SUBMISSION TO

THE COMMITTEE FOR RADIOACTIVE WASTE MANAGEMENT

RESPONSE TO CONSULTATION

MANAGING NUCLEAR WASTE – FINAL REPORT

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RESPONSE TO CONSULTATION

MANAGING NUCLEAR WASTE – FINAL REPORT

SUMMARY

CORWM's task was to "review the potential options for managing UK radio-active waste – those for which there is no long-term solution." 2nd Consultation Document – April 2005.

We are very mindful that the outcome of this task and CORWM's report will be used by Government and decision makers to assess and determine the desirability of future nuclear energy generation. We therefore lay great emphasis on addressing the magnitude and complexity of the task that CORWM has been set. We believe that it is of the utmost importance that where matters cannot be resolved that this is made clear and explicit within the report.

In compiling this submission we have considered many of the detailed background papers, commissioned by CORWM, including those relating to the final inventory, the short listed options and the implementability of the different options. We have also considered the associated Royal Society report, the papers and proceedings of the Royal Geographical Society and independent reviews of current and proposed systems prepared by independent nuclear advisers.

From our evaluation of the documentation and our discussions we contend that there is no solution to nuclear waste, only different methods of managing it.

This view was also expressed in the CORWM draft report tabled at the Cardiff plenary in January 2005 "If Ministers accept our recommendations, the UK waste problem is not solved. Having a strategy is a start. The real challenge follows." Para 64.

In considering the different methods of management it appears that many uncertainties remain and that no method or combination of approaches provides a solution which can be universally applied to deal with nuclear waste.

In our submission we address the nature and characteristics of nuclear waste which sets it apart from other materials, we consider what uncertainties pertain to the storage/disposal of such materials and what knowledge and experience can be applied to evaluate the way forward. Most importantly we urge that the long term implications of managing and containing the effects of nuclear waste are fully demonstrated. Particularly, that in many cases there is 'no solution', but an acceptance that there will need to be ongoing commitments and responsibility for very many years, and in some cases, millennia, to ensure that the harmful effects of radiation are properly contained and do not cause harm or damage to future generations or the environment.

While not wishing to cast doubt on the manner of CORWM's operation we also raise and consider whether it was able to achieve the widest representation of views; and if it was possible to take account of those with dissenting voices. We also have concerns as to whether sufficient peer review and independent critical analysis was applied to the papers and submissions which were considered.

We raise this to ask CORWM if it is confident that it has identified the true unknowns and disadvantages of any system; that it has evaluated if these can be overcome and accurately ascertained what level of risk each system commands/possesses.

In conclusion we submit that the ultimate goal would be:

‘To ensure a safe, secure and stable repository for nuclear waste, which does not prevent or compromise the ability of future generations to revisit and review its management as more knowledge and science becomes available.’

However in reality we submit that this will not be attainable – and we therefore urge that CORWM sets out clearly, honestly and unequivocally those matters which cannot be resolved and the risks and uncertainties that still remain.

1 THE ISSUE OF NEW BUILD NUCLEAR REACTORS

This response deals only with addressing the inventory of nuclear waste which already exists, arising from nuclear power stations, research and development, etc and for those wastes which will be created as a result of decommissioning.

This response is not intended to confer, sanction or imply any acceptance of waste management for additional nuclear waste which would arise from the commissioning of any new build nuclear reactors.

We submit that the consideration of waste from new build reactors, and the issue of new build, are completely different subjects; with inherently different considerations and should be subject to a fully separate consultation by Government, etc.

In essence, we take it as a given that the wastes arising from previous decisions must be dealt with responsibly, but that wastes arising from further nuclear reactors is a completely separate issue, and subject to many greatly different criteria.

2 THE NATURE & CHARACTERISTICS OF NUCLEAR RADIOACTIVE WASTE

2.1 We ask that in compiling its Final Report the Committee explicitly sets out the nature, properties and characteristics of the nuclear radioactive waste which it has been asked to address and manage.

Also, that in so doing, it makes clear the complexity of the task and the difficulties to be faced in devising a strategy to manage materials and substances which are radioactive.

2.2 Although the Inventory sets out the different types of material and substances which are involved, we do not think that there is a clear explanation as to how radioactive waste differs from any other industrial waste material.

There appears to be insufficient recognition of the properties and characteristics which pertain to radioactivity, as opposed to the chemical, physical or biological waste products of other systems.

Most importantly there is no detail or clear explanation as to what risks and harm are posed by these properties and characteristics and why personnel, the public and the environment need to be shielded from these effects.

Thus far there does not appear to have been any qualification or quantification of:

1 the differing levels of radiation which will be emitted from the different substances and materials in the inventory

2 how much these levels of radiation will change over time for each given substance – the time scale of decay

3 what impacts and effects could/would be caused by exposure to the varying substances and their levels of radiation; both in

   a the short term and

   b the long term,

   to personnel, to the public and to the environment.

2.3 Currently the waste has only been differentiated into High, Intermediate, Low, and Very Low Level wastes and Plutonium, Uranium and Spent Fuel. It is not apparent that there has been any further quantification or qualification of the characteristics of the differing components and substances contained in each level of waste and their inherent properties and potential effects.

We note that in the 2nd Consultation Paper only 1 page out of the 43 dealt with substances contained in the Inventory, and there was no reference at all in the document to the impacts and effects of these materials. Nor was there any assessment of the risks and hazards posed in handling, storage or disposal of radioactive waste.

While Doc 1279 – CORWM's Final Inventory of Radioactive Waste and Materials Inventory, sets out in more detail the amounts of waste that it is envisaged will subsequently need to be dealt with, again this assessment is primarily in terms of volume and comparative levels of radioactivity.

There is only very limited mention of the implications and effects of exposure to any of the different substances in Doc 1279 – Final Inventory, Para 3.3 Page 6.- which states:

"Radioactivity is potentially harmful to people and the environment,"

Similarly in the leaflet:

'What is radioactive waste?' – CORWM Nov 2005 – again, this is very brief:

See Page 6: "Why is radioactive waste a problem?

"Radioactivity can harm people and the environment. High levels of radioactivity can kill, and lower levels may cause cancer and birth defects."

This does not convey the magnitude of the issues that CORWM has been asked to consider – nor the inherent hazards of the waste.

For it is the properties and effects of this radiation which sets nuclear waste apart from the wastes and by-products of other industries. Also it is these different properties and characteristics which demonstrate the complexity and concerns that need to be addressed and assessed in determining how radioactive waste is managed.

Furthermore, it is evident that both in the public and government sectors there is still a perception that nuclear waste is one entity, with uniform characteristics. Also, that there is a lack of understanding that dealing with radioactive waste is different from dealing with waste produced from any other industrial process.

We know of no other substances that are so potentially harmful that some will require a containment regime to be effective for up to a million years.

2.4 We feel that the final report should contain a full inventory, which sets out:

1. all the different categories of waste which the Committee has identified,
2. that these categories comprise different substances from the waste stream and an indication of the many types there are,
3. an explanation of the differing levels of radioactivity which is ascribed to each category and substance,
4. for each given substance what risks and harm this poses to people and the environment
5. what the implications are for management of these substances, in terms of how long they remain radioactive
6. what are the implications of how the levels of emissions change, or remain the same, over time.

2.6 It is crucial that an explanation of the effects of radioactivity is included to explain why it is necessary to prevent stored materials emitting radioactivity. This should also encompass the effects of exposure to personnel, the public and the environment and what danger and harm is posed by varying levels of emission and exposure.

2.7 Also we feel it should be pointed out that many of the substances which have been created as a result of nuclear activity are not naturally occurring within the Earth's sphere. They present a novel and unknown situation, with attendant and harmful implications.

2.8 **We therefore ask that CORWM sets out the magnitude and complexity of the full inventory of nuclear waste and its inherent properties and characteristics. The report should also make clear how this waste differs from that encountered in any other situation, why it needs to be dealt with differently than other substances and what the implications and effects are from not dealing with this in a responsible and satisfactory manner.**

3 ADDRESSING THE UNCERTAINTIES

3.1 In drawing up the Final Report, and in coming to a conclusion on the preferred management strategy which the Committee recommends to Government, we would be grateful if the report could set out the areas of uncertainty which have been addressed, how these have been resolved and stipulate any caveats which still remain.

Also we would be grateful if the report could ascribe what levels of confidence it attributes to any given storage/management regime and how this pertains to differing substances in the inventory and over time.

3.2 We have studied the two CORWM documents prepared by Enviros on the Short-Listed Options (Docs 1166 July & Nov 2005), the Final Waste Inventory (Doc 1279), the report by Jackson Consulting on the Implementability of Waste Management Options (Doc 1167) and briefing papers for the Jan 20 meeting.

We appreciate the open and transparent way they have detailed the limitations of each system and the unknowns and uncertainties for each management option. Also, the sections of the papers that deal with the key assumptions, that have been made in regard to each option, have proved very helpful in further defining the limitation/application of each system. The detailing of uncertainties in the Inventory document has also proved very useful.

Together these set out clearly, and in the public domain, which matters must be considered and resolved in evaluating the containment and security of the different management options.

We have also had regard to several papers from independent nuclear advisers who have considered existing and proposed waste management systems.

3.3 As stated above, many of the substances which are being dealt with are novel and there is no data on how these materials will react over time and in response to the way in which they are stored.

3.4 In determining the preferred management strategy we ask that the Committee sets out:

1 What the various elements of the strategy comprise,

2 Which substances/sections of the inventory are to be dealt with by each element/option,

3 For each substance/section of the inventory - what method of encapsulation is to be used; vitrification, concrete, bitumen, steel casing, copper, etc – whether the material is to be stored wet or dry.

4 What other barriers are to be incorporated; bentonite, asphalt, concrete, etc

5 What engineered barriers are to be built or excavated.

6 What characteristics are needed for any given geological site.

3.5 For each of the selected options we ask that the Committee is explicit about what is known and unknown about any given scenario and the range of barriers incorporated into any each system.

As stated above (Para 3.2) the limitations, uncertainties and unknowns set out in the various Docs (1279, 1166 &1167) must be addressed.

We append at Appendix 1 some of the key extracts from the paper on Implementation (Doc 1167).

Some similar concerns are also set out in the Enviros papers of March 2005 and November 2005.

3.6 We ask that in addressing these uncertainties the Report should include and make clear:

1 The qualification and quantification of the radiation levels for each element in the waste stream

2 What effects would result from exposure to this radiation (as per our concerns in Section 2 of this submission)

3 What evidence there is to identify how well each of the components in the multi-barrier system(s) perform.

We understand that typically the elements of a multi-barrier system are:

- The solid conditioned wasteform, the waste container and the waste overpack which collectively are referred to as the waste package;
- The buffer that separates the waste package from the rock (clay for HLW and spent fuel, cement, grout or crushed rock for ILW); and
- The linings and supports of the disposal/repository chambers and tunnels
- The geology and characteristics of the surrounding rock.

3.7 In particular we attach great importance to:

1 The determination of what levels of radioactivity are likely for each particular section of the inventory

2 How this will change over time

2 How this will be contained over time

3 What level of radionuclide migration is expected for each scenario and how is this expected to change over time.

4 What lifetime is attributed to:

a the maintenance of each element of the barrier system

b what is the estimated time that it will fail.

3.8 Further expansion of these concerns is contained in Section 5 of this submission, which relates to the input of independent nuclear advisers, critical analysis and peer review. We would be grateful if the Committee would also take these concerns into account in determining what uncertainties have been addressed.

3.9 **We ask what evidence, factual data or experience there is to support a level of confidence in each option and its component elements, and for this to be made clear.**

Also for the report to be explicit as to where there is uncertainty on any point or prediction and what assumptions have been made in determining any given option.

4 WHAT DO THE EXPERIENCES OF OTHER COUNTRIES TELL US?

4.1 The Energy Minister Malcolm Wicks has publicly stated that "the UK's failure to deal with its nuclear waste is a national disgrace".

Refs: Radio 4 Today programme – 22 Jan 06, Independent - 24 Jan 06, Guardian 23 Jan 06, Radio 4 - Any Questions 10/11 Feb 06.

The implication being that other countries have satisfactorily resolved the problems of dealing with their nuclear waste.

However the various papers that have been prepared for CORWM, and by others, indicate that many countries have not resolved the ultimate solution to the problem.

We append at Appendix 2 a brief synopsis of the experiences and current situation in other countries – taken from CORWM's own documents.

4.2 It appears that no body or country has as yet been able to define the optimum approach which enables the waste to be conditioned, packaged and disposed of without the requirement for further monitoring and possible retrieval.

We submit that the Report should be explicit as to what other countries have agreed – and the limitations and considerations that they have placed on the implementation of their decisions.

This would enable the Government and decision makers to assess the context of the UK situation in relation to the international perspective.

Most importantly it would demonstrate that there is no simple solution which can be universally adopted and applied, but that each element of the waste stream will require specific consideration, implementation, and monitoring for many years to come.

4.3 In setting out the international context we ask that the Report makes clear:

1. that many countries may have taken 'decisions in principle' as to their chosen methods of management – but that many are still evaluating sites to determine whether they have the necessary characteristics

2. that the very long time scales required – during which the waste will have to be monitored – pose difficult issues which have not yet been resolved

3. that there is very little factual evidence or practical experience of how the wastes and barriers will react and perform over the time that the wastes will need to be contained

4. that factors like 'institutional control' and 'retrievability' have not yet been satisfactorily determined

5. that most countries are still envisaging a time scale of at least 300 years before sealing off repositories.

4.4 **It is vital that there is a clear exposition setting out the current situation in Sweden, Finland, Canada, the US, Japan, etc, which details which waste elements have been considered, what issues still require resolution in each situation and what time scales have been adopted for monitoring and retrieval.**

We ask that the report is explicit about the problems other countries are facing in dealing with nuclear waste and demonstrates that it is not only the UK which is finding it immensely difficult to provide a robust, safe, and secure management system for nuclear waste.

5 HAVE THE FULL RANGE OF VIEWS BEEN CONSIDERED – IMPLICATIONS, CRITICAL ANALYSIS & PEER REVIEW

5.1 While not wishing to cast doubt on CORWM's operation, we are concerned that it has not been possible to draw on the knowledge and experience of some of the independent experts in the nuclear field**.**

We appreciate the lengths that CORWM has gone to in considering the ethical and social implications of nuclear waste management, but it seems that the modus operandi of the process may have militated against the involvement and inclusion of well qualified nuclear scientists beyond those from the ‘industry’ sector.

5.2 Looking at the make up of the Specialist Workshops it appears that there is significant representation from the industry, whose attendance would form part of their employment. However, for those who are independent, the time required to take part in CORWM’s deliberations would be at the cost of their own practice and possibly, for them, not a commercially viable option.

This also raises the issue of how much of the submitted material and reports, which CORWM has considered, has been subject to peer review – or independent critical analysis.

An evaluation of the different waste management systems, together with their component parts, represents a significant and substantial amount of work. If CORWM was not able to fund independent assessment of this material then there will remain concerns that the limitations and uncertainties of the various management options have not been fully explored and identified.

5.3 Also we are worried that the full range of ‘dissenting voices’ may not have been heard. In particular we are aware of the concerns of the Low Level Radiation Campaign and its stance on the evaluation and implications of exposure to low level radiation in relation to nuclear waste.

We understand that a recent report from the Institut de Radioprotection et de Surete Nucliare (IRSN) has also given weight to their concerns and that the IRSN ‘considers that it is urgent to initiate specific researches’ in the areas which were the subject of discussion in the report.

To feel confident that full cognisance has been afforded to health and safety criteria it would be better if at least the LLRC case could have been heard by CORWM and taken into consideration.

5.4 There are several areas where we feel this lack of representation and independent critical analysis, from scientists in the field, may have affected the material which CORWM has considered:

1 In the assessment of the efficacy and efficiency of the management systems to contain radiation

2 In determining the reliability of the different elements of a multi-barrier system to perform over time

3 In evaluating how the different elements of a multi-barrier system will inter-react over time

4 In assessing the rate of change, degradation and deterioration of the system components over time

5 In evaluating the differing levels of emissions of the contained materials, and what changes there will be over time

6 In assessing what impacts these emissions, at their varying levels, will have to personnel, people and the environment

7 In determining what the immediate and cumulative effects of exposure to the varying emission levels are anticipated and predicted

8 In defining what indicators are selected to determine the effects of radiation exposure

9 In identifying the methods and modes of radionuclide migration from any given system

10 In evaluating how this migration will/may change over time – and the effect it may have.

5.4 As particular instances where such evaluations appeared to be lacking full rigour we refer the Committee to the Specialist Workshops Scoring Report. Doc 1502

The consideration of Radiological Pollution in the Environment (Pages 60-65) does not appear to have merited much consideration. Not only were there very few participants, but they seem to be drawn almost exclusively from the industry or government agencies. There was no representation from any of the environmental groups.

Furthermore, the report of the deliberations is very brief; with very little evidence of what data or knowledge was applied to the evaluation. The consideration of the long term effects appeared even more scant. This gives little confidence in the scoring and outcomes of the process.

As the effects of radiation on the environment is one of the key issues in determining how radioactive waste is to be dealt with we find this extremely worrying.

In addition we note that the Specialist Workshop which dealt with Safety, which includes public safety from radiation in the short and long term, appeared to consist of mostly industry or government agency representatives.

Also that most of the information provided had come from established industry sources and that: 'The general lack of key information sources and evidence to support scoring from outside the industry was noted.' Doc 1502 Page 11.

The concern here is that this lack of balance in documents and personnel has not allowed a full assessment of the risks posed by radiation to the public in either the short or long term. Again a key issue.

With reference to 'Collective dose', the represented bodies also appeared to be heavily weighted in favour of those who wished to ignore this criteria:
"In particular it was noted that by ignoring collective dose it would not be possible to discriminate against those options that are capable of distributing a low dose to a large number of people." Doc 1502 Page 11.

As the effects of radiation on the public is also another key issue we find this extremely worrying.

5.5 We have now considered several independent papers which have evaluated other systems. These have articulated and detailed many of the unresolved concerns which apply to systems which have been agreed 'in principle'.

However we are not aware that such a process has been applied to the short listed options which CORWM has drawn up.

While we accept that such critical analysis may be specific to the eventual site chosen for storage or reposition; in terms of rock characterisation, etc, there is still the evaluation as to the most appropriate means of containment for each component of the waste stream.

"The most critical parameter may be the lifetime of the waste package and its stability and resilience to corrosion (from the inside-outwards and also the outside-inwards), temperature and humidity."

Implementability of Radioactive Waste Options – Doc 1167, Page 33

We do not know when, and at what stage, it is intended that this crucial evaluation will take place.

5.6 In the critical analysis undertaken by Large & Associates of the Swedish SKB system many areas of concern were highlighted:

REVIEW OF THE SVENSK KÄRNBRÄNSLEHANTERING AB† PROPOSAL TO DISPOSE OF IRRADIATED FUEL TO A DEEP REPOSITORY KBS-3

CORROSION, DISSOLUTION AND SOLUBILITY OF DISPOSED IRRADIATED LWR FUEL

Extract:

"In fact, this Review demonstrates that SKB's own published research shows the corrosion-dissolution processes of irradiated spent fuel to be very much more complex, and to involve greater uncertainty, than that presented above.

Moreover, it shows that the present understanding of these processes is far from complete, so much so that we are not yet in a position to be able to reliably predict when and how the fuel will break down, and what will be the precise nature of the products of this breakdown, their subsequent interactions with and rate of migration through the repository geology."

We found this paper, and also a critique of the Swiss proposals at Benken, greatly informed our understanding of the many outstanding matters that still have to be resolved. We have appended both to this submission – and would be very grateful if the Committee would have regard to their content and the linked documents. See Appendices 3 & 4

The SBK proposal for the KBS repository has been much vaunted as a possible disposal method. Indeed it scored highly in the Specialist Workshops as is indicated in Briefing Paper 8 provided for the Bristol meeting of Jan 20.

However it appears that there are still many concerns relating to this proposal. It would be much appreciated if the Committee could have regard to the issues that are raised and ascertain if such a process of critical analysis has been applied to any of the options that it recommends.

5.7 **We therefore remain very concerned that without independent critical analysis and peer review, CoRWM can be confident it has identified all the true unknowns and disadvantages of any system.**

For CoRWM to be certain that it can make unequivocal recommendations it must be sure that all the evidence and data has been sufficiently tested and examined.

If the Committee has failed to correctly evaluate what level of risk each system commands and possesses, how these risks are to be overcome or if they remain without resolution, this could have major, far-reaching and possibly catastrophic implications for future generations and the environment.

6 COSTS

6.1 We note there are wide variations in the estimated costs for the differing options. Quoted figures range from £7bn to £30bn with large ranges in each option. (Papers provided for the Stakeholder day in Bristol – 20 Jan).

Given this wide variability we wonder how much reliance can be placed on these figures, particularly when no site specific criteria have been included in their compilation.

(We understand that CoRWM will propose generic outcomes – as opposed to site specific recommendations.)

In determining the containment of radioactive waste to ensure no adverse effects now, and for the next million years, we wonder how realistic these cost projections can be.

Our over-riding concern is that the issue of cost should not be a major consideration, but that the issues of safety and protection for personnel, people and the environment, now and in the very long term, should be of paramount importance.

7 CONCLUSIONS

CORWM's task was to "review the potential options for managing UK radio-active waste – those for which there is no long-term solution." 2nd Consultation Document – April 2005.

The response to this task carries a great burden of responsibility. The outcome of CoRWM's deliberations and its report will not only drive the policies of how we manage nuclear waste for many millenia, but will inevitably be used to advance the consideration of possible new nuclear build.

It is therefore difficult to over-estimate the long term implications and effects that CoRWM's report will generate.

The Nuclear Energy Authority stated in 2005: "that maintaining good quality storage that is robust, safe, secure and protects the environment over long time periods is a complex technical activity with many challenges."

Given the import and consequences of CoRWM's report we submit that, in determining its recommendations, CoRWM must have unequivocal confidence that all those challenges have been met.

From our consideration and evaluation of the various documents, papers, presentations and currently implemented systems we believe that many unanswered questions still remain. Many uncertainties pertain to the efficacy and efficiency of the various waste packages and multi-barrier systems and how these will perform over time. In addition, the factors relating to institutional control and the desirability of possible retrieval of wastes also contain many unknowns.

CoRWMs task has not only had to encompass the present day situation but to also look far into the future; with all the inherent complexities and uncertainties that includes. What will be the long term effects of the interaction of the stored waste with its containment, geology and hydro-geology? What do we really know of how this interaction will then contain or allow radionuclide migration and subsequent impact on people and the environment?

The risks posed by under-estimation of the problems and on false reliance on untested models could be major and far-reaching, and in some cases catastrophic.

We therefore submit that only when CoRWM can demonstrate, beyond all reasonable doubt, that it has identified all possible risks and determined how these can be overcome, will it be acceptable to make its recommendations.

Wherever there is doubt or uncertainty in any situations or outcomes we ask that CoRWM makes this explicit and clear within its report. Where matters remain unresolved or insoluble, this should be highlighted.

Only when all these criteria are met will the public be able to have confidence and assurance in the final report and its recommendations.

Openness and transparency have been guiding principles in the task that CoRWM has undertaken; we urge that in the final report that these principles are of even greater relevance and magnitude. The outcome of the report will not only be of paramount importance now, but for very many generations to come.

J Bayley
On behalf of Glos Green Party
February 2006

LIMITATIONS, UNCERTAINTIES AND UNKNOWNS **APPENDIX 1**
AS IDENTIFIED IN CORWM PAPERS

Extracts from Discussion Paper on the Implementability of Radioactive Waste Management Options
TS082/2D Doc 1167 1st July 2005 Issue 2

We cite the Page numbers from which these extracts have been obtained. We highlight certain key points in bold and our comments are expressed in italics.

1 LONG TERM STORAGE OPTIONS

"NEA points out that maintaining good quality storage that is robust, safe, secure and protects the environment over long time periods is a complex technical activity with many challenges. Some of the key implementation factors necessary to preserve safety and security are:

- Suitable waste packages that are stable and resistant to corrosion, adequately packaged and well contained in a store of modern design with good records of the waste's origin and characteristics and their location within the waste store.
- Effective control of the store environment such as temperature and humidity and ambient chlorine content in dry stores and water chemistry in wet stores.
- A robust system of monitoring of the environmental and radiological conditions within the store especially to monitor for potential degradation of stored waste packages.
- A system of planned periodic maintenance of the store structure and infrastructure for handling and inspecting waste packages.
- Measures to assure the security of the site and the storage facility from malicious interference and inadvertent human events, including terrorist attacks and accidents.
- Protection of the site and the storage facility from foreseeable natural events, such as flooding, hurricane, major seismic events and the effects of climate change.
- Retention of intelligent capability over long timescales to recognise when repackaging, store refurbishment or replacement of equipment is required and to perform such operations.
- Retention of intelligent capability to assess risks from planned routine operation and expected degradation of waste packages and facility infrastructure, and also to assess risks from unplanned events such as fire, flood, seismic activity and climate change, and develop and apply appropriate mitigation strategies for these.
- Maintain a capability to remediate contaminated parts of the storage facility and recover waste packages in the event of any potential failure of safety or security.

- Maintain a system of governance and institutional control over the storage facility, retaining sufficient organisational capability, staff training, safety culture and technical knowledge to continue these tasks over potentially long timescales.

- Provide secure financial resources and political and societal commitment to continue and fund the measures above over potentially long institutional timescales.

Page 31/32

"**However the engineering design life of the store may not be the most important factor that determines the implementability of the store from a technical perspective. The most critical parameter may be the lifetime of the waste package and its stability and resilience to corrosion (from the inside-outwards and also the outside-inwards), temperature and humidity.**

It is foreseeable that at least some waste packages will eventually degrade requiring either repackaging (probably using a simple over-packing arrangement to minimise handling of the waste) or if this is not possible recovery of the old waste package succeeded by treatment and reworking of the waste into a new waste package container.

At present many wastes are contained within stainless steel waste packages of various types. However stainless steel is a relatively modern material first introduced circa 1910. Its corrosion resistance and overall resilience to degradation over long periods much greater than 100 years is not known with certainty although radioactive waste packaging standards specified by Nirex are intended to ensure packages of waste are safely retrievable for periods of up to 300 years. In contrast, during the early 1990s some 45 year old ILW waste packages originating from Sir John Cockcroft's original experiments at UKAEA Harwell in the 1940s[37] were found to have almost completely disintegrated inside their concrete storage vaults at B462.

The Harwell Vault Stores have now been completely refurbished to modern standards and a programme of recovery and repackaging of the wastes is currently taking place. **Nevertheless experience at B462 provides some indication of the difficulty of assuring the lifetime of waste packages."**

Page 33

"Some stakeholders considered that long term interim stores could be constructed for periods of 300 years and possibly up to 1,000 years, although the limiting factor was likely to be the lifetime of individual waste packages.

The key uncertainty is the length of time that conditioned and packaged wastes are likely to survive before they degrade and release their contents. Currently no proof of performance exits beyond longer than 100 years although some waste packages might perhaps survive for up to 10,000 years.

Industry stakeholders considered that different waste packaging standards would probably be needed for wastes intended to be stored in a long term interim storage facility than for wastes disposed in a geological facility."

Page 34

***We note that this it is the view of industry stakeholders – but this raises the question – what is the view of non-industry stakeholders and independents?*

2 Deep geological disposal options

"Nevertheless although the engineering feasibility of geological disposal as a concept is well established, the problem remains that internationally there is very little practical experience in the nuclear industry of operating geological waste repositories or deep borehole disposal facilities.

World-wide only one geological disposal facility for long lived waste is currently licensed to operate, the US Department of Energy's (US DOE) Waste Isolation Pilot Plant (WIPP) located in Carlsbad New Mexico. The WIPP repository is 700 metres deep. The site was originally selected in 1974 but following a difficult licensing process WIPP was eventually opened and began operation 25 years later in 1999[49].

Between 1984 and 1987 US DOE also disposed of some plutonium wastes in large diameter boreholes 25 metres deep at the Nevada Nuclear Test Site, although the practice was subsequently discontinued and the boreholes sealed[50].

More controversially beginning in the 1960s and over the past 40 years injection boreholes have been used to dispose of large volumes of liquid high level radioactive waste in geological strata at depths of between 200 to 500 metres at Krasnoyarsk-26 and Tomsk-7 in Siberia in the Former Soviet Union (FSU)[51].

Probably the most controversial issue concerning the implementability of deep geological disposal is the confidence with which safety and environmental protection can be assured following closure, backfilling and sealing of the repository or boreholes. Post closure safety is a critical aspect of the overall viability of any deep geological disposal option and relies on complex computer modelling to determine whether any radioactivity from emplaced waste packages is likely to escape (leak) to groundwater and potentially harm human health by entering the biosphere, returning to the surface of the earth and entering the food chain.

In addition to computer modelling the safety justification must also be supported by simple deterministic arguments and lines of defence as well as probabilistic safety assessments.

However it is important to remember that safety and environmental protection is not provided by technical assessments but by a well designed and properly sited repository system.

Several implementation factors can be identified for geological disposal which are necessary to preserve safety and security and ensure protection of the environment:

- *Effective isolation of wastes from surface processes*. **The safety of the repository relies on reliably containing emplaced radioactive wastes deep below the Earth's surface for many thousands of years using both engineered and natural barriers.**

- *Protection of the Earth's biosphere*. The repository must be suitably designed so that the biosphere is shielded and protected as far as practicable from the radioactivity of the wastes, which reaches its peak in the first few hundred years after disposal.

- *Effective waste packaging and containment*. The emplaced wasteforms must be immobilised in suitable waste packages that are stable and resistant to corrosion, well contained and emplaced within a repository of modern design.

- *Monitoring and retrievability*. During the period of operation of the repository and before backfilling, the repository design should allow emplaced wastes to be monitorable and retrievable if necessary, for example to allow repackaging.

- *Radionuclide containment*. **The repository should substantially achieve complete containment of short lived radionuclides for some hundreds or thousands of years, largely within the engineered barriers of the repository.**

  Limitation of releases. Waste packages should be extremely durable, suffering only gradual deterioration over many years with low and predictable releases of radioactivity taking place in a slow and predictable manner from the repository.

  Leakage and dispersion. The repository design should delay the release of radionuclides from progressive degradation of the engineered barrier system and limit their concentrations in the geological environment."

Page 44

"Internationally IAEA and NEA regard deep geological disposal as technically feasible. However its practical implementation depends on identifying a host disposal site with suitable geology. In the UK these issues were previously examined at the Nirex public inquiry held in 1996 following which the Secretary of State refused planning permission in 1997[52].

Although the outcome of planning inquiries does not set legally binding precedent (for example preventing the development of similar facilities elsewhere), in practice the recommendations and decisions from planning inquiries are highly persuasive. Against this background many local government and NGO stakeholders considered that the past failure of the Nirex public inquiry represented a significant hurdle for the developers of any new deep geological repository site to overcome. Nevertheless it is important to remember that
failure of the Nirex public inquiry was mainly caused by technical issues and safety assessment uncertainties related specifically to the local geology of the Sellafield site rather than fundamental problems with the deep disposal concept. Indeed the Local Planning Authority summarised its case in the public inquiry as "a poor site, chosen for the wrong reasons"[53]. Page 45

Re: Option 7 – Deep geological repository

Historically the principal technical difficulties identified at the public inquiry were that the reliability of multiple barrier geological containment was difficult to prove risking early release of radionuclides into the geological environment; it was difficult to be certain that the repository access shafts could be hydraulically sealed risking rapid return of radionuclides to the surface of the earth through leakage pathways; and that the rock geology and groundwater flow hydrogeology underlying the Sellafield site was complex resulting in wide

uncertainties within safety and environmental risk assessment calculations of projected radiation doses to humans from leakage or early escape of radionuclides in the respository.

From an engineering perspective deep geological disposal repositories are regarded as technically feasible by IAEA and NEA but their practical implementability depends on site-specific factors such as the underlying geology and hydrogeology of the host disposal site under consideration."

Page 45

* We note that it may be possible to identify a generic system – but the key issues will be the uncertainty of how the geology, hydrogeology and the containment of the waste packages will interact.

Re: Option 8 – Deep geological boreholes

Internationally there is little practical experience of deep borehole disposal of radioactive waste, with only the Former Soviet Union disposing of HLW in deep injection boreholes at Krasnoyarsk-26 and Tomsk-7 in Siberia. The early development of the technology appears to be related to Russian underground nuclear weapon testing programmes in the 1950s. Boreholes were attractive for soviet nuclear weapons testing since this made analysis of Russian nuclear weapon capabilities much more difficult for Western countries.

The main attraction of deep borehole disposal is that it places the disposed wastes well beyond the reach of humans. Borehole technology may be particularly attractive for the disposal of strategic wastes such as plutonium and spent fuels since repository disposal options have the disadvantage that it may be possible to recover plutonium from underground repositories by drilling down from the surface ("plutonium mining") in the future.

Plutonium mining would be much more difficult for wastes disposed in deep boreholes and indeed this reflects one of the major problems of borehole technology; once the packaged wastes are emplaced in the borehole it would be extremely difficult if not impossible to recover them. The emplaced wastes are not monitorable or retrieveable.

A further difficulty is that drilling deep borehole shafts may significantly disturb the geology and hydrogeology of the disposal site whereas repository disposal allows some flexibility to excavate the repository tunnels in optimum locations while avoiding other areas where the local geology may not be suitable.

Emplacement of the wastes and sealing of the borehole would need to be completed relatively quickly to minimise any possible effects from disturbance of the geology from the borehole drilling process. Indeed borehole drilling on land is environmentally notorious for accidentally penetrating drinking water aquifers, causing contamination problems in abstracted drinking water.

Boreholes may also suffer from operability problems. For example wastes packages might became blocked in the borehole during emplacement especially if a deep seismic event occurred that might miss-align the borehole from which it would be very difficult to recover the waste resulting in early abandonment.

A considerable amount of work would probably be required to demonstrate

the practicality of deep borehole disposal since there is little experience of drilling boreholes to the proposed depths and little knowledge of the conditions that may be encountered so that new drilling and sealing techniques would probably be required."

Page 50

Re: Option 9 – Phased deep geological repository

"The technical and engineering challenges of phased deep geological disposal are very similar to deep disposal discussed in Section 4.2 above. The key difference is that a phased deep disposal repository would operate as a monitorable and retrievable store in the first instance, where the emplaced wastes would remain monitorable and retrievable for up to 300
years until society decided that the repository could be safely backfilled and permanently sealed.

Some variations in repository design would be needed to accommodate different types of waste, with high level wastes and spent fuel being emplaced in parallel disposal tunnels, while intermediate level wastes and uranium and plutonium would be emplaced in excavated caverns.

The requirements for monitorability and retriveability of the waste over several hundred years would mean that the facility would need to be carefully designed to take into account heating effects from high level waste and spent fuel, which continue to generate decay heat after emplacement, and criticality hazards from plutonium and enriched uranium. IAEA and NEA regard deep geological disposal as technically feasible although its practical implementation depends on identifying a host disposal site with suitable geology."

Page 51

"During the 300 year period of retrieveability a phased deep disposal repository would operate in a similar way to a long term interim store discussed earlier in Section 3 and would face similar challenges;

the need to assure ongoing institutional control and financing over many years; uncertainty over the lifetime of the waste packages particularly for stainless steels;

the need to minimise corrosion of the waste packages by carefully controlling the environmental atmosphere within the repository using a well designed underground ventilation system; and

the need to provide waste recovery, reworking and repackaging facilities for waste packages that might become degraded or damaged in the future during the period of retrievability."

Page 52

*Can CoRWM be confident that all these matters can be satisfactorily resolved?

3 Non-geological disposal options

"However although much experience has been gained operating near-surface repositories for radioactive waste relatively little experience has been gained closing them[65].

Most repositories remain under institutional control with some active management arrangements in place. The site operators have proved reluctant to close older repositories since unexpected problems have been experienced with the rapid leaching of radioactivity from disposed wastes and radionuclide releases due to the flooding of disposal trenches by rainwater or a rising water table (sometimes called the bathtubbing effect). As a consequence most NEA countries have plans to continue to apply institutional controls after the closure of near-surface disposal facilities for between 100 years to 300 years after the facility has been finally sealed."

Page 53

"Because the suitability of non-geological disposal options is limited mainly to short lived wastes, in practice non-geological disposal may not be especially useful in the UK because historically British waste has not been segregated into short and longer lived waste forms.

Research commissioned by Defra and Nirex in 2004 indicated that much of the current inventory of radioactive waste contains a mixture of short and long lived isotopes which would be difficult or expensive to segregate[66,67], although it may be possible to plan decommissioning operations to achieve better segregation of wastes in the future.

Earlier in June 2002 the Government's former Radioactive Waste Management Advisory Committee (RWMAC) had also advised Ministers that the way in which the majority of existing radioactive waste holdings in particular ILW have been accumulated over the years is likely to make retrospective separation by half-life a very difficult if not impossible task[68].

Nevertheless a national LLW disposal facility exists at Drigg in Cumbria although its Conditions for Acceptance (CFA) criteria place very restrictive limits on the amounts of longer lived radionuclides such as plutonium, radium and thorium that may be disposed at Drigg[69]."

Page 54

From Briefing Paper 3 This option uses what is called a 'multi-barrier containment system'. This means the packaging of the wastes (for some wastes), the materials used to fill in the chambers, and the surrounding rocks would all help prevent radioactivity leaking out. Even so, very small amounts of radioactivity could probably reach the surface over very long timescales. Estimates of how much radioactivity, and over what timescales, are uncertain because this depends on many factors, such as the geological conditions. Regulators would have to have sufficient confidence in the estimates to give approval for the disposal of wastes in such a facility.

WHAT OTHER COUNTRIES ARE CONSIDERING FOR NUCLEAR WASTE MANAGEMENT — APPENDIX 2

Our notes are shown in italics. Our emphasis in the text is highlighted in bold, and extracts from the papers shown between quotation marks.

1 Recent decision on waste management - Canada

In November 2005, after a study lasting three years, Canada opted for the approach of Adaptive Phased Management:

"Adaptive Phased Management is a technical **method** and a management system. The method is implemented in stages with the end goal of centralizing all of Canada's used nuclear fuel in one location, and isolating and containing it deep underground in a suitable rock formation. The management **system** is phased and adaptive, with explicit decision-points to incorporate new social learning and technological innovation as it is implemented. At each stage options, including a contingency for temporary shallow underground storage, can be evaluated and the plan modified before proceeding. A future society will decide whether and when there is sufficient confidence in the safety of the approach to seal and backfill the repository."

*Note: Canada have decided to allow 'new social learning and technological innovation' to be incorporated into the decisions and thus allow for evolving modifications – **most importantly – they have decided that at the moment there is insufficient confidence to proceed to the stage of sealing and backfilling repositories.***

We append the full press release – as this fully explains the concept of 'Adaptive Phased Management'. *See Appendix 2a.*

2 Extracts from Briefing Paper 3 – Stakeholder meetings, Jan – Feb 06

2.1 France & the Netherlands:

"Most countries currently store radioactive wastes until it can be placed in a disposal facility. The Netherlands has selected disposal as its long-term management option, but has decided to postpone going ahead with this for at least 100 years and has built a long-term interim store. France has also selected disposal, but is carrying out research into the long-term storage of High Level Waste and spent nuclear fuel in case it is not possible to be confident in the safety of disposal". Page 2

Note: Discussion and research still ongoing – not yet determined final position.

2.2 Concepts accepted but still not developed or implemented

"Considerable work has gone into the design and safety assessment of this option. Many national and international authorities have **accepted the concept, but it needs to be demonstrated on a case-by-case basis, taking into account types of radioactive waste, design variations and local site characteristics."**

"Some countries plan to 'co-dispose' of long-lived ILW, HLW and spent fuel in the same facility. The different types of waste would be placed in separate parts of the facility, which would be purpose-designed for that type of waste. **A deep geological disposal facility of this type has not yet been constructed and operated."**

Page 5

Note: Planning still ongoing – and no proof that concept will work.

3 Extracts from Enviros Descriptions of Short Listed Options – March 2005 - Doc 1166

3.1 France

"• Spent fuel; the CASCAD facility at Cadarache in France
This modular vault facility began operations in 1991 [Bonnet and Gallagher 1993]. It is designed to be operational for approx. 50 years. "

Page 9

Note: This facility is designed only to be operational for 50 years – it does not provide a long term solution

3.2 Germany, France & the Netherlands

"Above-ground, centralised, unprotected stores are currently in operation in other countries for a variety of radioactive wastes. Examples include those at the COVRA facility in the Netherlands; at Ahaus and Gorleben in Germany; CASCAD in France. Only the COVRA facility has been designed with an intended storage period up to 300 years. Even then, Dutch policy anticipates transfer of the wastes to a geological repository at some time in the future. Most of these designs are for small volumes of a few waste streams. They would need to be scaled-up to be applicable to the large volumes of the different wastes in the CoRWM inventory."

Page 11

Note: Only COVRA in Netherlands intends storage for up to 300 years – and most examples are for small quantities – not the size of UK inventory.

3.3 France & Canada

"In France, CEA are conducting studies into long-term storage of spent fuel in shallow subsurface facilities as part of research mandated by law in 1991. Several options are being examined [Moitrier et al 2000]. These include:

- High thermal density concrete bunker

A semi-underground storage solution incorporating massive fuel holders utilising either passive ventilation or a water-cooling system

- Natural convection air-cooled concrete bunker

This involves the use of existing storage facility designs but built in a shallow excavation (no ground cover above).

- Subsurface interim storage facility

A wholly underground **concept,** with wastes cooled by passive air circulation, similar to that suggested by Davood et al 2004 (above), but with horizontal access into the side of a hill. Crystalline rocks are suggested as most suitable due to their geotechnical stability.

In its 2004 annual review of this work, the French National Scientific Evaluation Commission (CNE) commented that in the case of a sub-surface storage facility, 'the rock protects the storage against aircraft crashes or intrusion', but pointed out that **'the possibility for a storage to last beyond a century without being renewed, is not guaranteed' [CNE 2004].**

Studies in Canada, where the Nuclear Waste Management Organisation is currently investigating management options for spent fuel, have proposed two alternatives to this option [CTech 2003];

- Casks and vaults in shallow trenches

Storage of self-shielded casks in concrete vaults. The vaults are modular concrete chambers with floors walls and a roof, linked at both ends and accessible from the surface by a sloped ramp. The vault is covered over with up to 3 metres of earth, intended to 'provide weather protection for the concrete chambers and added physical protection from sabotage and aircraft impact'. There is no structural concrete above the facility in this design.

- Casks in rock caverns

Storage of spent fuel in self-shielded casks, in caverns excavated in competent bedrock at a nominal depth of 50 metres, in order to provide 'a high degree of physical protection and stability'. Cooling is by forced air convection. Casks would be stacked on top of each other, and up to 948 casks would be stored in each of 11 separate caverns, linked by tunnels.

It should be noted that none of these overseas examples are designed to accommodate the very large volumes and number of waste streams in the CoRWM inventory."

Pages 26 & 27

Note: our emphasis - these are still very much in the study phase – not adopted

3.4 Key General Points in relation to Deep Geological Disposal

"No country is yet operating a deep repository for HLW or spent fuel, although some countries such as Finland and the US have identified candidate sites and facilities may be operational within 10-15 years provided all necessary permissions are obtained."

"Considerable work has gone into the design and safety assessment of deep geological repositories and many national and international authorities have accepted the fundamental safety of this concept, although it requires to be proven on a case by-case basis to account for national inventories and design variants, and local site characteristics." Page 29

Note: Even this has not been fully agreed – or implemented – either by the US or Finland.

"Designs for the waste packages vary from country to country and are, to some extent, dependent on waste type and the pre-disposal management system. For spent fuel and HLW, many countries plan to adopt carbon or stainless steel for the waste package but, in Finland

and Sweden, it is proposed to encapsulate spent fuel in cast iron containers surrounded by a thin copper shell, in the so-called KBS-3 concept. In the United States, it is proposed to use steel containers with a nickel-alloy (Alloy 22)shell. Other proposed materials for the waste package include titanium and ceramics." Page 30

Note: all these are planned or proposed packages – not implemented as yet

"Various designs for the emplacement of HLW and spent fuel packages have also been developed. In some designs for crystalline rocks (e.g. those in Switzerland, Spain and Japan), current plans are for waste packages to be emplaced axially along the disposal tunnels. In Finland and Sweden, waste packages are planned to be emplaced in short vertical boreholes drilled in to the floors of the horizontal disposal tunnels. This is referred to as KBS-3V and is also the basis for the concept currently favoured in the UK by NIREX [McCall and King 2005] (see Option 9). In the US, it is planned to load waste packages on specially designed railway carriages and to shunt them into the horizontal tunnels which may or may not be backfilled depending on the decision made for the final closure strategy for the repository. In current designs for salt and soft clay in Germany, Belgium and the Netherlands, horizontal emplacement in roadways or 'blind tunnels' has been proposed, taking benefit from the tendency of excavations in these rocks to close over time due to compaction and creep."

Page 30

Note: again these are still only planned or proposed or still in the design stage

"**There is currently no operational repository for HLW or spent fuel anywhere in the world**, although programmes to implement this option are actively being pursued in several countries such as Finland, Sweden, Japan and the US. In some cases it is planned to co-dispose long-lived ILW in these facilities. Decisions have not yet been made in many instances as to whether 'early seal' or delayed or phased closure of the repository would be implemented."

Page 32

Note: While countries are actively pursuing this option it is still very much in the research, rock characterisation and assessment stages as is demonstrated in the following paragraphs:

"Most international deep geological repository development programmes are each developing slightly different designs that are appropriate for national waste inventories and geological environments. Currently, detailed work is underway to assess the viability of different host rocks: salt by Germany and the Netherlands; clay by Belgium and Switzerland; crystalline rocks by Canada, Sweden, Finland and Switzerland; and volcanic tuff by the United States.

Underground research laboratories (URLs) have been operated for some years in each of these rock types and considerable knowledge of the behaviour of excavations and of various waste packages in repository conditions has been obtained. Demonstration of the technology required to excavate a repository and to emplace the waste has also been carried out, and there is considerable confidence in the available techniques. Most of this research has focussed on HLW and spent fuel.

In some cases, URLs are operated or are planned to be operated at potential repository sites with the intention of confirming the suitability of the geological environment (such as at Olkiluoto in Finland). In other cases, URLs are operating at generic sites that are not under consideration for hosting a repository (such as Mizunami in Japan). Others are examining potential sites where a repository may be developed if conditions allow (such as Bure in France).”

Page 33

Note: Even where sites are more developed none are likely to be operational until further permissions are authorised

“According to current plans and programmes, it is likely that the first deep geological repository for spent fuel could be operational in Finland in 2020 subject to receiving the appropriate permissions [Posiva 1998]. The scheduled dates that other deep geological repositories for HLW or spent fuel could be operational are: Sweden 2018, Japan 2035 and the US 2015”.

“examination of a single site for a spent fuel repository at Yucca Mountain in Nevada was mandated by a 1987 Law, but it is yet not clear as to its suitability despite many years of investigation and the expenditure of billions of dollars.”

Page 33

Note: Assessments that are still needed even if research has demonstrated feasibility of construction and emplacement.

“Considerable work has been carried out under the auspices of the EU Framework Programmes, with a number of underground demonstration facilities developed in this context in representative rock types and as part of IAEA-sponsored initiatives. For example facilities exist in clay in Belgium, salt in Germany and in crystalline rocks in Canada, Sweden and Switzerland. Research has demonstrated the feasibility of repository construction and waste package emplacement, but site-specific investigations are required to confirm the suitability of proposed repository locations due to the inherent variability of geological and hydrogeological conditions. Most of this research has focussed on HLW and spent fuel.

For submission of a safety case to accompany a licence application for a deep repository, it will be necessary to demonstrate adequate knowledge of:

Waste form behaviour: how long it will remain stable in repository conditions; how it will interact with the waste canister and backfill material, the surrounding geology and any infiltrating groundwater.

Canister behaviour: how long it will remain intact; how it will corrode; how it will interact with the backfill material, the surrounding geology and any infiltrating groundwater;

Backfill material: how it will interact with the canister, surrounding geology and any infiltrating groundwater. How it will control the migration of material leached from the waste form and out of the repository.

The surrounding geology: how it will influence the stability of the repository; how it will control the flow of groundwater both into the repository and out, in terms of sorption and retardation of radionuclides.

Migrating groundwater: how it will infiltrate the repository; how its chemistry will affect the dissolution of the backfill material, the canister and ultimately the waste form. How it will return to the surface environment and how its chemistry will control the ability to transport various radionuclides.

Geological evolution of the site: how the geological conditions will change over the time that the waste remains hazardous; how these changes will affect the performance of the various barrier components.

Engineering capabilities: how proposed repository activities can be carried out using available technology and what needs to be specially developed.

Safety issues: what are the risks to workers and the public from all related repository activities, including transport and routine operation.

Where co-disposal of ILW is planned together with HLW and spent fuel, the impact of large amounts of cementitious material from the grouted waste canisters and cavern backfill must be assessed on the evolution of the repository environment. Vitrified HLW and spent fuel are susceptible to corrosion in such hyper-alkaline conditions and must be physically separated from the ILW disposal areas."

Page 35

Note: The uncertainties listed here apply equally to other countries as well as the UK..

We have also found many further examples in Doc 1166 which detail the limit to which other countries have so far progressed and would be happy to submit these references if required.

4 Sweden & Switzerland

In preparing our report we have also had regard to the two papers prepared by Large Associates relating to the SBK proposals for the KBS 3 system in Sweden and the Swiss repository at Benken.

Both papers and presentation raise many concerns as to the uncertainties, shortfalls and omissions in the schemes and the critical features of the repository designs.

We are appending papers on the SBK scheme and the Bergen scheme to this submission. Further information can be obtained from the linked website.

APPENDIX 2a

News Releases

November 3, 2005 Home News News Releases NWMO Recommends Adaptive Phased Management

NWMO Recommends Adaptive Phased Management

OTTAWA - Canadians expect to accept responsibility now for the long-term management of used fuel produced by the country's nuclear electricity generators. They want a system for future management put in place that is safe, secure and fair. Used fuel is currently safely stored on an interim basis in licensed facilities at the reactor sites where it is produced.

After a comprehensive three year study that engaged specialists, stakeholders and citizens from all walks of life, the Nuclear Waste Management Organization has recommended Adaptive Phased Management for the long-term care of used nuclear fuel. The NWMO today presented its report and recommendation to John McCallum, Minister of Natural Resources Canada. The Government must now decide on an appropriate approach.

"Our recommendation is firmly rooted in values that Canadians hold dear," said NWMO President Elizabeth Dowdeswell. "It commits this generation to take first steps now to manage used nuclear fuel we have created. And it is flexible, allowing for the ongoing involvement of citizens in decision-making about how it is implemented," she added.

Adaptive Phased Management is a technical **method** and a management system. The method is implemented in stages with the end goal of centralizing all of Canada's used nuclear fuel in one location, and isolating and containing it deep underground in a suitable rock formation. The management **system** is phased and adaptive, with explicit decision-points to incorporate new social learning and technological innovation as it is implemented. At each stage options, including a contingency for temporary shallow underground storage, can be evaluated and the plan modified before proceeding. A future society will decide whether and when there is sufficient confidence in the safety of the approach to seal and backfill the repository.

The NWMO was required by the *Nuclear Fuel Waste Act* to consider three technical methods: deep geological disposal in the Canadian Shield; centralized storage either above or below ground; and storage at nuclear reactor sites. In assessing the three, each was found to have distinct advantages but none perfectly met all of the objectives citizens said were important. This led the NWMO to develop a fourth approach. Adaptive Phased Management builds on the strengths of the others.

Adaptive Phased Management:

- Commits this generation to take the first steps now to manage the used nuclear fuel we have created.
- Recognizes that over the long term it would be imprudent to rely on a human management system alone with its changing forms of institutions and governance.
- Will meet rigorous safety and security standards through its design and process.
- Allows sequential decision-making, providing flexibility to adapt to experience and social change.
- Provides genuine choice by taking a financially-conservative approach, and providing for capacity to be transferred from one generation to the next.
- Promotes continuous learning, allowing for improvements in operations and design that would enhance performance and reduce uncertainties.
- Builds confidence in the technology and supporting systems before the final phase is implemented.
- Provides a viable, safe and secure long-term storage capability, with the potential for retrievability of used fuel which can be exercised until future generations have confidence to close the facility.
- Provides for continuous monitoring and contingency against unforeseen events, either natural or man-made.

- Is rooted in values and ethics, and engages citizens allowing for societal judgements as to whether there is sufficient certainty to proceed with each step.

More than 18,000 people, including 500 specialists, contributed to the NWMO study. 2500 people took part in NWMO-supported dialogues designed and delivered by national, regional and local Aboriginal organizations. When the Government of Canada decides on a management approach the NWMO will become the implementing agency. “We intend to seek an informed, willing community to host the central facilities,” said Ms. Dowdeswell. “The siting process must be open, inclusive and fair, giving everyone with an interest an opportunity to have their views heard and taken into account.”

The NWMO will focus its siting efforts in Ontario, Quebec, New Brunswick and Saskatchewan – provinces which are directly involved in the nuclear fuel cycle. If communities in other regions express an interest they will be considered.

APPENDIX 3

FROM: http://www.largeassociates.com/3016/R3016-A4.pdf

REVIEW OF THE
SVENSK KÄRNBRÄNSLEHANTERING AB†
PROPOSAL TO DISPOSE OF IRRADIATED FUEL TO A DEEP REPOSITORY
KBS-3
CORROSION, DISSOLUTION AND SOLUBILITY OF DISPOSED IRRADIATED LWR FUEL

CLIENT: GREENPEACE SWEDEN

REPORT REF No R3016-A1

18 January 1998

†SKB - Swedish Nuclear Fuel and Waste Management Company

First Issued 14 October, 1997

Large & Associates, London

R30

This Appendix is attached separately as it is a PDF file – as it cannot easily be incorporated into this word document.

APPENDIX 4

FROM: http://www.largeassociates.com/waste_not_want_not.pdf

The full Power Point presentation can be found at:
http://www.largeassociates.com/SWISSradwaste.ppt

WASTENOT,WANTNOT

A CRITICAL REVIEW OF SWITZERLAND'S PROPOSED DEEP REPOSITORY AT BENKEN

ILLUSTRATED PRESENTATION

MITTWOCH, 25.MAI 2005, 20:00 UHR IM GASTHAUS SONNE, B E N K E N (ZH)

Since the onset of nuclear power, the worldwide nuclear industry neglected the growing stockpiles of nuclear waste. Indeed, some of its practises, such as spent fuel reprocessing, not only despoiled the environment by liquid and atmospheric discharges but resulted in a marked increase in the accumulated volumes of radioactive waste. Now, as the first and second generations of nuclear power plants are closing down and are being prepared for decommissioning, another process that gives rise to staggeringly large volumes of radioactive wastes, the nuclear industry is having to face up to and address the realities of its past activities.

Switzerland also shares this radioactive waste dilemma: By the time that its present generation of nuclear power plants close, it will have accumulated about 130,000 cubic meters of radioactive waste, including 3,500 tonnes of intensely radioactive spent fuel and 300 or more tonnes of vitrified high level waste imported back from its fuel reprocessing contracts in the United Kingdom and France. Switzerland is presently introducing mixed oxide (MOX) plutonium-bearing fuel to its ageing nuclear reactors with this spent fuel requiring quite arduous institutional and post-institutional management for thousands, hundreds of thousands and millions of years.

John Large, the international Consulting Nuclear Engineer, examines the NAGRA (National Cooperative for the Disposal of Radioactive Waste) proposals for interim storage and then irretrievable disposal of Switzerland's burgeoning stockpile of radioactive wastes in a repository under Benken, from which he identifies a number of uncertainties, shortfalls and omissions in the deep repository scheme.

He finds there to be doubt and/or uncertainty about critical features of the repository design, including the design life of the canisters that provide the first containment barrier for the spent fuel and high-level wastes; that aspects of the canister post-failure performance have not been included in the repository modelling; and that instead of multiple geological barriers being available to slow down and contain the spread of radioactivity over the million or so years required, the geology of the Benken area is likely to provide only a single barrier of limited depth. For the overall disposal scheme, the safety case for the on-surface interim storage facility has yet to be developed (and/or published); for the transport of the radioactive wastes from the generating sources to the repository site, a transportation safety case and radiation exposure assessment as not been completed for those communities alongside the routes; and there has been no open and accountable discussion to determine the vulnerability to terrorist attack and other forms of malicious act of the elements of the disposal scheme (transport, interim store and repository). In terms of the sustainability of the repository development, John Large finds that there has been no assessment of the collective radiation dose arising from the long-term (10,000+ years) published; by virtue of the intended placement procedures, once deposited it will be virtually impossible to recover any high level waste that might require re-packaging; and there is no benefit, only detriment and uncertainty to be faced by future generations occupying the areas nearby and in the larger region of the Benken repository.

Finally, John Large concludes by posing the question of trust of NAGRA and its values of the environment. He does so in the context that up until 1982, Switzerland and NAGRA's antecedent organisations were responsible for dumping large volumes and (radio)activities of waste into the North Atlantic, accounting for almost 10% of all of the radioactive wastes dumped by the western nuclear states, being second in its disregard to the marine environment only to the United Kingdom.

Further information from John Large 44 (0) 20 8317 2860 44 (0)7971 088086 – further information and presentation slides can be downloaded from http://www.largeassociates.com/SWISSradwaste.ppt

MAIN REFERENCES

1 Several Documents from the CoRWM document vault, including:

1.1 1st Consultation Document – Nov 2004 – Doc 831

1.2 2nd Consultation Document – April 2005 – Doc 947

1.3 Summary Descriptions of CoRWM Short Listed Options – Enviros March 2005 - Doc1166

1.4 Discussion Paper on the Implementability of Radioactive Waste Options 2nd Issue - July 2005 – Doc 1167

1.5 Final Inventory of Radioactive Waste Materials – July 2005 – Doc 1279

1.6 Thumbnail Descriptions of the Short Listed Options – Enviros - Nov 2005 Doc number not known

1.7 Specialist Workshops Scoring Report: COR004 – Jan 2006 – Doc 1502

1.8 Briefing Papers for Stakeholder meetings – Jan 2006 – Docs 1493 – 1499

1.9 CoRWM Information Needs: Ref 16 Option Summary – Issue 2 – Nov 2005 Doc number not known

1.10 CoRWM e bulletins – Dec 05 & Jan 06

2 Environment Agency – Peer Review of CoRWM specialist work packages; Dec 2005

3 The Royal Society report: Policy Document 01/06: The long term management of radioactive waste: the work of CoRWM. Jan 06.

4 The Geological Society of London: Papers and proceedings of January 2006 meeting;
see www. geolsoc.org.uk/template.cfm?name=Radwaste456546

5 Institut de Radioprotection et de Surete Nucliare (IRSN) report DRPH/2005-20: Health consequences of chronic internal contamination by radionuclides. Comments on the ECRR report "The health effects of ionising radiation exposure at low doses for radiation protection purposes" and IRSN recommendations. Published 9 Dec 05.

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