

The UK's National Policy & Programme for the Management of Spent Fuel and Radioactive Waste – 16574

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ABSTRACT

This paper provides a broad overview of the United Kingdom's (UK's) national policies and national programme [1] for the management of spent fuel and radioactive waste. The aim of the paper is to ensure a clear understanding of the approach taken in the UK so that opportunities for learning lessons and joint working, where they exist, can be identified and to ensure a general understanding of the interdependencies between the various approaches taken in the UK.

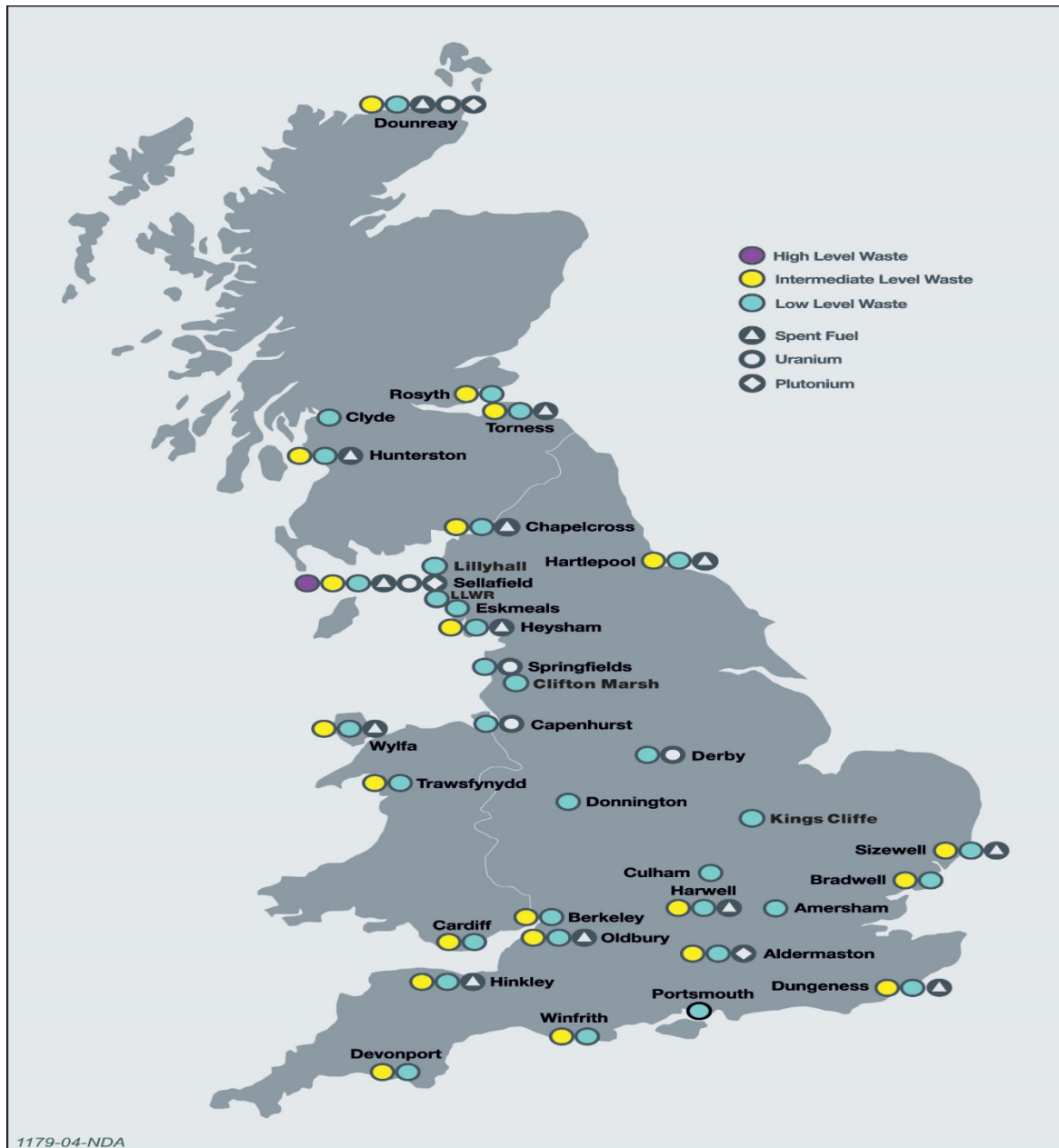
INTRODUCTION

The use of nuclear technology, first for defence purposes and later for electricity generation, has a long history in the UK. There have been many different designs of research, prototype and nuclear power plant reactors that have been built and operated since the UK started its nuclear programme in the late 1940s/early 1950s. Radioactive substances have been and continue to be used in activities such as electricity generation, defence, industry, medicine and research & development. The last of these has been extensively used to support the expansion and improvement of nuclear power through, for example, new reactor types and various fuel cycles. Additionally, the UK has had programmes for reprocessing spent nuclear fuel (both from UK reactors and from overseas customers) at the Sellafield and Dounreay sites (though the programme at Dounreay has now ceased).

All these activities produce radioactive waste. Much of the Low Level Waste (LLW) and Very Low Level Waste (VLLW) has been disposed of already to the Low Level Waste Repository (which is near the town of Drigg in Cumbria) ('the LLWR') and other near-surface facilities. A larger amount of LLW/VLLW currently exists only as "committed" waste i.e. waste that will certainly arise in the future as reactors and other facilities are operated and then decommissioned. Radioactive waste that cannot be disposed to surface facilities is held in storage pending final disposal in a suitable facility.

Figure 1 shows the current locations of the UK's nuclear installations and disposal sites.

Figure 1: Map of UK Nuclear Sites



DISCUSSION

The "Waste Journey"

The overall management of UK radioactive waste is summarised in Figure 3. This depicts the UK "waste journey". LLW and VLLW are subject to various types of processing before being sentenced for disposal or being cleared for recycling. Higher Activity Waste (HAW) is processed to make it suitable for both interim storage and disposal before being stored prior to ultimate disposal - in the UK it

is envisaged that disposal of such wastes will be via a Geological Disposal Facility (GDF). Vitrified High Level Waste (HLW) and Spent Nuclear Fuel (SNF) is stored pending encapsulation optimised for the final GDF design.

The management of the various waste classes may be characterised as follows:

- LLW and VLLW: processing to minimise the mass and the volume of waste requiring disposal (in line with the UK's waste hierarchy - see Figure 2);
- HAW: retrieval and processing of raw wastes to enable passive interim storage followed by disposal to a GDF. Alternatively in Scotland Intermediate Level Waste (ILW) (i.e. non heat generating waste) and some LLW will be sent instead to a near-surface disposal facility when it becomes available. Vitrified HLW will require some form of additional packaging to provide additional containment for disposal; and,
- SNF: reprocessing or storage (wet or dry) at the site of production or Sellafield pending the availability of a GDF. Like vitrified HLW, SNF will require some form of additional packaging to provide additional containment for disposal.

Figure 2: Waste hierarchy from the UK LLW waste strategy

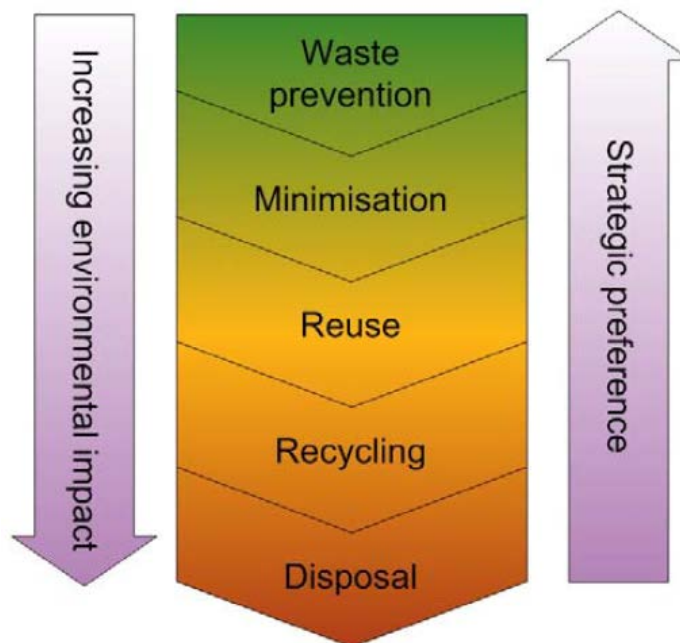
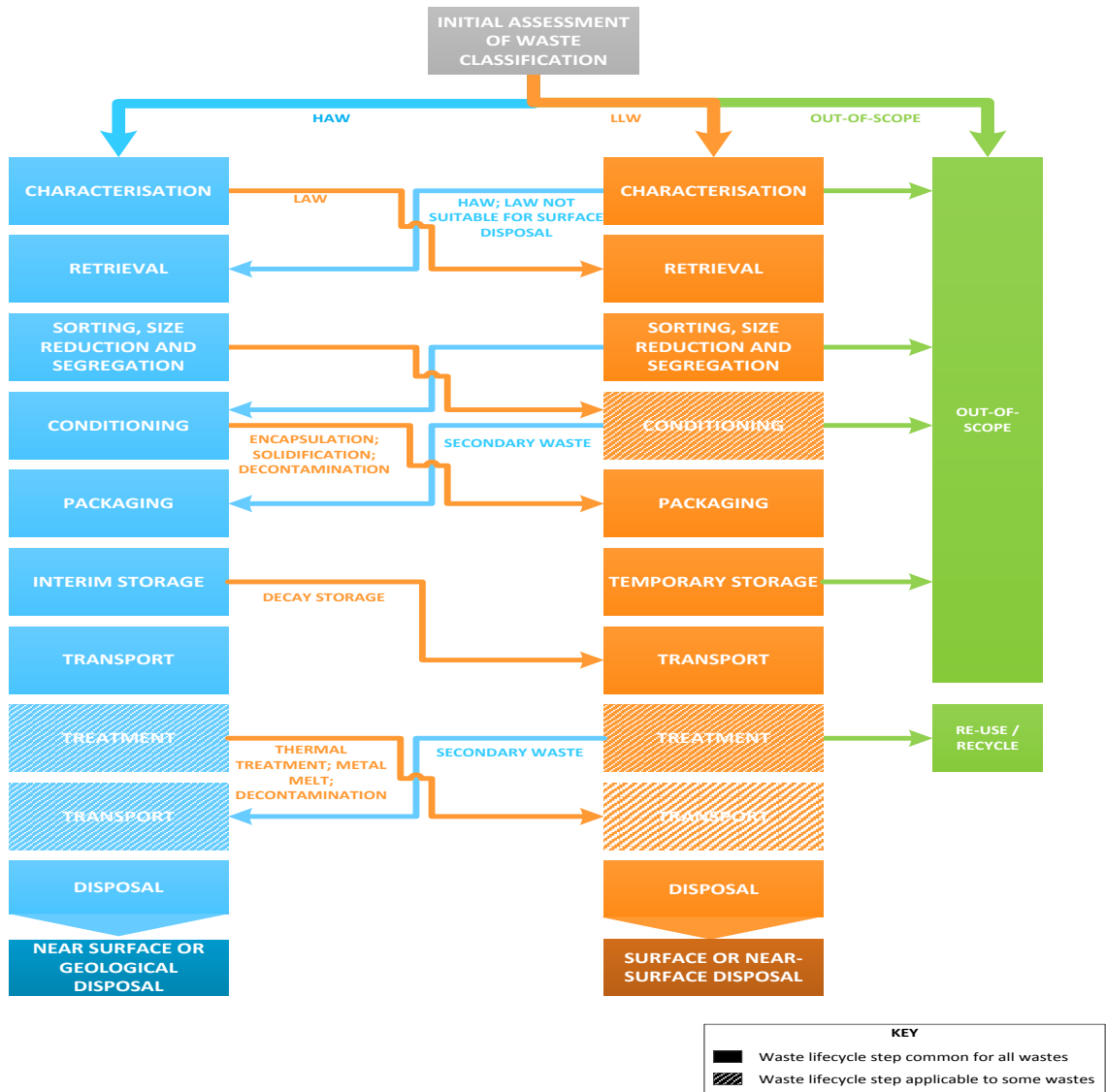


Figure 3: UK “Waste Journey” from Generation to Disposal



Main Policy Principles

In the UK there are some powers and responsibilities that are devolved from the UK Government in Westminster to the Governments of Scotland, Northern Ireland and Wales. While nuclear safety is reserved to the UK Government, radioactive waste management is a devolved issue. However, the various UK Government and Devolved Administration policies on radioactive waste management are all based on the same basic principles.

That is to say that radioactive waste must be managed and disposed of in ways which protect the public, workforce and the environment both now and in the future: i.e. that management aims to process wastes into a passive form and to take into account the impact of today’s activities on future generations. Within this approach in the UK we maintain and continue to develop policies and regulatory frameworks which ensure that radioactive waste:

- is not unnecessarily created in accordance with the waste hierarchy (see Figure 2).
- is safely and appropriately managed and treated; and
- is then safely disposed of at appropriate times and in appropriate ways.

Producers and owners of radioactive waste bear the cost of managing and disposing of their waste and are responsible for developing their own waste management plans, ensuring that:

- they do not create waste management issues that cannot be safely managed using current techniques, or techniques which could be derived from current lines of development;
- where it is practical and cost-effective to do so, they characterise and segregate waste on the basis of physical and chemical properties, and store it in accordance with the principles of passive safety; and,
- they undertake strategic planning, including the development of programmes for the disposal of waste accumulated at nuclear sites within an appropriate timescale and for the decommissioning of redundant plant and facilities.

The ongoing implementation of these radioactive waste management policies is seen in the progress made towards decommissioning of redundant nuclear facilities and continuing efforts to update and improve the site selection process for a GDF.

Higher Activity Waste (HAW)

UK Government and Northern Ireland Policy for HAW is set out in the 2014 White Paper "Implementing Geological Disposal" [2]. This commits to the packaging of radioactive waste followed by safe and secure interim storage until such time as a GDF becomes available. It also commits to a process for identifying and selecting potential sites for a GDF based on working in partnership with willing communities and led by UK Government and its delivery bodies. This process will provide information to the public in relation to:

- the land-use planning process to be applied to any GDF development,
- the national geological screening based on the role of geology in supporting a GDF safety case; and,
- the development of detailed processes for local community representation and decision making, including a final test of public support prior to any decision to proceed with GDF development at a given location.

The 2014 White Paper defines geological disposal by stating that it involves isolating radioactive waste deep inside a suitable rock volume to ensure that no harmful quantities of radioactivity ever reach the surface environment. The NDA have published a Generic Disposal Facility Design document [3] that is intended to provide information on the work undertaken on the development of a number of illustrative designs for a geological disposal facility in the UK. It also provides the basis for the safety assessment that underpins the disposal system safety case.

Following a review of the practical implementation of previous geological disposal facility siting procedures, the UK Government and Northern Ireland Executive published a new White Paper in July 2014. This updates (and replaces in England and Northern Ireland) the previous 2008 White Paper but retains the clear commitment to working in partnership with willing communities to pursue the siting of a geological disposal facility. The Welsh Government has also confirmed a policy for the geological disposal of higher activity radioactive waste.

The 2014 White Paper, applicable in England and Northern Ireland, sets out a two year programme of initial actions that will be undertaken by the UK Government and by the developer (Radioactive Waste Management Limited) to help implement geological disposal. These initial actions, in the areas of national geological screening; national land use planning and working with communities, are designed to provide more information to communities in advance of formal discussions with the developer which will enable communities to engage in the process with more confidence.

Early community investment payments will be made available to communities that engage with the developer early in the siting process and communities will have a right to withdraw at any stage of the siting process leading up to a test of public support. Formal discussions between interested communities and the developer will not begin, however, until the two year programme of initial actions is complete and the results available to all potentially interested parties. This period of the programme is due to be completed at the end of 2016. The graphic below (Figure 4) provides a high level overview of the process being followed to establish a GDF in the UK.

Figure 4: Process for the delivery of a GDF in the UK



The Scottish Government approach is that the long-term management of higher activity radioactive waste should be in near surface facilities.

Spent Nuclear Fuel (SNF)

The policy for managing SNF in the UK is that it is a matter for the commercial judgement of its owners, subject to meeting the necessary regulatory requirements. However, in 2012 the UK Government made a clear decision to cease reprocessing in THORP (Thermal Oxide Reprocessing Plant). In the next five years we expect that the THORP and Magnox reprocessing plants will complete their committed reprocessing programmes. This policy applies across all parts of the UK.

Currently all spent Magnox fuel and AGR fuel is sent to Sellafield for storage and/or reprocessing. Reprocessing is currently the only recognised way to manage Magnox fuel. Some of the spent fuel from the existing UK AGR power stations and all of the spent fuel from Sizewell B PWR are not currently destined for reprocessing. In the absence of any new commercial proposals for reprocessing, these fuels will be interim-stored pending direct disposal to a GDF. In considering reprocessing in the context of nuclear new build, the 2008 White Paper 'Meeting the Energy Challenge: The Future of Nuclear Power' [4] stated that, in the absence of any proposals from industry, any new nuclear power stations that might be built in the UK should proceed on the basis that spent fuel will not be reprocessed and that plans for, and financing of, waste management should go forward on this basis. If such proposals were to come forward in the future, they would be considered on their merits and consulted upon".

Other types of Radioactive Waste

Low level waste (LLW)

The UK has a LLW policy that requires dedicated strategies to be developed for nuclear industry LLW, non-nuclear industry LLW and Naturally Occurring Radioactive Material (NORM) waste. The resulting Strategy for Solid LLW from the Nuclear Industry sets the application of the waste hierarchy at its core and identifies methodologies for its application throughout the industry. As a result, a range of alternate treatment and disposal routes have been established and are in use by the nuclear industry to treat and/or dispose of its VLLW and LLW. These routes include, for example, the use of conventional landfill sites for the disposal of appropriate types of high volumes of very low level waste (building rubble etc) from site decommissioning activities. LLW Repository Ltd has the responsibility for integrating and optimising the management of LLW from the nuclear industry nationally.

Non-Nuclear Industry Radioactive Wastes

The strategy for non-nuclear industry radioactive wastes recognises that most of the waste is either exempt or LLW for which disposal routes exist. Users are required to ensure that these routes are employed. It is a condition of use of high-activity sealed sources (HASS) that licensees make financial provision for disposal. The small amounts of waste that cannot be disposed are placed in storage facilities operated under contract from the NDA. Here they may decay to radioactivity levels that allow near-surface disposal or else they are kept in storage pending the availability of a GDF.

Naturally Occurring Radioactive Material (NORM) waste

NORM waste should be managed sustainably, efficiently and in line with the principles of the waste hierarchy. This requires a policy framework that enables and encourages waste producers to avoid unnecessary waste production and to manage arisings in an environmentally appropriate way.

National Regulatory Framework

There are two principal strands to the UK legislative and regulatory framework relevant to radioactive waste management. The first strand addresses nuclear safety and occupational radiation protection aspects of spent fuel and radioactive waste management on nuclear sites, and is primarily comprised in the Health and Safety at Work (etc.) Act 1974 (HSWA) and the Energy Act 2013, together with associated provisions in the Ionising Radiation Regulations 1999 and those parts of the Nuclear Installations Act 1965 (NIA65) that concern licensing and safety.

Licensees are expected to apply the defence-in-depth concept to any design of spent fuel or waste management facility regardless of whether the facility is new, under modification or under decommissioning, with an emphasis on safety measures designed to prevent the accident occurring. The UK's nuclear safety regulator's (the Office for Nuclear Regulation – ONR) safety assessment principles (SAPs) expect licensees to make provision for controlling faults that

develop within the design basis and to mitigate consequences should a fault progress outside of the design basis.

The extent to which a licensee can incorporate preventative safety measures, in preference to mitigating measures, may justifiably be dominated by restrictions posed by the age of a facility, the nature of the risk it presents (especially if the design activity pertains to an overall decommissioning or hazard reduction programme). ONR inspectors would seek evidence that licensees have demonstrably reduced 'risk so far as is reasonably practicable' through alternative measures in the defence-in-depth hierarchy applied in a graded manner.

ONR inspectors further expect licensees to design passive safety measures with greatest preference over those which are automatically initiated or manually initiated or indeed administrative in nature. Where a design has predominant emphasis on active safety measures or administrative controls, inspectors would seek evidence of a robust demonstration that the costs associated with passive measures would be grossly disproportionate to the safety benefit to be derived. As part of the overall approach which is based on reducing the risks so far as is reasonably practicable, operators have a duty to seek to learn the lessons from past experience, both domestically and internationally, so that continuous improvements to nuclear safety can be developed and implemented.

The second strand addresses environmental protection and public exposure to radioactive substances in the environment and is expressed through controls on the keeping, use and disposal of radioactive substances on nuclear sites and elsewhere. In this context, disposals include radioactive discharges and radioactive substances including radioactive wastes. This is addressed through the Radioactive Substances Act 1993 (RSA93) in Scotland and Northern Ireland. For England and Wales the provisions of RSA93 were incorporated into Schedule 23 of the Environmental Permitting (England and Wales) Regulations 2010 (EPR10) in April 2010.

Environmental permits under EPR10 permit conditions require nuclear site licensees and non-nuclear operators to apply Best Available Techniques (BAT) in managing radioactive wastes. In the UK Government's Environmental Permitting Guidance for Radioactive Substances Regulation (September 2011), the term BAT is taken to mean 'the latest stage of development (state of the art) of processes, of facilities or of methods of operation which indicate the practical suitability of a particular measure for limiting discharges, emissions and waste. The Guidance also states that '.....BAT for a particular process will change with time in the light of technological advances, economic and social factors, as well as changes in scientific knowledge and understanding. So, much like the application of so far as is reasonably practicable, achieving BAT is not a static state but rather a position of continuous improvement.'

Financial Considerations

The UK Government expects all nuclear operators to take the steps necessary to ensure that their work on decommissioning and radioactive waste management is adequately funded. For nuclear new build, the UK Government has issued guidance on the required funding arrangements for decommissioning and waste

management and, in 2008, established the Nuclear Liabilities Financing Assurance Board (NLFAB), an independent advisory non-departmental public body.

For the non-nuclear industry UK Government, the Devolved Administrations and environmental regulators have important roles to play in improving regulatory practice. The UK regulatory regime relating to planning provides the framework for ensuring that waste needs are planned for and that there are sufficient facilities in the right locations and of the right type to meet those needs. However, investment decisions over provision of facilities and disposal routes are ultimately for the market. Waste producers are responsible for their wastes, and should be planning for the effective management of waste as a part of good business practice. Effective implementation of UK non-nuclear radioactive waste strategies will lead to better information and data availability leading to a stronger market and ensuring the UK is better able to deal with changes to the volumes of wastes produced by opening new waste facilities and preserving existing ones.

Nuclear Decommissioning Authority

The NDA is responsible for the management and decommissioning costs for 17 of the UK's nuclear licensed sites. The NDA calculates its projected spending on an annually basis based on the best estimate of the future costs of the decommissioning programme, which is expected to take until 2137 to complete, and reports these findings in the publication of the NDA Annual Report and Accounts.

The NDA also considers credible risks and opportunities which may increase or decrease the estimate of the cost of decommissioning, but which are deemed less probable than the best estimate. These include the variability in the cost of construction and operation of any future LLW, or Geological Disposal Facilities; consideration of options to accelerate the clean-up of legacy research sites; and the cost of new construction, decommissioning and post operational clean out work in the long term at Sellafield.

Funding of Geological Disposal

In order to ensure the provision for a future facility for the disposal of HAW, the GDF lifetime plan will be produced by Radioactive Waste Management Limited (RWM) as the developer. This is then used to provide an assessment of cost to NDA, which will in turn incorporate the cost assessments into its Annual Report and Accounts. However, other waste producers share the liability for the provision of a geological disposal facility, thus the NDA is not solely responsible for ensuring the full provision of a future facility. For example, as reported in the 2013-2014 Annual Report and Accounts, NDAs portion of liability to fund GDF is reported at £4,077m.

Funding of Decommissioning and Waste Management for New Nuclear Build

Under the Energy Act 2008, a prospective operator of a new nuclear plant is required to submit its plans for decommissioning and waste management in a

Funded Decommissioning Programme (FDP). As part of the FDP, it also needs to ensure it has secure financing arrangements in place to meet the full costs of decommissioning and its full share of waste management and disposal costs. The NDA scrutinises the operator's proposed waste and decommissioning plans and assesses the cost estimates to advise the Secretary of State for Energy and Climate Change on their suitability for approval.

The funding arrangements within the FDP are examined by the Nuclear Liabilities Financing Assurance Board (NLFAB) - an advisory non-departmental public body, sponsored by the Department of Energy and Climate Change - which advises the Secretary of State on the adequacy of the proposed measures; NLFAB will also continue to provide a regular review of funding once the measures are implemented. NLFAB undertakes impartial scrutiny of the FDP in order to provide independent and transparent advice.

Alongside approval of an operator's FDP operators are expected to enter into Waste Transfer Contracts (WTCs) regarding the terms on which the UK Government will take title to and liability for the operator's spent fuel and ILW for disposal. WTCs are framed so that operators of new nuclear power stations are charged for waste disposal linked to actual expenditure in all but the most unlikely cases, with a requirement to make provision against projected cost during the operation of the plant.

The WTCs will include a pricing methodology which, in particular, will provide for the Waste Transfer Price to be determined at a specified date during the operational lifetime of the power station. In addition, the operator will pay the UK Government a risk premium for fixing the price ahead of the date of disposal to ensure that the taxpayer is appropriately compensated for taking the financial risk of any subsequent cost escalation. Due to the way the price will be determined, the operation of the contracts is projected to be advantageous to taxpayers as the price will include a contribution to the fixed costs of the GDF which would otherwise have been borne by the taxpayer.

CONCLUSIONS

With a legacy that dates back to the late 1940's/early 1950s the UK have a range of complex and difficult issues to resolve that have evolved over time. What was considered to be acceptable in the past is not thought of in the same way today. We therefore need to be forward thinking, innovative and above all ready to adapt our practices and policies to address previously unknown issues and complications.

Due to the wide range of types of radioactive wastes and materials to be managed in the UK we have needed to establish a set of high level principles to cover all radioactive waste types while at the same time ensure that specific approaches for specific issues are developed within that framework. In the UK we have also had to consider the issue of integration to ensure that an approach that addresses one issue does not inadvertently cause a problem elsewhere – for example: in disposing of the high volumes of very low level waste we needed an approach to ensure that other low level waste has a disposal route.

Financing of decommissioning and future waste management is clearly one of the biggest challenges to be addressed. As mentioned above ensuring that the legacy left for future generation is not one of a burden - we need to ensure that measures are in place to fund and manage long lived radioactive wastes.

Finally, it is clear that not all radioactive wastes are the same and therefore different approaches are needed for managing the different types of material. This requires a proportionate and prioritised approach so while the same ultimate goal is applied (i.e.: the safe and responsible management of radioactive waste) some radioactive wastes are more equal than others and need to be treated accordingly.

In the UK we believe that we have a broad programme in place that allows the right balance to be struck in managing all our radioactive waste and spent fuel in a proportionate, safe and responsible manner.

REFERENCES:

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