

MOVING FORWARD WITH RADIOACTIVE WASTE MANAGEMENT IN THE UK

ELIZABETH ATHERTON and JOHN MATHIESON*

Nuclear Decommissioning Authority, Radioactive Waste Management Directorate,
Curie Avenue, Harwell, Didcot, Oxon., OX11 0RH, United Kingdom

Michael Egan, Quintessa Limited, Chadwick House, Birchwood Park, Warrington, WA3 6AE

*Corresponding author. E-mail : John.MATHIESON@nda.gov.uk

Received December 6, 2007

Radioactive waste has been produced in the UK for many decades. Since the 1950's much of this has been associated with civil nuclear power production and the nuclear weapons programme. There have been a number of unsuccessful attempts in the UK since the 1980s to deal with the waste and find suitable sites for its disposal. However, the UK Government has addressed this and in 2001 introduced the "Managing Radioactive Waste Safely" programme. The aim of this was to make decisions on the long-term radioactive waste management policy through stakeholder engagement. In 2006, it adopted a policy of geological disposal for higher activity wastes and following further consultations, is now at the stage of choosing how that policy should be implemented.

KEYWORDS : Radioactive Waste, Geological Disposal, Stakeholder Engagement

1. HISTORY OF RADIOACTIVE WASTE MANAGEMENT IN THE UK

In order to provide context for what is discussed in this article, it is useful first to look briefly at the history of radioactive waste management in the United Kingdom.

The production of radioactive waste began in the 1920s with the early uses of radioactivity in medicine and industry. The country was subsequently a pioneer in the development of civil nuclear power with the commissioning in the 1960s of the first 'Magnox' power plants. These used natural uranium fuel, a graphite moderator, and carbon dioxide gas as the coolant. The characteristics of Magnox spent fuel meant it had to be reprocessed. However, in the 1970s and 80s the advanced gas-cooled reactors (AGR) which used slightly-enriched uranium oxide fuel were built, and finally in 1995 the pressurised water reactor at Sizewell was commissioned; these spent fuels do not necessarily have to be reprocessed.

The range of waste materials that need to be managed in the UK (see Section 2) is more complex than in most other countries because of the variety of reactor types and fuels that have been used, the by-products from reprocessing and military applications.

In addition to civil nuclear power plants and the Sellafield reprocessing plant, the UK also developed, a variety of nuclear laboratory complexes, research and prototype reactor facilities, and other fuel reprocessing

and fabrication plants (see Fig. 1). Many of these facilities are now redundant, or nearing the end of their operational life. Having once been important sources of research and development or power production, these ageing sites and facilities, and the waste materials they contain, now provide a legacy that represents a considerable public liability.

There was little public concern over radioactive waste management during the early development of the UK nuclear industry and the nuclear weapons programme. Government policy was to provide disposal routes (originally to both land and sea) for a range of less active wastes, while the remainder was accumulated on nuclear sites. However, sea disposal was suspended in 1983 and the practice never resumed.

Following a review by Government, in 1981, the stated policy on high-level waste (HLW) from nuclear fuel reprocessing was to store for at least 50 years, but that for other types of radioactive waste was for disposal as soon as practicable. In 1982 the Nuclear Industry Radioactive Waste Executive was set up; in 1985, this became United Kingdom Nirex Limited (Nirex) which was owned by the major waste producers to take forward the disposal programme.

Nirex's original task was to search for suitable sites for the land-based disposal of low-level (LLW) and intermediate-level wastes (ILW). However, this failed primarily due to public opposition. The final attempt came to an end in 1997 with the rejection by Government



Fig. 1. Principal sites of radioactive waste production in the UK [1]

of Nirex’s attempt to gain permission to build a Rock Characterisation Facility for a deep geological repository in 1997.

In response to this failure, the Government eventually launched the *Managing Radioactive Waste Safely* (MRWS) programme in 2001 (see Section 3) which adopted a more transparent consultative process for reaching decisions on policy and programme.

In 2002, the Government launched a further consultation paper “*Managing the Nuclear Legacy*” to review the management of decommissioning and clean-up for legacy nuclear facilities. In 2005 it established the Nuclear Decommissioning Authority (NDA), with strategic responsibility for 20 of the UK public sector civil nuclear sites and their wastes. Further, Nirex was integrated into the NDA in April 2007 with the aim that this should form the basis for implementing an agreed way forward on long-term waste management (Section 4).

2. RADIOACTIVE WASTES IN THE UK

2.1 Waste Categories

Historically, in the UK, radioactive wastes have been

categorised in terms of their activity content but unlike several other countries, there is no differentiation in the UK between short-lived and long-lived intermediate level wastes.

The key categories used in the UK are [1]:

Low level waste (LLW) – is defined as radioactive waste having a radioactive content not exceeding 4 GBq/te of alpha or 12 GBq/te of beta/gamma activity. A sub-category of LLW is Very Low Level Radioactive Waste (VLLW). LLW includes lightly contaminated metals, soil, building rubble and organic materials (such as protective clothing etc.).

Since 1959, some 1 000 000 m³ of LLW has been disposed of to the near-surface facilities at the low-level waste repository (LLWR) near Drigg in Cumbria and to a lesser extent at the Dounreay site in northern Scotland. The site near Drigg is owned by the NDA and the facility is operated commercially by the LLWR Site Licence Company, providing a UK-wide disposal service to a wide range of waste consignors.

Intermediate level waste (ILW) – is defined as radioactive waste that exceeds one or both of the upper limits on activity content for categorisation as LLW, but without the self-heating properties of high-level waste. ILW arises mainly from the reprocessing of spent nuclear fuel, from general operations and maintenance of radioactive plant (e.g. in filters and ion exchange resins), and from the dismantling of nuclear reactor components.

The 2004 Inventory [1] reveals that there were at that time 82 500 m³ of ILW in storage, 16 400 m³ of which had been conditioned to achieve passive safety by forming stable packages for long term management.

Projected future arisings of ILW in 2004 were 134 000 m³ of (mostly) untreated or partly treated waste, making a total volume of 217 000 m³.

High level waste (HLW) – is defined according to its heat generating properties which means that it is almost entirely associated with the fission product waste stream from nuclear fuel reprocessing.

The 2004 National Inventory reports that there were at that time 1430 m³ of liquid HLW stored in water-cooled tanks at Sellafield. The equivalent of a further 1300 m³ or so liquid HLW had been converted at Sellafield into a solid and stable form by immobilising it in glass (vitrification) within stainless steel canisters, each with a capacity of about 140 litres.

Reprocessing of spent fuel from overseas customers has been carried out on a commercial basis at Sellafield since 1994. It is Government policy that wastes from commercial reprocessing of foreign spent fuel should be returned to their country of origin.

2.2 Other Materials

Not all radioactive material in the UK is currently classified as waste as some may have commercial use in, for example, new fuel manufacture (MOX). This includes

some 100 tonnes of plutonium dioxide, approximately 60 000 tonnes of uranium. Likewise, spent nuclear fuel for which no reprocessing contracts have been established, is also a potential asset and resource for the future.

There is also a range of different spent fuels from research reactors and other irradiated material has which amounts to some 500 tonnes of heavy metal.

In order to inform the development of UK strategy on the management of these materials, the NDA has recently published macro-economic assessments of the life-cycle implications of alternative approaches [2,3].

3. THE NUCLEAR DECOMMISSIONING AUTHORITY

In November 2001, the Government announced its intention to make radical changes to existing arrangements for the management of liabilities associated with the civil nuclear sector. This nuclear 'legacy' was identified as including the decommissioning, clean-up and waste management responsibilities associated with:

- The nuclear sites and facilities operated by the United Kingdom Atomic Energy Authority (UKAEA) and British Nuclear Fuels plc (BNFL), and the wastes, materials and spent fuels they produced in support of the Government's research programmes between the 1940s and 1960s.
- The fleet of Magnox nuclear power stations designed and built between the 1950s and 1970s (operated at that time on behalf of the Government by BNFL), as well as the plant and facilities used for the reprocessing of Magnox fuel and all associated wastes and materials.

The decision was taken to establish a single organisation that would be given the task of giving strategic direction to nuclear legacy clean up, while delivering best value for money for tax payers, who inevitably would have to underwrite the cost of the work.

The Energy Act 2004 paved the way for setting up the Nuclear Decommissioning Authority (NDA) in April 2005. The Act established the following key principles:

- The NDA owns the sites and associated assets and liabilities, but does not directly manage them. Instead, it contracts with "site licensees", which are responsible for delivering, on an incentivised basis, the clean up programme for each site, consistent with relevant regulatory requirements.
- Site licensees, in turn, work closely with the NDA and the regulators to develop (and regularly update) comprehensive long-term plans for clean up, as well as short-term works programmes for delivering (with support from relevant subcontractors) against priorities identified in those plans.
- The NDA is also responsible for a number of related functions, including:
 - carrying out appropriate research into decommissioning,

clean up and disposal;

- education and training on such issues; and
- giving encouragement and other support to activities that benefit the social and economic life, or otherwise produce environmental benefits, for communities living near designated installations, sites or facilities.

The annual budget for delivering the NDA's remit in 2007/8 is in the region of £2.79 billion with approximately half coming from Government with the remainder coming from commercial operations including power generation from remaining operational Magnox power plants and reprocessing.

Major decisions by the NDA are taken only in the light of full consultation with stakeholders, and the interests of local communities are taken into account on decisions concerning the clean-up of individual sites. Consistent with this, the NDA strategy is also legally required to include:

- an account of priorities;
- how it intends to promote and maintain a skilled workforce, effective competition for contracts and good practice in the control of its assets and liabilities;
- how it proposes to give encouragement or support for activities benefiting the socio-economic or environmental development of communities near its installations and sites;
- an explanation of the rationale for arriving at the decisions and proposals set out in the strategy; and
- arrangements for publicising its strategy, engaging in stakeholder dialogue and listening to external views.

The NDA published its Government-approved strategy in March 2006. The Strategy covers the period up to 2011, and is now supplemented by a rolling three year business plan, which sets specific priorities and targets.

4. THE "MANAGING RADIOACTIVE WASTE SAFELY" PROGRAMME

4.1 Defining a Programme for Policy Development

Following the collapse of the Nirex programme in 1997, an 18-month enquiry was conducted by the Select Committee on Science and Technology of the House of Lords [4]. In responding to the Committee's report and recommendations, in 2001, the UK Government, together with the devolved administrations of Scotland, Wales and Northern Ireland, launched a process for undertaking a wide-ranging review of policy for the long-term management of nuclear waste in the UK, with the goal of developing a programme that would "inspire public support and confidence" [5].

This was the *Managing Radioactive Waste Safely* (MRWS) programme. The components of the MRWS programme were identified as:

Stage 1 – Consultation on techniques for public engagement, research methods and institutional arrangements for carrying out the policy review.

Stage 2 – A programme of investigation into the strengths and weaknesses of the available management options, with public engagement, resulting in recommendations on a comprehensive long-term waste management strategy. Government decision on the option(s) to implement.

Stage 3 – Consultation on the Government's proposed framework for how its preferred strategy should be implemented.

Stage 4 – Implementation of the programme required to carry out the recommended strategy, supported (if necessary) by any required enabling legislation.

4.2 The work of CoRWM

One outcome of the Stage 1 consultation was a decision by Government to carry out separate review processes for policy on LLW and higher activity wastes.

The review of LLW policy [6] was largely carried out by inter-departmental groups within Government, through consultation with identified key stakeholders. Meanwhile, an independent committee – the Committee on Radioactive Waste Management (CoRWM) – was established to oversee the evaluation of waste management options (Stage 2) and to advise on a recommended way forward for higher activity wastes. Members of CoRWM were appointed in 2003.

CoRWM was an advisory body whose appointed members brought a range of expertise on scientific, social, economic, environmental and public perspectives on the issue of radioactive wastes. Its final recommendations [7], published in July 2006, the committee made the following key points:

- In the long term, disposal of radioactive waste deep underground, an option known as geological disposal;
- Robust interim storage, in recognition of the fact that the process leading to the creation of suitable facilities for disposal may take several decades;
- An equal partnership between Government and potential host communities based on a willingness to participate;
- The immediate creation of an oversight body to begin the process of implementation.

As noted in the committee's final recommendation report, CoRWM's approach to the task that was assigned to them embodied a series of elements:

Ethics – CoRWM paid explicit attention to the way in which ethics inform decisions on long-term management, emphasising the role of equity and sustainability considerations in the assessment of options. In reaching its recommendations, CoRWM had to achieve a consensus that incorporated the different ethical positions held by its members.

Participation – CoRWM placed a very high value on the need to engage with stakeholders and citizens, with four main phases of public and stakeholder engagement. A range of different techniques were used, including stakeholder round-table discussions, Citizens' Panels, a National Stakeholder Forum and open meetings. Plenary meetings of the committee were held in public, and these included public question and answer sessions.

Use of Expert Knowledge – CoRWM engaged with the scientific community in a variety of ways. For example, intensive use was made of panels of experts in conducting the detailed assessment of short-listed options within the framework of a multi-criteria decision analysis.

Deliberation – CoRWM adopted a deliberative approach to its work from the outset, with the aim of being inclusive and facilitating consensus building through expressing and integrating divergent viewpoints. Deliberation was a major feature of the committee's own discussions as well as in engagement with the public and stakeholders.

Democratic Decision Making – By encouraging equality of exchange between participants, and attempting to reflect all relevant viewpoints and values, the committee sought to enable decisions to be reached on the basis of shared understanding. CoRWM considered that the outcome of its process represented a far more informed basis for political decision making than had existed previously.

Integration – The committee's final recommendations were not simply an expression of expert knowledge and judgment, but founded on combined understanding that had been developed collectively by members of the committee.

Implementation – CoRWM rejected the imposition of solutions decided from the centre in favour of a more inclusive approach to the implementation of its recommendations. Proposals were developed for partnership approaches to the relationship between the implementing organisation and communities, based on the principle of an open and equitable relationship.

Interdependence – CoRWM's proposals to Government formed a carefully articulated and integrated set of recommendations, which they considered to be interdependent and therefore indivisible. While recognising that geological disposal was the right endpoint for all, or almost all, the UK inventory of higher activity legacy wastes, due recognition was also given to the importance of storage, both as an interim arrangement on the route to disposal as well as a contingency in the event of interruptions to the disposal programme.

4.3 Government Response to CoRWM

The UK Government and devolved administrations published a formal response to CoRWM's recommendations in October 2006. They accepted the main recommendation, that geological disposal, preceded by safe and secure interim storage, should be the way forward for the long-term management of the UK's higher activity radioactive wastes. In addition, they announced that there would be

further consultation on a framework for implementing geological disposal.

In its statement, Government also stated that the NDA would be given responsibility for planning and implementing geological disposal. Taking into account the NDA's existing responsibilities under the Energy Act 2004, this meant that the organisation now has the sole overall responsibility for national strategy in the management of higher activity wastes, in both the shorter- and longer-term. As part of this process, it was decided that Nirex should be incorporated into the NDA and Nirex staff and resources were transferred into the NDA in April 2007.

Following elections in May 2007 there was a change of administration in Scotland, and the new governing parties in Scotland decided not to sponsor further consultation on the MRWS implementation process. The Government's consultation paper on plans for the implementation of geological disposal was nevertheless published (Stage 3), in partnership with the devolved administrations for Wales and Northern Ireland, in June 2007 [8]. It was emphasised that the consultation was open to the whole United Kingdom.

The consultation document underlined the Government's view that implementation of practicable solutions for the UK's higher activity wastes depended on the following key principles:

- achieving long-term protection of people and the environment;
- acting in an open and transparent way that inspired public confidence;
- basing decisions on sound science; and
- ensuring the effective use of public monies.

The 2007 consultation paper places particular emphasis on those aspects of the CoRWM recommendations dealing with the interaction between Government, a future implementing organisation and potential host communities. It includes proposals for how the principle of voluntarism (based on the expressed interest of communities in taking part in the process) could be made to work in a UK context, and how a staged, partnership approach to the development of a geological disposal facility could be applied. The consultation period was open for a period of 4 months, closing on 2 November 2007. It is intended that implementation (Stage 4 of the MRWS process) should commence in 2008.

5. MOVING FORWARD

5.1 Roles and Responsibilities

An important component of the latest consultation document in the MRWS programme [8] is that it establishes the respective responsibilities of Government, the NDA and other key actors in relation to implementing geological disposal. These roles are summarised as follows:

Government will set the policy, take final decisions and engage with all actors to ensure that the objectives of the MRWS programme are met.

NDA will be the implementing organisation, responsible for planning and delivering the geological disposal facility. As part of this process, NDA will engage with the communities and other stakeholders involved.

Communities with a potential interest in hosting a geological disposal facility will have the opportunity to work with the NDA and others in a partnership approach during the process.

Local Government will be fully engaged in a partnership approach and will play a part in decision making during site selection.

Regulators will ensure robust, independent regulation, according to their statutory responsibilities for ensuring the national, European Union and other international safety, security and environmental legislation and standards are met.

CoRWM will be reconstituted to provide independent scrutiny and advice on the Government's and NDA's plans and programmes for delivering geological disposal.

It is emphasised in the consultation paper that there should be a staged approach to decision making in developing a geological disposal facility. Consistent with CoRWM recommendations [7], it also points out that there should be key points when communities formally affirm (or re-affirm) their desire to continue, or make a decision to withdraw.

The intention is that expressions of community interest to participate in the process should be directed towards UK Government (or the appropriate devolved administration government), and that initial discussions about the implications of involvement should be carried out at that level. An initial 'screening-out' of unsuitable areas would then be carried out, on behalf of Government, by the British Geological Survey. The NDA will then become involved more closely in the siting process, through more thorough evaluation of suitability, only when a short-list of volunteer communities willing to continue with the process has been identified. In doing this, the NDA will be charged with working with communities to ensure that local issues are properly addressed. This would eventually lead to a local and national Government decision on one or more candidate sites to be taken forward for more detailed geological investigation.

5.2 NDA Organising for the Future

The NDA has reviewed how it can best manage the geological disposal delivery programme, in collaboration with newly-integrated colleagues from Nirex. A new NDA Directorate – the Radioactive Waste Management Directorate (RWMD) – has been established, into which the majority of the previous Nirex team was transferred.

This Directorate will assume responsibility for the planning and development of a geological disposal facility for higher activity waste.

In line with its duties under the Energy Act 2004, the NDA is responsible for ensuring that a significant amount of implementation work is subject to competitive procurement through the supply chain.

Government is expected to announce its policy on the framework for implementing geological disposal in the first half of 2008 and thereafter, depending on the outcome of the latest consultation, enter into the site selection process.

REFERENCES

- [1] Defra, *The 2004 Radioactive Waste Inventory – Main Report*, Report Number DEFRA/RAS/05.002 prepared by UK Nirex Limited, October 2005.
- [2] Nuclear Decommissioning Authority, *Uranium and Plutonium: Macroeconomic Study – Final Report*, NDA Report KP000040 prepared by Environmental Resources Management, June 2007.
- [3] Nuclear Decommissioning Authority, *Spent Fuel Management: Life Cycle Analysis Model – Final Report*, NDA Report KP000068 prepared by Environmental Resources Management, September 2007.
- [4] House of Lords, *Management of Nuclear Waste*, Third Report of the Select Committee on Science and Technology, March 1999.
- [5] Defra and Devolved Administrations, *Managing Radioactive Waste Safely – Proposals for Developing a Policy for Managing Solid Radioactive Waste in the UK*, September 2001.
- [6] Defra, DTI and the Devolved Administrations, *Policy for the Long-term Management of Solid Low Level Radioactive Waste in the United Kingdom*, March 2007.
- [7] Committee on Radioactive Waste Management, *Managing our Radioactive Waste Safely – CoRWM's Recommendations to Government*, CoRWM Document 700, July 2006.
- [8] Defra, DTI and the Welsh and Northern Irish Devolved Administrations, *Managing Radioactive Waste Safely – A Framework for Implementing Geological Disposal*, June 2007.