trust is vital for public acceptance[51] and CoRWM later expressed worries on "public confidence in the MWRS process" (CoRWM 2007). For with the announcement of a new nuclear programme, the context has worsened. As CoRWM's *Report* Overview put it, when conflicts over reprocessing and radioactive waste were receding, memories of major accidents were fading and nuclear energy was in retreat, it seemed possible that both pro- and anti-nuclear interests might work together to find the best solution to deal with the hitherto intractable problem of radioactive waste.

The Sustainable Development Commission (at least a leading member of it as well as its chairman) in saying there "is no clear consensus on how to deal with the nuclear waste" from a new generation of nuclear plants,[52] voiced widespread informed opinion that amounts to a judgement that CoRWM failed the Flowers requirement. Several of the authors in the compendium on *Nuclear Consultation* (Dorfman 2008) judge likewise. With nuclear new-build on the agenda, it has become impossible to separate managing the legacy from managing new nuclear wastes. And CoRWM's protestations and pains to distance themselves from their "solution" being used for new-build nuclear wastes have been in vain. The trust deemed essential in CoRWM's mandate has dwindled and their claim to a 'solution' has been critically analysed and effectively rejected. CoRWM2 if not still-born is severely disabled.

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[51] Submission to the DEFRA Consultation on UK Long-Term Radioactive Waste Management., Professor Brian Wynne, Institute for Environment Philosophy and Public Policy, Lancaster University March, 2002

[52] Professor Tim Jackson, Economics commissioner at the Sustainable Development Commission, said (10 January 2008; http://www.sd-commission.org.uk/pages/100108.html):

"Some of the most crucial questions around nuclear energy, cited as major concerns by people on all sides in the recent consultation, remain unanswered. It would be totally irresponsible to commission a new generation of nuclear power stations when there is no clear consensus on how to deal with the nuclear waste they will produce. And we have serious concerns over the role of the private sector, with the ever-present risk that the British taxpayer will be asked to pay for any cost over-runs that may occur - particularly considering the history of over-optimism in the nuclear industry.

"Unless the country can reach a real consensus, with solid answers to legitimate concerns over waste and liabilities, the SDC believes that a new generation of nuclear power stations remains the wrong option. The Government should instead be focusing on delivering more sustainable methods of generating electricity, and on absolute reductions in our demand for energy."

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ANNEX 1 Conflicts of Interest via NNC and AMEC

The government's choice of NNC to run the process was a clear mistake due to their longstanding nuclear industry pedigree and involvement. NNC were the UK's leading private sector supplier of nuclear engineering, technical and safety services, when they were awarded the contract for managing CoRWM's programme in 2004. CoRWM's Chair admitted to discomfort over this closeness to the nuclear industry (meeting with NGOers, Bristol, 20 January 2006; Annex 6) but said that NNC were forced on them by Defra. This left CoRWM in no position to withstand the influence of vested interests. One example occurred in the presentation of NNC's own GeoMelt® technology for rad-waste at CoRWM's 22 Feb. 2005 meeting, on which ex-NNC's Mark Dutton prepared CoRWM's Notes (Doc.985).

When welcoming NNC at the July 2004 meeting, the Chair stated (not minuted) that Dutton would "sever" his connections with NNC; then, at the Sept. 2004 meeting (Doc. 720), Dutton declared an interest via his "employment with NNC up to 2002, since when he was only undertaking NNC consultancy work outside the UK" (see Dutton's letter*). Being outside the UK does not, of course make the interest innocuous, especially when the work was used for a dubious paper on ethics (Doc. 334.1) and setting narrow terms for the Grimston ethics study (Doc.514). Dutton wrote a CoRWM paper explaining the concept of long-term interim storage and variants, which relies largely on Hillis's paper for CoRWM (Doc. 615) while Hillis works for NNC. Moreover, Dutton and Hillis jointly wrote a paper for the European Commission covering similar and overlapping ground (EUR 21021, 2004), referred to in Ref. 1 of Doc. 615.

In July 2005 AMEC acquired NNC, creating the division of AMEC-NNC. With AMEC's overt agenda for new-build nuclear power, NNC's position as programme managers became untenable under conflict of interest criteria, yet nothing changed. Indeed, NNC's Sam Usher who manages the CoRWM contract was bold enough to write an article for the company's in-house magazine entitled *Waste management strategy critical for nuclear new build* saying "This is a high profile contract that puts AMEC at the leading edge of developing nuclear strategy – not only in the waste management industry, but to have an influence on new build." He explained: "There is an argument that you shouldn't build new nuclear power stations if you can't manage the waste from existing ones". An internet article in July 2006, *Exposed: CoRWM's Close Ties to the Nuclear Industry* (Spinwatch 2006) used documents disclosed under Freedom of Information to detail the close influence that Sam Usher had in CoRWM's processes.

In January 2006, AMEC joined UKAEA and CH2M HILL to form a new alliance to "target opportunities in the UK's £56 billion nuclear clean-up market" (http://www.ukaea.org.uk/news/2006/16_01_06.html). Sir Peter Mason, chief executive of AMEC, said at the time: "This team has the right blend of nuclear and

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* Dutton's letter to Mackerron, 7 Oct. 2004
http://www.corwm.org.uk/pdf/m%20dutton%20_nnc%20links.pdf
Doc.334.1 is 'A Note on Ethics in the Context of Long-term Radioactive Waste Management.', Mark Dutton, April 2004
Doc. 514 is 'Principles - Scope of ethics task', Mark Dutton 15 June 2004

commercial skills to win a sizeable slice of the £2 billion a year market." Thus AMEC were tendering for government contracts on nuclear decommissioning and waste at the same time as running the programme for the supposedly independent CoRWM.

ANNEX 2 Problematic CoRWM Process

Faulkland Associates were engaged to assess the Public and Stakeholder Engagement (PSE) processes from January 2005 and help CoRWM to improve them. They noted that in the early stage of framing criteria and options, it was unclear what working groups existed, what their membership was, or the minutes of their meetings (Faulkland 2005a). One has to plough through the document list, or work back from references at the plenary meetings to find them. CoRWM's claims to a 'transparent' process were compromised in Phases 1 and 2 by this unclear structure and delays in posting documents on a second-rate website.

Neither Faulkland's evaluation of the consultations, nor that of the NNC for PSE1 (NNC 2005) say what standards they used to guide their analyses, an unprofessional omission; neither refers to the central guidance on Consultation (*Code of Practice on Consultation*, Better Regulation Exec. 2005) that government departments and agencies are required to use. As neither picked it up, this basic flaw persisted in all consultation exercises. NNC's (2005) evaluation dissected responses into component points, yet as Faulkland (2005a) comments, stakeholders "expect to have their arguments considered, not just component points which may be less meaningful when taken out of context".

Consultation events were over-focussed on nuclear site communities; no effort was made to hard-to-reach groups. Faulkland warned that the problems due to time pressures in PSE1 would be repeated in PSE2. This proved true (section 3.4). Because of the time schedule, the short-listing was reviewed and finalised (Cardiff plenary, July 2005) when there was no report/summary of the PSE2 responses. Just one member (Barker) had read through them.

In PSE1, *Discussion Groups* were supposed to elicit basic views and concerns (*Report* Table 7.1), then CoRWM formed four Citizens' Panels to achieve intensive engagement in shortlisting, options assessment, etc. to fulfil Renn's CDM. The *Report's* Ch.7:20 implies the Panels did this successfully, yet the facilitators (Lancaster Univ.) report patchy results and also a diversity of views which go unreflected in CoRWM's *Report*. The Panels were formed too late to validate the short-listing process (Doc.1750), and found themselves pressed to choose options in advance of even basic information. At specialist briefing and questioning sessions, there was complaint at the exclusion of counter-specialists from NGOs. There was disaffection and hostility over 'swing weightings' for the MCDA (Doc.1532, 4.3.1) described as subjective judgement piled on subjective judgements. They had the task to develop ethical perspectives and address "more difficult ethical issues in the context of technical solutions" (*Report* Ch.7:20) where the "quality of the discussions and output was high". The facilitators' summary (Doc. 1532, 5.2.1) showed on the contrary an amateur, human-centred ethic, uninformed by sustainable development legal concepts,

and largely limited to a 300yr timescale. One Panel did go deeper, expressing ideas of genetic continuity and stewardship of the biosphere, but these didn't get through to CoRWM's discussions.

We found some reporting of public and stakeholder meetings to be inadequate (even biased). In particular, the argument for a specific (~ million years) timescale for 'disposal' was suppressed in the Minutes of the Bristol stakeholder meeting (Doc. 1161; May 2005) and again in the record of public comments at the Cardiff plenary meeting** of July 2005. The Bristol record was both mistaken and false in reporting that the Stakeholders there agreed to a "national meeting", when they actually decided against pressure from the falicilators to seek a further round of regional Round-Tables.

The 'stakeholder' meetings were loaded in favour of nuclear industry membership and expertise. Because they were linked to existing nuclear sites, numbers attending from the 'public' were employed or relatives of employees on these sites. Though the Renn MCA divides the scoring process into a technical appraisal by expert specialist and value judgements by non-expert stakeholders, both the regulators and nuclear industry were nevertheless well-represented at the 'non-expert' Round-Tables as well as in the Specialist Groups. Nuclear critics were inevitably far out-numbered at the specialist workshops, but even NGO specialists from LLRC (www.llrc.org) were squeezed out. The consequence, naturally, was perceived bias in scoring and lack of confidence in outcomes.

ANNEX 3 CoRWM's Adoption of Volunteerism

CoRWM's ToR invited the Committee to consider such issues as 'whether local communities should have a veto or be encouraged to volunteer, and whether they should be offered incentives' (*Report* Annex1:1). CoRWM made 'volunteerism' into a principle in their Recommendations (No.10), and the government has elevated it further into a 'key principle'.

In March 2004, Mackerron as chair stated after a presentation from NIREX that for "areas such as potential host communities and veto and volunteerism... CoRWM (is) in the lead" (Doc 236.1). Then NIREX who were advocating this idea handed over five reports written by and for them:

E. Atherton, A. Hooper and J. Mathieson, *Concepts That Could Aid a Site Selection Process*, A NIREX Technical Note, 2000. (document 226)

P. Robinson, *Legal Issues Relating to Veto, Volunteerism and Community Benefits*, A Report for NIREX by Burges Salmon, 2002 (document 229)

K. Rawles, *Compensation in Radioactive Waste Management: Ethical Issues in the Treatment of Host Communities*, A Report to NIREX, May 2002 (document 230)

** The comment (Doc. 1131 Annex A) was mis-recorded as "The need for CoRWM to establish clear timescales, for example for the period during which regulatory controls could be relied on", when the comment actually covered the geological timescales and not the social or regulatory timescale that was NNC's and CoRWM's agenda.

United Kingdom NIREX Limited, *NIREX Response to the Defra and Devolved Administrations' Consultation Paper 'Managing Radioactive Waste Safely'*, March 2002 (document 231)

K. Rawles, *Ethical Issues in the Disposal of Radioactive Waste*, A Report to NIREX, 2000 (document 235)

A search on CoRWM's document library shows just three passing references to the concept by end of 2005

April 2004 "concepts, policies and principles such as *volunteerism*, compensation, community veto, retrievability, intergenerational equity, environmental risk, sustainable development... useful to identify those issues which the Committee really does need to discuss in some depth". The Complementary Programme - ideas and proposals, Andy Blowers (Doc. 349)

January 2005 "implementation issues might involve the role of representative democracy and site-related issues such as vetoes, *volunteerism* &c." Summary of phase 3 Working Group Meeting (Doc. 944)

June 2005 Topic 92 Volunteerism - should involve democratic institutions not individuals / companies.

PSE 2 Outputs Reporting, from *National Stakeholder Forum* (Doc. 1186, Sec 7B, p12)

The appropriate place for discussion 'in some depth' would have been the Sept. 2005 Ethics Workshop. The report on that in March 2006 (Blowers 2006) shows from the external experts:

- Kate Rawles mentions 'volunteerism' in passing, as an issue, in the introductions
- Barbara Adam would rule it out as taking a short-term anthropocentric view of the planet
- Anna Vari, in reflections after the workshop, describes the difficulties found in practice in various countries (abandoned in Sweden), but gives no analysis of the ethical back-up.

Volunteerism gets no mention in the body of the *Report* (Ch.7, citizens and stakeholders involvement), nor is it explicit in reports of the Citizens' Panels (who saw little burden or unfairness to a host community). Thus it was never an issue for consultation and was not given the in-depth consideration required of a new "principle" with significant ethical implications. Contrary to any intent for CoRWM to take a lead role, it appears they took over NIREX-sponsored studies and added CoRWM gloss with a few references.

ANNEX 4 Gas Generation from long-term Repositories

The Secretariat's *Note of NIREX meeting* of 20th February 2006 (Doc 1608) mentioned gases but only as a geochemical issue:

> "Gas generation was a recognised problem caused by the corrosion of waste packages in water. The objective was to manage the balance of

> containment/release of gas in groundwater. The ideal was to ensure that gas left the repository and dissolved in the external groundwater before it caused disruption through pressure build-up. This would require site-specific investigation."

Gases from corrosion are not in fact restricted to watery environments – water vapour is important and its diffusion through seals and rocks suffices for microbiological processes generating gases. The Secretariat's summary of April 2006 (Doc.1693, *Uncertainties Associated with Geological Disposal*) did not cover miocrobiology or biogenic gases. Para.24 referred just to earth sciences, chemistry and geo-chemistry, posing the issue as "how long it will take for radioactivity to reach the surface in groundwater".

NIREX in their *Viability Report* (NIREX 2005a) admitted the radioactive carbon problem as a "major uncertainty" that could give up to 1000 times excessive dose via the "gas pathway":

Carbon – *14 in the Gas Pathway*

> "The one major uncertainty that we are still tackling at the generic stage is the possible generation and migration of methane containing carbon-14 (C-14). There are three potential sources of C-14 containing gases that are typically identified. These are irradiated graphite, irradiated metals and organic wastes.
>
> The possibility of the release of gaseous C-14 from irradiated graphite and irradiated metals has not previously been included in gas pathway calculations in the generic documents. Models have now been developed to allow these possible sources to be included in the calculations.
>
> Since it is uncertain how any release of C -14 in wastes will occur, scoping calculations have been carried out to bound the consequences if all the carbon in these materials reacts to form C-14 bearing methane and that this migrates as a free gas to the biosphere. These assumptions have a significant impact on the calculated risk from the gas pathway with peak annual individual risks up to of order 10^{-3} per year being calculated. However, groundwater has the capacity to dissolve methane and work is underway to see if this capacity can be scoped in the absence of site-specific information."

Two of the EA's key technical challenges (Section 5.2) involved C-14, namely the release rates of C-14 gases, "particularly where these estimates depend on models of microbiological processes" and the assumption that all C-14 in carbon dioxide does not escape from the repository, but reacts with backfill via a carbonation reaction.

The NGO (2006) critique reminded CoRWM of the gas issue in March 2006, referring to the Sellafield Inquiry. At the same time, New Scientist carried an article (Nielsen 2006) on the Swedish studies for deep disposal that said

> "in recent years it has become clear that microbes could pose a threat to any repository".

CoRWM, however, remained uniformed about this issue – due, presumably, to their NNC managers and the UK nuclear industry as a whole having ignored it. Evidently NIREX had not been following the work in Sweden and had failed to follow modern research on the microbiology of rock-living microbes, so were still (in Sept. 2005) making crude chemical assumptions.

ANNEX 5 Mistaken Choice of Multi-Criteria Decision Analysis (MCDA)

Following the explicit Minute of the chairman's statement (July 2004 plenary – see Section 6.1) CoRWM selected the MCDA process on the basis of a review commissioned from Prof. Gregg Butler (of 'IDM'; *Report* Annex 5:1.4), which was considered by a "Phase 3 group" but not by the full committee. It failed to incorporate any substantial critique or identification of the shortcomings of MCDA (only claimed positives are listed in Annex 5:1.5). It's a matter of concern that Gregg Butler (2006) has a nuclear industry background, with on-going connections and funding, and is well-known to several members of the committee (Barker, Blowers, Davies, and Warren) through his membership of RWMAC where he served as *'consultant specialising in nuclear fuel cycle and nuclear industry matters'*. The paper's reviewer Prof McDaniels is quoted in CoRWM's Annex 5:1.6 as declaring MCDA is *"the only method that I know of to address these features of such decision problems in a responsible manner"*. Such an explicit and unqualified endorsement - in the context of general critiques and acknowledged limitations of MCDA - implies a deficit in the balance and impartiality needed of a reviewer.

An MCDA, by its structure, separates dimensions (aspects or factors) which are actually interrelated and often co-constitutive. Yet, eg. ethical aspects are intrinsic to technical and economic assessments. Section 6.3 of the text describes why an inclusive democratic approach is essential in the strongly contested arena, characterised by disparate knowledge bases and disparity in power. As this is accepted policy in the health field, it was a clear mistake for CoRWM to choose an MCDA, especially one with a strong technocratic basis derived from the nuclear industry.

The facilitators gave no consideration of how trust might (or might not) be established. No consideration was given as to the information base or option setting that has to go into a decision-making process. There was too little time allocated for a real deliberative process. Instead the "Phase 3 group" influenced by Gregg Butler's review decided "an intuitive assessment might be woven together... to encourage deliberation" (Walthall 2005) by letting the holistic assessment be made by CoRWM members rather than by citizens as in Renn's model.

The MCA process shaped much of CoRWM's further work - for instance, a lot of discussion went on about how to define the options and criteria so that an MCDA would 'work'. These had to be decided at the July 2005 meeting, before stakeholder responses on the "short list" had been assembled and analysed.

CoRWM should have sought a 'robust' way forward in July 2005 from PSE2 responses, by seeing if they could meet the most critical comments, through redefining the options (Section 3.3). But with no analysis of responses, there was little re-examination of the 'broad' options to look at variations and how options might be amalgamated or differentially used (e.g. storage and research, or a realistic timescale for stores).

adapted from NGO critique (NGO 2006)

ANNEX 6 NGO Objections at Bristol, 20 January 2006

Following prolonged argument over the programme and facilitation at the Round-Table that was intended to confine particpants to setting scores on pre-defined option-criteria (MCDA), a special session was agreed where objectors could present criticisms for recording by a CoRWM Member (Lynda Warren). These were transcribed as Appendix 5 to the report of *CoRWM PSE3 Roundtable - Bristol, 20 January 2006* (no Doc. number) and are cryptic because written large on a wall-chart and with Warren's phrasing. In late afternoon, Gordon Mackerron arrived for a pre-arranged discussion with some six NGOers, joined by Lynda Warren and Fiona Walthall. The record from our side is below.

Anti-nukes criticise CoRWM at Stakeholder Round-Table, Bristol, 20 Jan.'06

The CoRWM secretariat wrote to us that the invitees had an "emphasis on engaging stakeholders from communities local to the (nuclear) sites". Yet ours had 8 "community" reps, compared with 8 from the nuclear industry out of 25. The exercise was intended to assess "your inherent values" said the Corwm rep (Fiona Walthall) so why involve (so many) nuclear industry staff and employees (or regulator and local authority people) ?

They eventually stopped our complaints about the process, allowing us to record a number of points in direct discussion with the CoRWM rep and afterwards in a 'bilateral' session:

1. the Corwm process makes us feel hostage to a warped decision-process, that's not open but tightly constrained in outcomes.
2. Corwm claims to record all stakeholder inputs, but the reality of the shortlisting process was that it was completed (Cardiff in July) when there was no report/summary of the PSE2 responses and just one member said he'd read through them.
3. We are concerned about the NNC-AMEC running the process, because of their nuclear industry involvement with perceived bias.
4. The bias in specialists appointed to the first stage of the MCDA leads to perceived bias in scoring and lack of confidence in outcomes
5. concern that the "Netherlands strategy" of storing for up to 100 years while pursuing studies of alternative long-term options was not in CoRWM's short-list
6. concern that sub-seabed disposal was dismissed in the artificial short-listing process
7. concern over the 300 year timescale in the "interim" store option, being overlong and unsound for assuming institutional control (the US specifies 100yr max)
8. concern over CoRWM's failure in their stakeholder and public information to link the "interim store" option with the package of potential options that may become feasible within decades (CoRWM shelved them for a "watching brief")
9. concern we were given selected knowledge, insufficient to base stakeholder decisions

10. concern that geology is highly important, but deferred by CoRWM till late in the process – which has meant failure to specify timescales that deep disposal has to meet in eg. the USA (1 million years for the Yucca Mtn store, as decided in Court with science advice)
11. concern that "ethics" was addressed too late, with the workshop output still not available and a tendency to reduce it to polling people's views
12. concern that the Quality Assurance group has been slow in getting going, is meeting rarely and is perceived as an inadequate check on NNC.
13. concern over reporting of public and stakeholder meetings; in particular the argument for a specific (~ million years) timescale for 'disposal' was suppressed in the Minutes of the Bristol stakeholder meeting (May) and again in the record of public comments at the Cardiff plenary meeting (July 2005). Also the Bristol record falsely says the Stakeholders agreed to a "national meeting", when they actually wanted a further round of regional round-tables.

We talked of walking out, but didn't in the end. The whole set-up is biased and intimidating, but we were strong enough to persist – others might prefer to walk out, demonstratively. We were allowed no opportunity for discussing the Specialist group 'scoring' as the draft agenda had promised. We were critical of the "option preferences" exercise, which facilitates choice according to prejudices with limited testing and scrutiny.

20 January 2006

GEOSCIENCES AND THE LONG-TERM MANAGEMENT OF RADIOACTIVE WASTE

Geological Society Meeting

January 9 2006

5 members of CoRWM attended: GM, FW, PW (part), WD, LW. These notes are based on notes that I took at the time; given more time I would have tried to draw things together better but this is the best I can do. Where there are abstracts I have not attempted to repeat what is written. We were told at the end of the meeting that speakers will be encouraged to make their presentations available for placing on the Geological Society website. My personal view is that it would be very useful for CoRWM members to have copies of these – there was a lot of useful information and references.

My general impression and conclusions – and these are personal conclusions that the other CoRWM attendees may dispute are as follows:

- *Geological disposal is THE option, for some of the waste at least*
- *Boreholes were not ruled out, however, for HLW wastes such as plutonium where irretrievability is at a premium*
- *Subductions zones are not suitable*
- *Stable geology is needed but it could be hard rock or clay (some slight indication that clay performed better)*
- *Choice of rock should determine choice of engineered barrier system (EBS)*
- *Retrievability did not figure largely and some clearly saw it as counter to the main objective of disposal*
- *There will need to be a long lead in time – site characterisation will not be straightforward and may prove controversial.*
- *Volunteerism is the way forward*

1 Introduction: The Links Back to the 1999 Report

Peter Styles
President, Geological Society; Director, British Geological Survey; Professor, University of Keele

No Abstract provided.

Geol Soc 1999 Report concluded that the only option was deep geological disposal at several 100 metres depth. He considered changes in circumstances since then, including climate change. Reference to sea level and coastline changes and gave maps with an extreme scenario of 84 m sea level rise creating the British archipelago.

Points of Possible Interest for CoRWM:
Claimed there were only 2 options for waste, above ground and below ground and that, if above ground, this was of no real interest to geologists. Talking to

people over coffee, this view was not shared; earth scientists will have a lot to contribute to above ground solutions in terms of climate change impacts.

2 A UK Overview: Process and Timetable, the Work of CoRWM

Gordon MacKerron

3 The UK Inventory, the Safety Case and the Waste Management Options for Nirex

Alan Hooper
Nirex

Abstract provided

Points of Possible Interest for CoRWM:

- Magnox power stations are not 'waste friendly' and present a challenge.
- Undue focus in past on mathematical modelling – confusing it with long-term safety case which is about a lot more.
- Focused on phased deep disposal for ILW/LLW and reference geological disposal concept for HLW/SNF based on Swedish KBS3 concept.
- 30% land area has potentially suitable site but BGS are currently reviewing this historical research for Nirex.
- Paul Davies (NDA) urged that care should be taken not to oversell geological disposal and asked whether there were any 'achilles heels' that needed to be raised here, because 'they will be later'.
- One of the issues he raised in this context was gas generation, especially the transport of C-14
- Alan's reply was that **'geological disposal is all very well until you get the maps out'.**

4 Progress in Europe – Sweden

Olle Olsson
SKB, Sweden

Abstract provided

Points of Possible Interest for CoRWM:

- 3 key factors in determining site for deep repository for SNF: rock + general safety; industry + environment; society + public confidence.
- Siting process started in 1993; hoped for 5-10 potential sites and got 8 for feasibility studies; narrowed down to 2 and expect to select in 2008 (**i.e. 15 years**)
- Approx 70% public approval in host communities; dropped to 40% at another site (**inverted nimbyism**)

- Risk target of $<10^{-6}$ pa over assessment period of 1 million years – over one glaciation cycle.
- Glaciation appears to be most significant effect – added pressures; melt.
- Both sites appear suitable; hope to be able to submit application in 2008 following detailed safety analysis. Then 'complex legal process' but hope to start construction beginning of next decade and start operations in 2017 (**i.e 19 years after application**)
- Note that Swedish geology is relatively homogeneous; sites are being sought in the Fennoscandian shield with granites and gneisses (crystalline rocks)

5 The Long-term Peformance of a Claystone Barrier for a High-level Radioactive Waste Repository in Switzerland: An Evaluation Using Multiple Lines of Evidence

Andreas Gautschi
Nagra, Switzerland

Abstract Provided

Points of Possible Interest for CoRWM:

- Demonstration of disposal feasibility went to government in Dec 2002; national and international review from 2003-5 and **public consultation from Sept – Dec 2005**.
- Expect favourable government decision in 2006
- Note that Switzerland has both crystalline, hard-rock geology and sedimentary clays. The hard geology is essentially in the alpine regions to the south where tectonic movements are continuing (the Alps are getting taller); the sedimentary rocks are in the north and are more stable. This neat differentiation makes it relatively easy to decide which type of rock to go for.

6 Technical and Scientific Advances made by Andra in the Investigation of the Meuse/Haute-Marne Site

Christian Ravenne
ANDRA, France

Abstract provided

Points of Possible Interest for CoRWM:

- 1991 Waste Act specifies areas of research and responsible bodies and **defined date for parliamentary date (2006)**
- Government decision to hold public debate in September 2005
- Debate organised by **National Committee for Public Debate**

- Aim is for Government Bill in first quarter of 2006, Parliamentary debate in second quarter with decision within 2 months (**so could be before CoRWM reports**)
- If approval is given (for clay – work on granite is less well developed), expects at least a further 15 years research
- **'Reversibility' is required by law; it requires flexible management of packages in repository, possibility of step-wise closure towards an increasingly passive configuration.**
- Both crystalline hard rock and clay were considered on geological grounds; reason for prominence of clay is social – difficulty of finding site to investigate for hard rock

Stability in the Context of Waste Management Overview and Evidence

Neil Chapman
ITC Switzerland; Sheffield University

Abstract Provided

Points of Possible Interest for CoRWM:

- Noted that first suggestion of geological disposal was US National Academy of Sciences publication in 1957 'Disposal of Radioactive Wastes on Land'.
- Traditional approach is to look at multiple barriers working in time sequence so that containers provide isolation until they corrode; engineered barriers prevent escape into geosphere, geosphere selected to slow down release into biosphere. Neil questioned this logic. Starting point is that there will be a 'back to nature' decline in radioactivity and can use a uranium ore site as comparator for this. Decay to this level will occur over one to a few hundred thousand years for ILW and a few thousand years for HLW. Therefore **focus should be on ensuring that the geology 'supports' the engineered barrier system (EBS) over this period** rather than worry about what happens after repository radioactivity falls below his natural analogue.
- Yucca Mountain is a very difficult site chosen for political not geological reasons. Could get away with 100,000 years but change to 1 million will present problems because of vulcanicity and seismic changes in this period
- In response to questions as to situation in Britain where no homogeneous blocks, said **can never find ideal site but should be able to match engineering to geological environment** – start with geology.

Repository Engineering – Principles and Recent Advances

John Hudson
Imperial College, Rock Engineering Consultants
Abstract Provided

Points of Possible Interest for CoRWM:

- We are looking to do something that does nothing, i.e going against nature (cf normal tunnel construction etc).

Accuracy of Prediction of Subsurface Fluid Flow: Experience from Oilfield Reservoir Modelling

Mike Christie
Heriot Watt University

No Abstract Provided

The author's experience is in the oil industry; he has no direct interest or expertise in radwaste. He made some interesting observations on the use of models for predictions.

Points of Possible Interest for CoRWM:

- Confidence in prediction requires 3 things: good data; a sound physical theory; a good numerical model.
- Need for adaptive sampling and reliance on Bayesian rules for probabilities
- Seemed to be suggesting that the scope for uncertainties in inferences is very difficult
- Maximum likelihood can be a poor predictor in practice
- Need multiple matched models with probabilistic forecasts

Stability and the Geological Settings in the UK

David Holmes
British Geological Survey

Abstract Provided

Points of Possible Interest for CoRWM:

- 1985 criteria for siting have not changed much – major exception is that may now be seeking to keep the repository open for longer
- Looked at what has changed since BGS previous review (?1985): better understanding of requirements for geological barrier; climate change; improved data handling and modelling; previous list based on ILW; did not consider HLW
- Possible new criteria: more emphasis on geochemistry (geochemical stability, microbial activity at depth); climate change; palaeohydrology
- Stability is most important factor and agreed that it needed to be demonstrated over 10-100 Ky not 100K-1 million as previously
- Need to understand natural conditions now and the impact of disturbance upon them

- Discussed landscape stability – i.e. near surface: climate change, sea level rise, flooding, coastal/riverine erosion, tsunamis, permafrost, glacial activity
- Discussed geological stability – weathering patterns, compaction, vulcanism (not so very far away from nearest volcano)
- Type of construction may need rethink if keeping repository open longer
- Knowledge base – learning and forgetting from the past
- Also covered societal stability and competition for geological resources.
- In questioning, subduction zones were raised as something to look at but audience response was highly dismissive with repeated references to the recent tsunami.

Technical Summary, the UK Situation

David Savage
Quintessa

Abstract Provided

A good overview paper, covering the main issues in a clear, easy to understand presentation.

Points of Possible Interest for CoRWM:

- **Retrievability is "quite controversial": places strong constraints on design and site selection**
- Move towards clay – internationally developing preference: diffusion-controlled transport; self-healing fractures; preservation of past evolution; explorability.
- But, 20 y knowledge gap since Nirex's investigation of shallow sites (audience queried the seriousness of this citing UK involvement in overseas work)
- EBS would need to be tailored specifically for clay
- Most clays in SE, therefore probably non-starter
- In summary: huge advances in some technical areas; further effort needed re HLW, site characterisation; further debate needed re retrievability, volunteerism, deep boreholes
- **Key hindrance is political and public will; technical problems fairly minimal**

Taking Forward the Science – An Outsider's View

Joe Cann
University of Leeds

Abstract Provided

Points of Possible Interest for CoRWM:

- **Public distrust models – often wrong and can only deal with the foreseen not the unforeseen**
- Advantage of geologists is that they think in the right time scales
- Advocated the use of natural analogues
- Said it was “given” that radioactive waste must be disposed of; we made it so we must deal with it; deep geological disposal is the only option – retrievability is a side issue
- Question, therefore, was how to energise and inform a rational public debate ending in an acceptable political solution.
- In questions it was suggested that “all models are wrong but some are useful”; Cann disagreed: “all models can be right but bear no relation to real world”.
- Question: **is there a large population of academic geologists that believe the geological ‘in crowd’ are biased in saying that geology plus suitable EBS will work?** Answer: **No; very close to solution; gap lies in persuading the public**
- Believed there are a **number of potential sites in the UK and a number of potential methodologies**
- Was not concerned at ‘dilute and disperse’ as alternative to ‘concentrate and contain’ in the context of release of radioactivity into the geosphere in the distant future because the mechanisms re movements of more mobile elements from repository to groundwater at about 100°C are well understood

Lynda Warren
January 13 2006

Draft 1: 03.11.04

Burning Uranium in the Existing Reactors (TS 026)

1. Summary

a. The burning of uranium that has been recovered from reprocessing is possible. About 15,000 tonnes of uranium from the reprocessing of Magnox fuel has been recycled to manufacture fuel for the AGRs.
b. This process has now stopped because uranium prices are low and British Energy wish to keep the existing stocks as a buffer against a possible rise in mined uranium prices in the future.
c. Now that the fast reactor programme has been stopped, the resource in the uranium that is stockpiled is the U-235. The uranium stockpile contains a range of U-235 contents from 0.25% in the uranium that is left over from the manufacture of fuel to 0.6% from the reprocessing of AGR fuel. The content that is required for AGR and Sizewell 'B' fuel is 4 -5%. Thus, to utilise the uranium from reprocessing, it is necessary to enrich it to the required amount. Apart from uses such as hardened nose heads for weapons and specialised shielding, the depleted uranium could only be used in a fast reactor.
d. The predicted stockpile will consist of about 90,000 tonnes of uranium when the existing reprocessing contracts are completed and will be a mixture of uranium left over from the manufacture of fuel and uranium recovered from the reprocessing of Magnox and AGR fuel. The information that is currently available to CoRWM does not contain information on the proportion of each type of uranium.
e. Assuming a U-235 content of 0.5% in the existing stocks, NNC estimate that 37,000 tonnes could be burnt in the AGRs and Sizewell 'B' if the process started now.
f. BNFL have intimated that about 50,000 tonnes will have been produced from reprocessing. Thus, even if British Energy started to use the existing stockpile now, it would not have used all of the uranium that will be produced from reprocessing. (British Energy have stated that the uranium from their past and present contracts could be burnt in their reactors well within their predicted lifetime, but this presumably only refers to uranium from the AGRs.) **The situation needs to be resolved).**
g. On the basis of the NNC estimate, if the stockpile started to be used now, about 35% of the total could be used in the existing reactors. Just under half of it appears to be left over from fuel manufacture and, in the absence of a fast reactor programme, is unlikely to be used in the foreseeable future unless there is a steep rise in uranium prices even if there is a programme of new build. The remaining 15% could be used if there were a programme of new build.
h. The uranium from the reprocessing of Magnox fuel can be used in AGR fuel without any modification to the AGR stations – see i) above. However, fuel that is manufactured from uranium that is recovered from AGR fuel is more radioactive due to the greater content of U-236. It would therefore be necessary to modify the AGR fuel route.
i. The economics of burning ex-AGR uranium has been assessed by British Energy but the information is considered to be commercially sensitive and is not publicly available.

2. Additional remarks

The security concerns associated with the stockpile of uranium are very much less than those associated with the stockpile of plutonium. All of it has a lower enrichment than uranium that is mined. The only reason for keeping all the uranium from reprocessing appears to be ensuring the availability of relatively cheap uranium in the event of a programme of new build.