THE ROYAL SOCIETY

The long-term management of radioactive waste: the work of the Committee on Radioactive Waste Management (CoRWM)

Summary

This Royal Society policy report has been informed by a seminar organised in November 2005. The Royal Society seminar brought together an expert group of scientists who met with representatives of the Committee on Radioactive Waste Management (CoRWM) and the Department of Environment Food Rural Affairs (DEFRA). The purpose of the seminar was to identify science-based issues that are of particular importance in the crucial final phases of CoRWM's work, prior to its report to Government in summer 2006. Recommendations are made to CoRWM about issues within their remit and to DEFRA about future needs and broader issues of policy.

Recommendations to CoRWM

1 **Engagement with the scientific community.** It is vital that CoRWM engages more effectively with the scientific community and obtains stronger scientific input as it moves into the final stages of its work, where the options will be scored by expert panels. This could be achieved by seeking early reactions to the outcomes of scoring of the options from relevant learned societies and incorporating the scientific community into CoRWM's multi-stakeholder weighting of the scores.

2 **CoRWM options and a waste management strategy.** The options short-listed by CoRWM do not in themselves make up a waste management strategy. CoRWM should consider how options can be combined in ways that are flexible enough to respond to changing circumstances over many decades in order to create an integrated strategy. Moreover, combining options will raise specific scientific and technical issues that need to be factored into decision-making. We recommend an adaptive, phased process of management and commend international experience in providing useful models.

3 **Phasing of geological disposal and retrievability.** Radioactive waste management programmes are inevitably decades long and phased, with different combinations of storage and deep emplacement as parts of phased strategies. Deep geological disposal and *phased* deep geological disposal are currently different CoRWM options. In reality, they are the same. Phased geological disposal and flexibility, possibly associated with retrievability, should be important elements in an adaptive phased process.

4 **Flexibility to technological innovation.** Whilst it is important that options such as storage should not be seen as a means of avoiding decisions until 'something turns up', options and strategies should be as flexible as possible to accommodate unexpected innovations.

5 **Managing the waste streams.** The complexity of many UK High Level Waste (HLW) streams requires special consideration, in which the nature of encapsulation is important for management options. CoRWM should give this issue particular attention.

6 **Confidence in geological disposal.** 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.

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7 **Options that should remain open.** Sub-sea repositories accessed from land should continue to be considered as they would not contravene international conventions to which the UK is signatory. A waste-specific disposal option of very deep boreholes (several kilometres) should be explored, for disposal of small quantities of fissile material such as plutonium (if these are reclassified as wastes), where retrievability is highly *undesirable*.

8 **Cost-benefit risk analysis.** It is important that the cost-benefit analyses being undertaken by CoRWM are informed by expert scientific input. CoRWM's safety assessment criteria will need to be quantified so that the cost-benefit risk analyses can be undertaken.

Recommendations to DEFRA

9 **A successor body to CoRWM.** The time scale for a final report in July 2006 is far too short to move from a series of discrete, favoured options to an integrated strategy. CoRWM may only be able to identify the parameters within which a strategy may lie. There will be a continuing need for a post-CoRWM body to develop a management strategy. This will need much greater scientific and technical capacity than CoRWM, but will still need to be independent and to have public engagement and education capabilities, as these will remain crucial attributes of strategy development as the process moves to site selection and implementation.

10 **The process of selecting sites for storage/disposal.** CoRWM seems unlikely to address this issue. It is important that a successor body identifies the processes through which sites should be selected and the criteria that any site would need to satisfy.

11 **Research capacity and skills.** The UK skills and research bases required to support planning and implementation of a major waste management programme have deteriorated seriously. DEFRA should, in collaboration with the Research Councils, the Department of Trade and Industry (DTI), the nuclear industry and others, undertake a study of research and human resource needs, and recommend how the UK capability can be reinvigorated.

12 **Security.** The security of nuclear stores and repositories is clearly an important issue for the public. Understandably, very little background information has been fed into the CoRWM process about it. It would be very helpful if a way could be found of addressing security issues during public engagement processes.

13 **Regulatory standards.** There is some debate over the Linear No Threshold hypothesis, which is used to set the current standards for radiological exposure. DEFRA should monitor the development of scientific understanding in this area and if necessary undertake a regulatory review.

1 Background

1.1 'The disposal of existing UK nuclear wastes is a serious and urgent issue that must be resolved regardless of whether a new generation of nuclear stations produces fresh volumes of waste' (Royal Society 2002). In its 2002 submission to the DEFRA consultation on policy for the management of radioactive waste, the Royal Society called for the creation of a body whose independence and stature would command public confidence in developing proposals for a UK policy for the long-term management and disposal of radioactive wastes (Royal Society 2002). Its role should be to elicit values and priorities from citizens and marry these with technical and scientific issues to produce proposals that were both technically efficient and commanded broad public support. A similar conclusion was reached by the House of Lords Select Committee on Science and Technology, to which the Royal Society gave evidence (HoL 1999).

1.2 In the event, CoRWM was set up by Government in November 2003 with the remit 'to review options for managing UK solid radioactive waste and to recommend the option or combination of options that can provide a long-term solution, inspiring public confidence and providing protection for people and the environment'.

1.3 The waste inventory for which CoRWM is required to propose policy options comprises High Level Waste (HLW), Intermediate Level Waste (ILW) and Low Level Waste (LLW) that cannot be disposed of at the shallow burial site at Drigg near Sellafield.

2 The CoRWM process

2.1 CoRWM decided to subdivide its work into three phases:

Phase 1 (March – September 2004): preparing a preliminary report on the inventory, creating a long list of management options, devising screening criteria to narrow down the list of options, developing and testing an assessment method for the subsequent short-list, and designing a process of public and stakeholder engagement (PSE).

Phase 2 (October 2004 – July 2005): publishing a final report on the inventory, and, after two PSE stages, seeking views on its proposed short list and assessment method, and then finalising a short-list of options.

Phase 3 (August 2005 – July 2006): specialist panels produce scoring schemes and apply them to the short-listed options; engagement with citizens and stakeholders eg on weighting criteria, managing uncertainties, and testing sensitivities; from these and other outputs, drafting the report and reporting to Government.

2.2 Phase 2 is now complete and a short-list of options for disposal has been agreed (CoRWM 2005a):

- Long-term interim storage
- Non geological (surface or near surface) disposal of reactor decommissioning wastes
- Deep geological disposal
- Phased deep geological disposal

2.3 Phase 3 is now underway, and in December 2005, work groups of specialists will score each of these options against a set of criteria (public safety up to 300 years, public safety beyond 300 years, worker safety, security, environment, socio-economic, amenity, burden on future generations, implementability, flexibility, cost) for the five waste streams in the CoRWM inventory (CoRWM 2005b) which are:

- Reactor decommissioning waste (ILW, and that LLW that is unsuitable for disposal at the existing UK facility at Drigg)
- Spent nuclear fuel and HLW
- Plutonium
- Highly enriched uranium
- Other ILW and other LLW unsuitable for Drigg, and depleted, natural and low-enriched uranium

2.4 In early 2006, these scores will be weighted by citizens' panels and be assessed by decision analysts. A 'holistic' process is also being used to assess each option as a whole. An ethics workshop has been held to inform both CoRWM members and citizens panels and to contribute to the overall assessment process.

2.5 In late 2004, the House of Lords Select Committee on Science and Technology was critical of the paucity of relevant technical knowledge directly available to CoRWM and the lack of direct involvement of DEFRA's Chief Scientific Adviser (CSA) in the creation of a committee that will be providing advice to ministers. This led to the creation by CoRWM of a Quality Assurance Committee, with three members of CoRWM and three independent members, with a remit to ensure the quality of specialist technical reports and other CoRWM processes. The DEFRA CSA also set up an expert group to fulfil the role of posing challenging questions about the CoRWM process and individual science issues. There now appears to be a useful two-way interaction between the CSA's group and CoRWM.

3 Royal Society seminar on radioactive waste, 7 November 2005

3.1 In recognition of the important role of CoRWM in developing policy options for a serious and important issue, the Royal Society organised a full-day expert seminar on 7 November 2005, in collaboration with CoRWM and the DEFRA CSA's Group (see Annex). The timing of the meeting reflected the fact that much of the previous work of CoRWM had focused on engagement with the public and stakeholders to elicit key issues of values, but that in Phase 3 and onwards, scientific and technical issues would be particularly important. The purpose of the meeting was therefore to identify key issues that CoRWM should take into account during Phase 3.

3.2 CoRWM regarded the meeting as a means of identifying key technical issues and as part of their quality assurance process in questioning and challenging their processes. The meeting identified issues that need particular attention from CoRWM and from DEFRA. The comments and recommendations of this report are directed both towards CoRWM and towards DEFRA, with its responsibility for policy and post-CoRWM processes. This report was prepared by those that attended the seminar who are either independent of CoRWM or DEFRA, or whose role it is to monitor and challenge the CoRWM process (see Annex).

4 Issues of process

CoRWM's options and their relation to a waste management strategy

4.1 CoRWM's essential mandate is to propose management options to Government that are technically sound and publicly acceptable. Good progress has been made in this respect. However, the 'options' being evaluated by CoRWM are not mutually exclusive. It is part of CoRWM's remit to identify the appropriate combinations of options. These combinations must be flexible enough to respond to changing circumstances over many decades in order to create an integrated strategy. The scoring of these combinations will be influenced by the management options that comprise them. Some of the decisions about how to deal with the waste are likely to occur after initial proposals have been made. In addition, further decisions will need to be made once a site has been selected. CoRWM is therefore likely to present Government with a strategy that includes the parameters of the problem but not a solution. Experience from all international radioactive waste management programmes shows that an integrated strategy covering all wastes arising requires elements of each option at different stages of a programme's life. This is particularly important for the UK, which has such a wide range of wastes to deal with. Developing a strategy for the UK will require integration of the options and stronger involvement of the science and technology community.

4.2 Consequently, we believe that CoRWM will need to consider providing recommendations based upon one or more combinations of its 'options' as alternative, integrated strategies – not just a simple choice of one option or another. It is an approach recommended in November 2005 to the Canadian Government by its Nuclear Waste Management Organisation (NWMO 2005), which deals with spent fuel management. After evaluating three options that were presented to it (geological disposal, storage at reactor sites and above or below ground centralised storage), NWMO noted that '...it became clear that each possessed some unique strengths, but also some important limitations. They are not necessarily mutually exclusive.' Taking what it calls the 'long view', NWMO has proposed a fourth option, 'Adaptive Phased Management', which takes both technical and societal factors into account, builds in sequential decision-making, preserves flexibility during implementation, and utilizes the best features of the three initial options by implementing them in a staged and integrated strategy. Such an adaptive, staged approach is based on concepts developed in detail in a report of the US National Academy of Sciences (2003). We commend this general approach to CoRWM and to DEFRA.

4.3 Such a staged approach should be specifically adapted to UK circumstances, including the nature, quantity and timing of UK wastes. It must not be used as a justification for delay in taking difficult decisions. At a time when other European countries are siting or building geological repositories and when the European Commission has identified such repositories as the preferred EU 'endpoint', the 'store and see' option is not a scientifically or technically convincing solution (EC 2004). It leaves the waste management issue for the UK unresolved, with the waste issue open and a focus of perennial criticism about safety and security.

4.4 CoRWM has argued that its options can be considered separately because an option that is part of early stage management of radioactive wastes will not prejudice the use of another option for the same wastes in the longer term. We disagree. Combining options to create a staged, integrated strategy will raise technical and scientific issues that will need to be resolved. For example, a strategy may involve placing different types of waste into the same facility at different times and their thermal, chemical/biochemical and physical interactions will need to be anticipated and planned for. The timing and duration of intervals of storage, as well as whether these are carried out underground (and in which part of a geological store or repository), will affect packaging requirements and the design of the facilities, including rock engineering, materials for engineered barriers and how and when they are emplaced. Although there is a substantial international R&D basis to help with these issues, solutions will need to be adapted to concept-specific or site-specific considerations.

4.5 It could be argued that this is merely technical fine-tuning that can be undertaken readily once the essential public acceptability of the 'options', the building blocks of a strategy, is established. However, we expect that as an integrated longer-term strategy is developed, and particularly as the process of site selection gets under way, when local communities in potential site areas will want to know about the longer-term strategy in which their area is to play a part, community and societal engagement will continue to be of vital importance.

Longer-term institutional arrangements

4.6 It is quite clear that the time scale for a final report in July 2006 is far too short to move from a series of discrete, favoured options to an integrated strategy based on those options. Indeed the current composition of CoRWM, with a relatively limited science and engineering representation, is not well adapted to the role of creating a strategy or the consequent implementation plan.

4.7 These considerations strongly suggest that a post-CoRWM institution will be needed to develop a coherent UK strategy and implementation plan. This will require considerable strengthening of scientific and technical expertise, whilst the CoRWM processes of societal and stakeholder engagement will need to be maintained to ensure that emerging strategies and implementation processes are able to command broad public support. It is therefore important that a successor to CoRWM remains independent of government and has continuity of aims, approach and some committee membership. It will need a strengthened science and technology membership and processes to engage the scientific community to a greater extent, since the development of a consensus within the science community will be important in establishing a credible strategy.

4.8 Moving into a post-CoRWM phase of integrated strategy development and implementation will require: a clear set of relationships between DEFRA with its responsibility for policy; a CoRWM successor as an independent adviser and interface with the public and stakeholders; a body responsible for radioactive waste disposal and a strong regulator who commands public confidence and has a remit to monitor environmental and radiological standards.

Multi-stakeholder weighting processes and engaging the scientific community

4.9 It is currently CoRWM's intention that the scores generated by expert panels during meetings in December 2005 will then be weighted by citizens panels and the results assessed by decision analysts. It would be valuable to use a range of stakeholder groups to weight the scored options. We recommend that views on weights should be obtained from, for example, scientific and technical organisations, industrial and regulatory agencies and other representative groups. This would permit the weighted responses of citizens panels to be set in a broader context.

4.10 Consultation and engagement are crucial parts of the CoRWM process. It is important that when CoRWM reports, it is able credibly to claim broad public support for the preferred options, irrespective of the views of any special interest group. Without this, the CoRWM process will have been yet another ineffectual stage in the history of the UK's failure to develop policy for this vital issue. We are concerned that the relatively limited engagement of CoRWM with the scientific and engineering communities, apart from in small specialist groups, might result in a negative response to the final CoRWM proposals. We suggest that CoRWM attempts to avoid this by seeking collaboration with scientific and engineering learned societies in exposing the outcomes of the specialist scoring process to them for their comments as soon as they become available, which might then help to inform the weighting process.

5 Comments on specific options and scientific issues

Managing the waste streams

5.1 Apart from large amounts of well-characterised spent fuel and vitrified HLW, the UK has a wide range of specific, high-activity or long-lived wastes, often in small volumes from specific, historical, nuclear industry processes and facilities. These wastes will require particular attention to conditioning technologies in order to ensure that individual waste streams can be accommodated in appropriate stores and repositories. There is some disagreement about the extent to which very highly concentrated plutonium wastes require special attention, even if used as second cycle fuel, which eventually creates even more complex wastes. Although encapsulation in glass is a relatively inexpensive option that provides robust containment for most such wastes, it may be necessary to consider novel processes of encapsulation and transformation for certain actinide-rich wastes, such as secondary mixed oxide (MOX) waste, if the mix of actinides is sufficiently different from that of spent fuel from uranium burning to require different treatment (Royal Society 2002). However, such decisions, to be cost-effective, should depend on a holistic view of safety, including the effectiveness of the geological barrier.

5.2 Much ILW is currently stored in steel canisters which are packed with cement. However some ILW cannot be encapsulated in this way and poses particular problems because of its large volumes and its inevitable tendency to degrade, with the potential to create complex products.

5.3 It is important for an effective strategy that decisions are made about whether uranium or plutonium are reclassified as wastes or remain potential fuels, and whether burning plutonium as MOX fuel in pressurised water reactors should be a preferred route for its disposal as a waste. The management of separated plutonium, as opposed to spent fuel HLW, is discussed in a previous Royal Society report (Royal Society 1998). Currently no un-reprocessed spent fuel (uranium and plutonium) is classified as waste, although CoRWM is considering spent fuel as a 'potential' waste stream. Any change in status will impact on the management strategy.

5.4 There is an urgent need for research into changes in the ageing wastes that date from the early years of the nuclear programme, and changes in their immediate environments, in order to inform long-term management strategies.

5.5 We do not think that the multi-criteria decision analysis (MCDA) scoring process will bring out the nuances in the options, such as those for the different waste streams involved, the condition of the waste and how it is treated.

Geological disposal – phasing, timescales and retrievability

5.6 We believe that a distinction should not be drawn between deep geological disposal and *phased* deep geological disposal (Royal Society 2005). The timescales of all nuclear waste management programmes are decades long, inevitably staged, with different combinations of storage and deep underground emplacement as parts of different staging strategies that will require and will allow management decisions to be taken by future generations well into the 21st century. The differences are likely to be reflected in the timing and nature of the decision points in a lengthy, staged implementation process.

5.7 A UK waste management strategy might require that wastes remain secure but retrievable (eg in underground stores or repositories) until future decision-makers are prepared to contemplate permanent closure. Current policies for the management of spent fuel (ranging from reprocessing to direct disposal), could very well be reversed in future decades, depending upon a fuel's contemporary resource value and upon prevailing strategic priorities, or new options for packaging or disposal. In principle, waste could be retrieved from any geological repository if so required. As operations progress towards closure, retrieval becomes more difficult, but is still possible, even long after closure. Appropriate designs can facilitate retrieval at particular periods of a repository lifetime whilst still offering high security and safety at all times. The timeframe of staged repository operation prior to final closure is proposed to be up to, say, 300 years, the period over which it is suggested that access to an excavation at the typical target depth of 500m could be maintained. Design concepts for such staged repositories with reversible waste emplacement include Nirex's Phased Geological Repository Concept (PGRC) for intermediate level waste, and the Cavern Retrievable (CARE) method, recently proposed in Japan for a staged repository for high level waste and/or spent fuel, which is stored in transport casks in caverns where they can be monitored and are retrievable for long periods before final backfilling.

5.8 Very deep boreholes (several kilometres) could be an important option for disposal of small quantities of fissile material such as plutonium, which needs to be safeguarded against diversion for illicit purposes. The ability to retrieve plutonium waste is therefore a positive disadvantage, and very deep boreholes, planned specifically for irretrievability, should be explored as a possible option.

Confidence in the integrity of geological disposal

5.9 Whilst science will continue to advance and technology to improve, we do not think that uncertainty about geological science can be used to justify a long period of storage prior to geological disposal. Perennially waiting for 'something to turn up' would be an abuse of the precautionary principle. Surface or near surface storage will almost certainly be part of a phased disposal strategy.

5.10 The principal concerns commonly expressed about the safety of geological disposal relate to the complexity of geological structures, the timescales of tens to hundreds of thousands of years for the decay of HLW and spent fuels to activity levels similar to those of uranium ore formations, and the impact of extreme events such as earthquakes and glaciation. There are also concerns about modelling and prediction of groundwater movement based on present-day observations and short-term measurements. 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 respect to surface climate change – the most important likely cause of environmental instability in the UK over a timescale of tens to hundreds of thousands of years. Studies have identified sedimentary formations whose internal physicochemical 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 hydrochemical 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. Unexpected features can be found during site investigations (indeed exploring whether they do is the purpose of such investigations) and could cause a site to be rejected, a possibility that must be anticipated in any phased strategy. International experience shows that site characterisation and selection is likely to take about 10-20 years, so that a properly staged programme must allow for alternative siting and design options to be pursued in parallel until candidate sites are thoroughly understood and well-informed choices can be made.

5.11 The British Geological Survey is currently identifying a wide range of potentially suitable geological, hydrogeological and hydrochemical environments in many parts of the UK as part of nationwide projects to evaluate geological options for repository sites. It is expected that the report of the study will be published in 2006. Given the practical capabilities of matching repository design to a wide range of environmental properties, there is a high degree of confidence that technically suitable areas can be found for a geological repository.

5.12 An important aspect of the criteria for specific 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.

Sub-sea repositories accessed from land

5.13 We reiterate the Royal Society's earlier recommendation to CoRWM that it should consider the option of sub-seabed access from onshore tunnels in more detail before this option is excluded (Royal Society 2005). As similar tunnels have already been used to access coal from the UK mainland, and other countries (such as Sweden) have already developed offshore facilities connected by onshore tunnels, most engineering challenges for this disposal option have already been addressed. Sub-seabed disposal from onshore tunnels would not contravene international conventions in the way that off-shore sub-seabed disposal would. We understand that CoRWM accepts this position.

The site selection process

5.14 International experience shows that the process of selecting specific sites for storage, and particularly staged disposal, can be far more sensitive and difficult than the process of agreeing generic disposal options. Specific site selection is rightly not a CoRWM responsibility. Although we believe that the processes through which sites should be selected and the *criteria* that any site would need to satisfy should have been a priority for CoRWM, it does not seem to have been a subject for its public and stakeholder engagement and cannot now be accommodated within the remaining CoRWM process. DEFRA should ensure that this is a priority for a successor body to CoRWM, which will therefore need the same independence and capacity to conduct engagement processes together with strengthened scientific capability.

Regulatory standards

5.15 The effect of low doses of ionising radiation on the health of the public is a controversial issue since direct epidemiological observation of such health effects is usually not possible (UNSCEAR 2000). The Linear No Threshold (LNT) hypothesis, which is used in risk models for setting the current and proposed ICRP standards, assumes a linear relationship between dose and effect down to zero dose (ICRP 1990). There is growing scientific support for the LNT hypothesis which is summarised in recent reports from the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 2000) and the US National Academy of Sciences (2005). However some groups have argued for a low dose threshold below which excess health risks do not arise (Académie des Sciences & Académie Nationale de Médecine 2005) whilst others claim that ICRP models tend to underestimate health risks, particularly for internal radiation (for summaries and counter-arguments see CERRIE 2004).

5.16 DEFRA should monitor scientific developments on this subject and, if necessary, undertake a review of the regulations relating to exposure.

Cost-benefit risk analysis

5.17 In developing and informing the cost-benefit risk analyses that CoRWM is proposing to undertake, it is crucial to involve scientists with expertise in the statistical aspects of radiation medicine, waste transport and geological stability. The safety assessment criteria set out in CoRWM's Phase 2 report (CoRWM 2005a) are vague referring only to the protection of public and workers from radiation. These need to be quantified if judgements are to be made about costs, as the detriment to an individual as a consequence of a specific dose is a significant parameter.

Technological innovation

5.18 Whilst it is not sensible to wait for new technological developments and new understanding of health issues and medicine before developing strategy, it is important to consider how developments might affect policy. For example new methods for conditioning and treating waste may be developed over the next ten years that may affect how an option is implemented or open up the use of previously dismissed options. Although it would be wrong to plan to use as yet unrealised or unproven technologies, it is crucial that management strategies be sufficiently flexible to be able to encourage development of and incorporate new and beneficial technologies.

Research capacity and skills

5.19 The collapse of nuclear industry funding for research in the 1990s has been matched by a decline of related research and teaching in UK universities, such that the research base and the availability of trained staff are currently inadequate. They are not appropriate to the needs of the programme of detailed planning for waste management and its implementation that the UK needs. Particular weaknesses lie in the fields of radiochemistry (important because of the diversity and complexity of UK waste streams), health, radiological protection, nuclear physics and engineering, geohydrology, applied geophysics and engineering geology (DTI 2002).

5.20 Although the Nuclear Technology Education Consortium, a consortium of eight universities and other bodies offering postgraduate education in nuclear science and technology, and the Dalton Nuclear Institute at the University of Manchester are welcome developments, more needs to be done to support such bodies. It is important that the Office of Science and Technology and the Research Councils, in consultation with DEFRA, the DTI and the nuclear industry, continue to discuss strategies designed to reinvigorate much needed skills in this area. The British Geological Survey has maintained, although in a diminished form, significant capability in this area. UK skills in safety research and modelling have also been sustained through the involvement of many UK scientists in overseas programmes and in their underground laboratory work. It is important that it is not permitted to decay further, and that a renascent UK capability in this area is linked with international research and development programmes. In May 2005 it was announced that by 2007-8 the combined Research Council spending on energy research will increase to £70 million per annum (DTI 2005). This will include funding to safeguard capability in nuclear engineering and associated areas.

Security

5.21 Any policy for waste management must address the issue of nuclear security at each stage of a planned programme, particularly in relation to surface or near-surface storage. The conditioning and passivisation of wastes and their movement to secure interim storage are important priorities if they are not to be misused. In principle, centralised stores should be more readily secured than multiple stores, and deep underground facilities offer a greater measure of security than surface facilities. The surveillance of stores and geological repositories for spent fuel or plutonium wastes needs be provided for the foreseeable future. Care and consistency are required in any reactor mounding (the reactor is defueled, dismantled, and the reactor core and bioshield

are mounded over for about 100 years) because of the presence of many different nuclides. We understand that little evidence of the security issues surrounding waste storage was made available during the CoRWM public and stakeholder engagement process. Whilst we understand why this might have been so, it poses difficult issues of public confidence in storage arrangements, and should be reviewed as a matter of urgency.

Public acceptability, perception and scientific analysis

5.22 CoRWM is to be commended on the processes of consultation and engagement with the public and stakeholders that they have developed and implemented. They are an important part of any waste management strategy and must be built on by the successor body that we have argued should be created. Informed debate is crucial to engagement. It will be a priority for any successor body to ensure that impartial and robust scientific evidence is at the heart of public dialogue.

5.23 The CoRWM process has revealed a number of areas of risk where public perception and scientific analysis are at odds. There is a very strong public antipathy to any transport of wastes, whereas the statistics of incidents during transport over several decades imply a very low risk. Similarly the public appear to be extremely uneasy about the possibility that geological disposal might hide unexpected risks for future generations, whilst geological analyses suggest that deep disposal can offer very low risks. We recognise that such conflicts are at the heart of the dilemmas that CoRWM has been created to address. It is vital to acknowledge the seriousness of public concern (Department of Energy 1987). However, we would like to be reassured that rigorous scientific analysis of these issues has been presented to the public and stakeholder consultation groups to ensure well informed deliberation. It is partly for this reason that we suggest that the weighting exercise that will follow specialist scoring in Phase 3 includes scientific and engineering groups.

International comparisons

5.24 CoRWM should continue to learn from the experiences of Finland, Sweden, Canada (NWMO) and Japan. France could provide a good model because of its having a similar waste inventory to the UK and many geological similarities (ANDRA 2001). The Finnish experience is useful as site selection included a long public engagement and gave communities a veto.

Annex – Participants in the Royal Society seminar on radioactive waste (7 November 2005)

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The Royal Society is grateful to the following Fellows who reviewed the report. With the exception of Sir David Wallace, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release.

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