

1.	Author	• CoRWM Secretariat and IoP
2.	Date	• 16 January 2009
3.	Subject	• IoP Meeting note 26/11/08
4.	Status	• Final
5.	Recipients	• All Members, other participants in meeting
6.	When commissioned by CoRWM	• standard practice
7.	Confidential	• no
8.	Document no.	• 2519

## **Note of Institute of Physics (IoP)/CoRWM Interim Storage Meeting, 26<sup>th</sup> November 2008, held at IoP London**

### **Summary**

After introductory presentations from two CoRWM members there were two discussion sessions: one on current and one on future storage facilities and waste packages<sup>1</sup>. The key points from both sessions are as follows.

- It is important to consider storage systems as a whole, ie the waste form, its container, the building structure, the storage environment, and the monitoring and inspection regime.
- The appropriate design life for new storage systems is at most 100-150 years. Such design lives can be achieved in various ways, for example using massive packages in simple buildings or using less robust packages in large concrete buildings. Simple buildings have the advantage that they are easier to decommission. Clarity on the storage period is needed to help define research programmes.
- Designing storage systems to last a few hundred years would be a major challenge and is unnecessary at present. This may change in future, in particular in Scotland.
- The current NDA waste package specifications give a target container life of 500 years. This is based largely on an assumption that it is necessary to design a geological disposal facility so that it can be kept open for up to 300 years, with waste packages easily retrievable. It would be expensive to achieve a 500 year container life and difficult to prove that a container could last that long. It is important to examine the whole issue of retrievability and its implications for waste form and container performance requirements. It may not be desirable from a technical point of view to delay a decision on retrievability until late in the process of siting a geological disposal facility.
- There is need for independent oversight and a national strategy for storage R&D.
- There is a need to “close the R&D loop” by ensuring that the results of research are fed back to waste producers and are taken into account in waste conditioning, packaging and storage plans and operations.
- There are concerns in the storage R&D community about the potential adverse impact of changes to the storage R&D infrastructure e.g. changes in ownership of SLCs and the NNL. Some key central and shared facilities are needed and these must be managed
- Innovation is important in order to improve waste conditioning, packaging and storage in future. It might be possible for the UK to adopt waste conditioning

---

<sup>1</sup> Throughout this note the term “waste package” is used to mean the wasteform and its container.

options developed and used in other countries. Also, in some technical areas there is much that could be learnt from the non-nuclear sector.

- There are both skills and resources issues to be resolved in ensuring that nuclear site licensees carry out sufficient R&D to enable them to manage their wastes safely.

### **Participants**

This meeting was attended by representatives of: the Environment Agency, HSE, AWE, IOM3, NNL, Magnox South, UKAEA, AMEC, SEPA, Loughborough University, BE, IChemE, UKERC, the Scottish Government, NuSAC, NDA, BGS, Sellafield Sites, Dounreay Site Restoration Ltd, University of Sheffield, Magnox North. Bill Lee and Marion Hill attended on behalf of CoRWM, for whose purposes this meeting was arranged.

### **Introductory presentations**

Bill Lee introduced the meeting and gave a presentation on Current Status and Future Needs for UK's Radioactive Waste Storage and R&D Programme (see pdf file). This highlighted the status of CoRWM forthcoming Interim Storage R&D Report and posed the following questions:

1. Is the UK's process for supporting storage R&D suitable?
2. What is the current status of the interim storage R&D and does it address risk and uncertainties associated with stored wastes and stores?
3. What do you forecast will be the requirements for the future?
4. What research will be necessary to meet these requirements?
5. How do you get innovation into storage R&D?
6. What are other countries doing?

Marion Hill gave a presentation on the current status of the March 2009 CoRWM Interim Storage Report (see pdf file). The scope of the CoRWM Interim Storage Report includes conditioning, packaging, interim storage and transport of higher activity wastes, management of spent fuels, management of Pu and U. R&D is an important aspect of all of these areas. It will report on legacy and committed waste, the report will not deal with new build wastes or spent fuels; CoRWM plans to start looking into new build waste and fuel storage in 2009. The Storage Report introduction will include a definition of storage – with the intention to retrieve waste (as opposed to disposal – without the intention of retrieval), and will take an integrated approach to storage and management. It will seek to assess the timescales on which decisions are necessary in order to maximise the options available. As was discussed at length at the NDA storage workshop on 28 October, the NDA's National Storage Review and the CoRWM Interim Storage report are two separate but related pieces of work. To avoid duplication the NDA's review will focus on the current storage situation and the optimisation of storage, while CoRWM will focus on the future. An outline Storage Report will be discussed at the 18<sup>th</sup> December CoRWM Plenary meeting before being posted on the CoRWM website for public and stakeholder comments.

## **Discussion 1: the UK's need for interim storage and the operation and long-term safety of current storage facilities and waste packages, chaired by Bill Lee**

Neil Smart from RWMD NDA introduced the current storage situation. The Nuclear Decommissioning Authority (NDA) is a strategic authority and provides oversight and contracting arrangements with 7 contracting companies over 20 sites. The Site Licence Companies (SLCs) are responsible for decisions on interim storage requirements and they have their own programmes of work that fit into the regulatory framework. The R&D programmes are SLC driven and articulated by Technical Baseline and underpinning R&D documents (TBuRDs) derived from the SLC Lifetime Plans (LTPs) which indicate what needs doing and why. Storage design and operating conditions are largely a result of engineering good practice, rather than specific R&D.

The NDA role is governance and contract management, helping to avoid duplication of similar work over all 7 SLCs. The NDA has created a network of subgroups across the UK ensuring that at the right operational levels people are linking to one another. Interfacing on a technical level is difficult for the SLCs. The NDA Research Board provides high-level oversight, including members from government departments, regulators, research councils (RCs) and two independent members including one from the HSE's Nuclear Safety Advisory Committee (NuSAC). At the operational level the Nuclear Waste Research Forum (NWRF) was set up<sup>2</sup>, to share information and create networks between SLCs, and is perceived to be working effectively. A number of NWRF sub groups have been established to look at topics such as high temperature processes, waste processes, contaminated land and interim storage. NDA co-ordinates the SLC programmes, understanding the strengths and weaknesses at different sites, and sharing this expertise. As a consequence the NDA has a unique view of the situation.

The UK has some very important decisions to make. A Geological Disposal Facility (GDF) is expected in 2040 for ILW and 2075 for HLW. One concern is whether waste packages should really be designed to last for 500 years. The 500 year package life was driven by stakeholder input to Nirex on geological disposal. In response to stakeholders, Nirex developed a package life specification based on 150 years on surface storage, 50 years operations and an extended period of retrievability of up to 300 years in a GDF, adding up to the timescale of 500 years. It would be expensive to achieve such a long container life and difficult to prove that any container would last that long.

Similar problems arise in designing stores for the eventuality of no geological disposal. Designing stores for 500 years would be a major challenge. Designing stores for 150 is possible but any longer would be problematic. The industry needs to accept that the store will need to be rebuilt after 100 - 150 years and packages thus moved. Monitoring and review is required. This is more a pragmatic approach than trying to design something for 500 years. This picture is complicated by the situation in Scotland, where no endpoint to storage has been endorsed by the Scottish Government. There was general concern that it was difficult to design storage R&D programmes without the storage period being specified.

---

<sup>2</sup> see page 23:

<http://www.nda.gov.uk/documents/loader.cfm?url=/commonspot/security/getfile.cfm&pageid=20962>

Regulators perceive a lack of transparency as to where research requirements are coming from and the principles they are trying to support. For example, when do we need to decide about retrievability? It impacts on the R&D programme and needs of the wasteforms and containers. Further basic research on retrievability issues is required to understand the consequences of delaying a decision (from Government, community partnerships) on whether to retain the ability to retrieve wastes, and if so for how long. Clarity and focus on research framing is required in order to optimise the work that is carried out.

The Managing Radioactive Waste Safely (MRWS) volunteer process has the potential to make the target of a 500 year package redundant. An early decision on whether retrievability should be taken into consideration in design of packages is needed. Ideally, R&D should be planned so as to maximise the [packaging] options available and mitigate risks. Leaving a GDF open for a long period is not going to satisfy worries about long-term leaking after it is closed as the conditions in the two periods will be very different.

Although TBUrDs are good documents they cannot be shown to be comprehensive as the range of research required is so large. Targeted R&D would be better in understanding where big technical challenges lie. Most SLCs do not have the resources available to do major R&D, and are reliant on the NWRf subgroups to pass the relevant research information on to them. There is also room for collaboration between smaller and larger SLCs in order to share R&D resources for ILW, but current priorities for them lie elsewhere.

There was not a consensus that the current research governance processes are able to address these challenges. It is not clear that innovation is getting into the R&D programmes. Too much R&D is currently driven in a 'bottom-up' fashion, rather than to strategically meet the UK's needs.

The NDA Direct Research Portfolio (DRP) is starting to identify these areas, as are the TBUrDs. The position of the Scottish Government is different: their policy on near-site long-term storage will not be clearly developed for another couple of years– a significant issue. The store at Hunterston has set a high standard in terms of environmental conditions inside it and the ability to monitor waste packages.

The most significant challenge for the UK is over decision making prior to R&D. Many good guidelines are already available, but compliance and inspection procedures are not sufficiently rigorous to ensure these are consistently adhered to. Further resourcing is required to ensure a high quality compliance regime. At the current time it is known that 'out of spec' packages are being produced, but the problem is of unknown scale and needs urgent monitoring. Tube stores and remote handling stores are difficult to monitor.

In essence the industry is trying to establish R&D programmes when the needs are not clear e.g. what is the functional environment? Identification of the functional requirements is needed in order to effectively identify the R&D required.

The NDA understand research needs. They have a whole range of standards, regulations and processes for SLCs to conform to but there are a lot of variables in the end game. From a

regulators point of view this is not the issue – it is that research needs are not transparent. They are not saying NDA do not know what the research needs are. A fit-for-purpose approach is important: ‘the best can be the enemy of the good.’ We need to know what R&D is required to get the job done in a good enough way. We need to live in a practical world.

Bill Lee asked the group if it is easy for others to get involved in the research, such as universities and others from outside the field for example in monitoring technologies? It was agreed some skills for remote monitoring will need to come from outside the nuclear industry.

Bill asked if there was a system in place that was making people outside the industry aware that these things are needed. The response was that in principle yes but in practice it is not working well. It is not clear which organisation could lead a coordinated approach. If you haven’t got enough money to do what you need to do, how do you do extra?

The DRP aims to enable the NDA to perform generic research and is a perceived mechanism for driving innovation into the programme. It comprises 4 Lots for which a competition was put in place covering University Links, Waste Processing, Materials Characterisation and Nuclear Materials. DRP Lot 1 should enable universities to engage with the supply chain. The NDA are trying to target high priority R&D areas in Alternative Processing, Alternative Encapsulants, Package Reworking, Storage Design, Monitoring and Inspection and Package Longevity. DRP work has been prioritised by looking at the TBuRDs and if the work required is on more than one TBuRD then it will move up the priority list. The university DRP was a rollover from the BNFL contracts. The National Nuclear Lab (NNL) was established on a competitive model so work needs to be competed. University work was separated out so that NNL and Serco could have an oversight role.

Mechanisms have been established before and applied elsewhere to introduce innovation and expertise from outside the nuclear industry. Networks can work but only if you have active management. There is a lot of reward to be had from bringing expertise from outside the nuclear industry but good resourcing would be required.

Work on corrosion and other areas such as Non Destructive Examination (NDE) is important in non-nuclear industries. RCNDE – a university /network forum for non destructive examination issues covers various industries. Bill asked if a similar body/forum is needed for corrosion since it could be useful for a range of industries such as marine, petrochemical as well as the obvious needs associated with stored and disposed nuclear wastes? There is a corrosion centre at Manchester but it is not a network. There was general approval of this concept. The Technology Strategy Board’s Knowledge Transfer Networks could be one approach.

DIAMOND (Decommissioning, Immobilisation and Management of Nuclear waste for Disposal, an EPSRC funded consortium of universities led by Leeds) is researching across these disciplines. It was driven by the EPSRC Letter of Arrangement (LoA) group. A concern is that the LoA group could be perceived by the public as industry telling Research Councils UK (RCUK) where to spend its money. Universities need to be seen to be independent for public confidence. Future nuclear economy is seen by Research Councils as a grand

challenge<sup>3</sup>. However, the counter argument is that the EPSRC LoA group presents the problem but not the solution. There is no constraint on the universities on how they react to these problems. There needs to be a process of bidding whereby universities can get their ideas across.

There is a need to understand there is a complete lack of transparency as the above fora do not meet in public or publish their minutes, they are difficult to access. Also there are other waste producers apart from the NDA so we need a UK programme not an NDA programme. An international perspective, obtained by examining programmes in countries such as Japan and Italy that have similar reactors, may be helpful in determining a way forward. Unfortunately CoRWM has finite time and resources for the report and will not be able to include all international experience in their forthcoming reports. The EPSRC Nuclear Engineering Doctorate programme (led by the Dalton Nuclear Institute at Manchester with Imperial College) can be used to support industrial research in a university environment and fund it.

In terms of International experience the European Framework Programme could be considered for funding - the NDA participate in a number of EU Framework projects, including Carbowaste. It was stated that the UK has a good record in securing nuclear industry funding through Europe: only France received more in the latest Framework Programme VII. It may be worth looking into disposal of steels and resins internationally.

A fundamental question is when will the R&D programmes deliver and will the timing be appropriate?

If the drivers for the research came from the Safety Cases to get the waste in a stable form but did not worry what it looks like in a few hundred years time, this would drive the research to focus on the packaging for the time before delivery to the GDF rather than performance in the GDF. Regulatory guidance and the Letter of Compliance (LoC) process make it clear that post-disposal performance must be considered when making safety cases for waste conditioning and packaging.

The key role of the LoC process is to look at the wasteform performance and its evolution over time. The LoC covers all aspects of the wasteform performance both in store and GDF. You can design packages that are adaptable throughout their lifetimes. You cannot wait 20-30 years for a decision on retrievability to come out. It is essential to start prioritizing and categorizing waste. Separating low and high risk packages in different stores is desirable in principle but can be difficult to achieve in practice.

The German Ministry for the Environment issued new waste package standards for a repository in June 2008. The package needs to survive for 500 years and keep the waste contained for 1000 years. This may be a deliberately unachievable target for new build wastes, so that no facility can be identified to allow this to happen. German regulators are very prescriptive.

---

<sup>3</sup> <http://www.epsrc.ac.uk/ResearchFunding/Programmes/Energy/default.htm>

Bill Lee highlighted that an issue for CoRWM was to scrutinize not only the NDA process for supporting R&D but also that the work is done and the results fed back into the SLCs and other users processes and procedures successfully. Is there an NDA process to close this loop?

## **Discussion 2 - The construction, operation and long-term safety of planned future storage facilities and waste packages, chaired by Peter Manning**

### **Storage**

Peter Manning commissioned many of the stores that are in use today at Sellafield. EPS1, the first Encapsulated Product Store, has waste in a void of its own and is an expensive, top quality solution. This keeps the waste and store structure separate so repair and refurbishment is straightforward. EPS2 has everything in the same space and is much cheaper per package but its Achilles heel is the crane rails which cannot be replaced. The limiting factor of any store is metals in cement (reinforced concrete) which eventually break down. As a result it is not technically possible to design a reinforced concrete store for more than 150 years, it is more pragmatic to plan for a re-build after 100 years. Even a bridge in Japan reinforced with stainless steel only has a 135 year design life. Only unreinforced domes can be designed with confidence to last for longer periods and they have to be buried.

British Energy are adopting a different approach at Sizewell B. Their view is that their spent fuel store will have self-shielded packages within a simple, inexpensive building that is expected to be rebuilt. A similar approach will probably be followed for their ion exchange resins, with self-shielded packages in an existing building. In these cases the building essentially only provides shelter from the weather, the emphasis is on the package for dose control, waste form protection and integrity and not the building. This concept means that there is no large building to decommission and demolish at the end of the storage period, and hence less waste overall.

Dounreay are planning a better quality store. Magnox North are leading on the update of the 2004 Nirex guidance on the care and maintenance of ILW packages. This work is being carried out through the NWRF; UKAEA are the contractor and Sellafield, all the Magnox sites, DSRL and RSRL are all providing input. Is there a need for national uniformity in store design?

Marion Hill said CoRWM need to set out what is meant by robust interim storage and the statement of at least 100 years, with the focus on storage arrangements as a whole, not just the building. This would be made much clearer in the new recommendations.

Peter Manning said none of the stores he was involved with allowed for inspection except at a minimal level. Is there a need for a uniform national monitoring and inspection regime? Will the new NDA guidance cover inspections? The NDA replied care and maintenance of stores is identified as an important area. But allowing human access makes it harder to control the conditions in the store. As a principle, conditions within the store must be kept as benign as possible.

The regulators are drafting joint technical guidance on storage, focusing on principles and objectives. A similar document will be written on conditioning. These will be consulted on widely in 2009.

We have to remember that geological disposal covers other materials as well with greater concerns, not just ILW.

Bill Lee asked if there is a programme in place to put Spent Fuel (SF) in stores?

The Sellafield route for fuel at the moment is reprocessing but assets need some investment and it might not be possible to reprocess all the fuel, therefore dry storage of some SF may be necessary. Sellafield is leading in best practice on containerising raw SF. NDA are developing strategies for the SFs at their sites. There are some urgent operational needs to deal with SF at British Energy. They have started a project to look at long term dry (cask based) storage of PWR fuel at Sizewell B. This project needs to be in place by 2015. There are promises of coordinated national approaches on various topics but pressing needs mean that BE cannot always wait for the NDA programme to evolve.

There is no doubt we are going to have spent fuel that is not destined for reprocessing, the question is how much? It is currently nearly all wet stored but Sellafield is looking at drying wet fuel.

To summarise there is a pragmatic need for a 100 year storage arrangements but we must be flexible on how this is achieved (ie it does not necessarily mean that the building, or all the equipment in it has to last for 100 years). Wastes have different characteristics and therefore different stores may be needed. No matter how long the process of storage and its variants there will always be urgent operational needs at nuclear sites that cannot wait to be implemented.

### **Wasteforms and containers**

Peter Manning said there had been increasing difficulties in this area. There has been no new waste treatment facility at Sellafield since the solvent facility was opened in 1994. Why is the SLC not able to write a cheque today to a contractor to go and construct a suitable process for Sellafield wastes?

Sellafield legacy ponds and silo waste issues are mainly concerned with sludges containing lumps of other materials including Magnox and U. The difficulty is emptying them safely. They are constrained to using a mechanical retrieval system. Magnox sludge beds release hydrogen which can cause localised disruptions. The current position is to grout material now on the basis that a notional inventory can be assigned to each waste package although an exact assay is not possible. Some estimation though will have to be made for example based on the weight of the wasteform. Double skinned non grout annulus containers will be used to allow the waste to expand. After a suitable period of time the annulus will be grouted. These are the UK's highest hazard legacy facilities, which have to be dealt with as soon as possible. Sludge always has lumps so it cannot all be pumped out.

Dounreay has moved away from a single conditioning solution for all ILW. They now have a

facility for shaft and silos and a different process for other wastes including liquid ILW and drummed ILW.

Bill Lee asked about high temperature treatment and the UK's aversion to it (other than in vitrifying HLW). It is used extensively e.g. in Europe and it has the ability to achieve large waste volume reduction. There is a question on the resulting wasteforms' compatibility with cemented products and cementitious backfill - but it should have a future as part of the ILW mix.

British Energy considered high temperature processing in its Best Practicable Environmental Option (BPEO) for Sizewell B ion exchange resins. It scored very highly but capability in the UK is not very good to fit in with operational need and time to do it. It would be suitable for future waste tranches. There is no proven example of it in the UK. The German company RWE hope for central facilities for incineration in the UK for new build wastes; they do not expect to have to build one. NDA are looking at a national central facility i.e. a processing plant and the possible movement of the waste to the site but there are stakeholder issues.

The above has been identified as a research area today but who will fund the research? This is an example of problems being faced today by the industry; people think money for R&D is optional and not readily available. SLCs are struggling to run plants already so to divert money to research would be done by begging and borrowing.

Bill Lee asked if there was lack of funding in research at the national level?

Yes - this is a strategic issue that comes back from all the SLCs. SLCs need more funding for R&D especially in strategic areas such as high temperature treatment.

The UK has large amounts of U, eg  $UF_6$  (Hex tails) and depleted U. Some may be processed to recover U235 but what is going to happen to the remaining waste (which has a very similar volume to the original material)? The NDA has commissioned a study to consider how much is worth processing to recover U235. They have recently received a request from an operator for an LoC for de-converted Hex tails. Marion Hill said the NDA has much of the required work in hand by developing its uranic strategy. A lot of the decisions are likely to be driven by the cost of uranium.

It should not be assumed that uranium etc will need to be placed in the same GDF as ILW. Marion Hill said CoRWM does not assume one disposal facility, all options need to be considered.

## **Final Comments**

Simon Wisbey from NDA added a personal comment – he is disappointed at how little innovation there is. Everybody seems to propose the same because it has worked in the past. For example freezing canisters can reduce the corrosion rate, surface contamination could be reduced by washing and drying, cuboid stores with stagnant corners are still being proposed. We should learn from the military how computers and aeroplanes can be brought

back into service after many years of storage.

In the current climate money is tight, money could be released by developing savings in the longer term. Solutions can be developed that provide value for money. The industry is changing and the people in industry are retiring – there needs to be a high level clever and innovative co-ordinated approach to R&D.

Bill asked if the impact of changes in industry including the formation of the National Nuclear Laboratory will impact R&D? Will overseas owners of UK nuclear companies be less likely to fund R&D?

The fundamental driver of NDA competitions is to bring in novel and innovative approaches to the sites and improve the overall operations. If overseas operators bring a better way of working into the equation then it will only make the situation better.

An important point to note is that SLCs will not make a profit or get funding if they do not deliver a cost effective solution. Innovation takes a long time. Old tried solutions have their safety case and therefore are an easy choice. Safety cases take a long time to get clearance. The industry is changing including the people. A lot of historical R&D is in danger of being lost. Even if the NDA gives SLCs funding and resources they may still not be able to do the work because they have a skills shortage: this is not just a funding issue. Regulators have been told second hand that SLCs do not have the right skills to do the work. There is a combination of an aging workforce and the limitations of re-training staff to do different work and not enough resources to do the work. France and the USA have similar problems.

It is hoped that the new Parent Body Organisation at Sellafield can provide innovation but there may be a resource problem. Recent projects have been expensive compared to historically comparative projects due to scarcity of skills, quick progress up the learning curve and the risk placed on contractors. There may also be issues to do with intellectual property (IP) rights with commercial companies being reluctant to share innovative ideas.