

What is geological disposal?

Geological disposal involves isolating radioactive waste deep inside a suitable rock formation to ensure that no harmful quantities of radioactivity ever reach the surface environment. It is a multi-barrier approach, based on placing wastes deep underground, protected from disruption by man-made or natural events.

Why is geological disposal the preferred approach?

The independent Committee on Radioactive Waste Management (CoRWM) was set up to review the options for managing the UK's legacy higher activity radioactive waste. Government made clear that it wanted all the options that had been given serious consideration by the international scientific community to be reviewed. These included, for example, the disposal of radioactive waste in the sea, in the ice caps, and in space.

CoRWM combined consideration of the scientific evidence with a process of engaging stakeholders and members of the public. It took its findings and combined them into a set of interdependent recommendations built around the view that geological disposal is the best available approach and it is the approach adopted in a number of countries including, Finland, Sweden, France and the US.

Geological disposal is also internationally recognised as the preferred approach for the long-term management of higher activity radioactive waste. The International Atomic Energy Agency for example, has expressed confidence in geological disposal.

In the UK, geological disposal is supported by the Royal Society, the Royal Society of Chemistry, and the Geological Society.

How will we know that the geological disposal facility will be safe?

No facility will be built unless it can meet the demanding safety requirements of the independent statutory regulators. It is these regulators who will determine if the proposed facility is safe enough to be given the go ahead.

The Independent CoRWM was satisfied that there was now sufficient confidence in geological disposal to include it as part of their package of recommendations. Also internationally there is consensus that it is the way forward. However, in the UK it will not proceed unless the independent regulators are content that it is safe, secure and environmentally acceptable.

How much waste will be placed in the geological disposal facility?

The White Paper gives the amounts of higher activity legacy wastes and materials that CoRWM considered might require disposal.

However, it is not possible to give a precise answer to this question. Legacy waste amounts will change over time due to changes in planned operations or if waste management technology or practices alter over time. There are also materials not

currently classified as waste that may eventually need to be managed through geological disposal and also proposals for new nuclear power stations.

The UK Radioactive Waste Inventory, compiled and updated every 3 years, will be the basis for tracking the latest estimates of wastes potentially destined for disposal. A process for updating the waste inventory for disposal (the Baseline Inventory) will have to be agreed between communities, Government and the NDA. It must be transparent and including processes for indicating any changes.

How much will it cost?

Final costs will depend on the site, the inventory of waste and the concept agreed. This will be a major investment incurred over a period of many years to ensure long-term public and environmental safety.

Cost estimates produced by Nirex in 2003 suggested the overall cost of a geological disposal facility development (including characterisation of a site and design, construction, operation and closure of the facility) estimated at around £10 billion (in 2003 prices) for the baseline (i.e. legacy) Inventory.

We are currently developing a parametric cost model which will allow the implications and costs of different scenarios to be assessed. The exact cost will be influenced by many different factors, including the inventory of waste, the geology at the site in question and the design of a geological disposal facility. Indicative figures will be published in our Annual Report and Accounts.

Our strategy on this matter will be approved by Government before implementation and in this way proper accountability will be achieved for the funds required to implement this long-term project. Government have committed to a staged implementation process that allows costs and value for money to be assessed at various points

How will a site be selected?

The stages in the site selection process are outlined in the Managing Radioactive Waste Safely White Paper, however, the process for assessing sites has still to be finalised.

Government has asked local communities to submit an Expression of Interest (without commitment) in hosting a Geological Disposal facility – a process called Voluntarism. The scope of initial discussions will be for mutual agreement between the local community (ies) and Government and could include discussion of at what point the NDA and others might become involved.

If the community is happy they can move on to the Decision to Participate phase of the process. The site selection process will require considerable engagement with communities. In order to achieve this, the Government favours a partnership approach

where all parts of a community work together with the NDA and other relevant parties to achieve a successful outcome.

Questions & Answers

The Siting Process

How long will it take to find a site?

Government wants to build on the momentum CoRWM helped establish and suggests that it is likely to be around two to three decades from the beginning of the site selection process to a facility becoming operational and ready for waste emplacement. It is important to emphasise, though, that the process will be dependent on discussions with local communities and that voluntarism and partnership are the key drivers in this process.

If an interest is expressed what will be the next steps?

Once a community has expressed an interest, the British Geological Survey would be asked to make an assessment of the area to eliminate any sites that are obviously geologically unsuitable.

At the same time, the community would engage further with local people and partners to ensure that questions and concerns about a geological disposal facility are addressed. It may then decide to make a more formal commitment to participate in the siting process. This would not mean the community has to host a facility – just that it will engage in further discussions with the Government and the NDA.

Would a community be negotiating with Government or the NDA?

An Expression of Interest will enable without commitment discussion between local communities and Government to begin. The scope of initial discussions will be for mutual agreement between the local community/ies and Government and could include discussion of at what point we and others might become involved in discussions.

Following a Decision to Participate, the site selection process will require considerable engagement with communities. To do so Government favours a partnership approach where all parts of a community work together with the NDA's delivery organisation and with other relevant interested parties to achieve a successful outcome.

What are our plans for engagement during the programme?

We, and in due course our delivery organisation, will work in partnership with potential host communities throughout the process of geological disposal facility siting, development and operation. This will enable engagement with those stakeholders and members of the public who would be most affected by development of a geological disposal facility.

At a local and regional level much of this engagement will be through our involvement in the Community Siting Partnership. It is anticipated that Government or NDA would

only organise local community engagement at the invitation of local authority decision-makers.

During the development of the geological disposal facility, we will use a range of activities at national, regional and local level in order to increase transparency, raise awareness and enable interested parties to provide input. These are likely to include: workshops and seminars; posting information on our website; providing briefings and presentations; and working with the media.

Engineering and Science

When will planning and development of the geological disposal facility actually begin?

The design and development of a facility will take many years, and will depend to a large extent on the views of the host community, the site that is chosen, regulators and others, and on the outcome of future research and development.

In parallel with ongoing community discussions, we will develop our plans for building a geological disposal facility, publishing and updating them progressively as the programme proceeds. Planning and development of a *specific* facility will only begin when there is an interested community with suitable geology that meets the necessary technical and regulatory requirements for safety and environmental protection.

How big will the facility be?

The dimensions of the underground areas of a geological disposal facility will be determined by the exact inventory for disposal, the properties of the host rock and the geometry of features within it.

Indicative geological disposal facility dimensions have been estimated for waste that CoRWM thought likely to be disposed of in a geological disposal facility. Those estimates indicate that the underground area of host rock required (i.e. the 'footprint') for an Intermediate Level Waste/Low Level Waste disposal facility would be of the order of 1km², and for a High Level Waste and spent fuel disposal facility (assuming that spent fuel were treated as a waste) would be of the order of 3km².

In practice it may be possible to build a geological disposal facility over a smaller area, by building deposition tunnels or vaults on different levels. This would however depend on the geology of the site.

Will a facility take new nuclear waste?

Following consultation, the BERR White Paper on Nuclear Power sets out that Government considers that it would be technically possible and desirable to dispose of both new and legacy waste in the same geological disposal facility.

This will be explored through the Managing Radioactive Waste Safely programme and a process for updating the waste inventory for disposal (the Baseline Inventory) will have to be agreed between communities, Government and the NDA. It must be transparent and include processes arrangements for indicating any changes.

The MRWS site selection process will look at whether potential sites are capable of accommodating all the wastes.

What about Spent fuel waste?

In addition to existing wastes, there are some radioactive materials that are not currently classified as waste but that may, if it were decided at some point that they had no further use, need to be managed through geological disposal. These include:

Spent fuel: Fuel that has been used to power nuclear reactors is not currently classified as waste, because it still contains large amounts of uranium (and some plutonium) which can potentially be separated out through reprocessing and used to make new fuel. Most of the UK's spent fuel from civil reactors has been or is proposed to be reprocessed in this way, producing separated plutonium and uranium and HLW, ILW and LLW as waste by-products. Spent fuel need not be reprocessed, however, and could instead be packaged and disposed of directly in a geological disposal facility, as is planned in Finland and Sweden. Some spent fuel from existing UK Advanced Gas-cooled Reactor (AGR) power stations and all the spent fuel from Sizewell B Pressurised Water Reactor (PWR) is not currently destined for reprocessing and may ultimately need to be managed in this way.

Other nuclear materials: Depending on the strategy adopted other nuclear materials, currently not classified as waste, such as plutonium may be placed in the GDF.

Co-location

Some respondents to the MRWS consultation questioned whether different types of waste could be safely co-located in a disposal facility. Research will be required to support the detailed design and safety assessment for the disposal facility for each type of waste, and in relation to any potentially detrimental interactions between the different disposal systems. Previous studies and evaluations have identified the most important interactions and these will be kept under review in light of any new research findings. This includes the exchange of information with a number of international waste management programmes.

In principle the UK Government sees no case for having separate facilities if one facility can be developed to provide suitable, safe containment for the Baseline Inventory. This is because the sharing of surface facilities, access tunnels, construction support and security provision could lead to significant benefits, including major cost savings and lower environmental impacts. There is no reason why this should not be technically possible, in theory, although the final decision would be made in the light of the latest technical and scientific information, international best practice and site specific environmental, safety and security assessments.

How long will it take to plan and build the facility?

The process is driven by discussions with local communities, so we cannot be exact, but it is likely to be around two to three decades from the beginning of the site selection process to when a facility can receive the first waste emplacement.

How deep will the facility be?

The depth at which the underground disposal vaults and tunnels would be located is likely to be somewhere between 200 and 1000 metres. This will depend on the geology at the site for the facility. The 200 metres depth is a minimum to ensure that the facility is protected from the potential effects of changes at the surface, for example ice ages or erosion resulting from future ice ages. The 1,000 metres depth is an approximate threshold below which there are likely to be significantly greater technological difficulties in excavating stable cavities in the rock.

How will waste be transported to the facility? How many movements will there be?

The waste will be transported to the facility in a controlled manner. The requirements for the safe transport of radioactive material by road, rail and sea stem from international agreements and European Directives. These requirements have been implemented in UK legislation setting out what types of transport package are allowed, how much radioactivity they are allowed to contain, and how they should perform against specified tests. Compliance with these requirements will provide the necessary levels of safety during transport.

It is not possible to provide an indicative number of transport movements at this time as they will be dependent upon the location of disposal facilities, the volume and activity content of the waste material and the associated type of packaging that will have to be used as prescribed in the regulations.

The NDA's delivery organisation will consider, with a Community Siting Partnership, the implications for waste transport to minimise movements of waste as far as possible. It will pay regard to existing waste distribution, and possible future arisings, as well as the need for safe and secure stores, and the uncertainties regarding siting a geological disposal facility.

What if it costs far too much? Will the government pay?

Legacy waste is waste from the UK's public sector nuclear programme which has accumulated over the last fifty years or which is already committed.

Government has long recognised that delivering and paying for a long-term waste management solution for legacy waste is a responsibility that falls to the public sector, in line with the polluter pays principle. Government has committed to a staged implementation process that allows affordability and value for money to be assessed at various points.

What will a geological disposal facility look like on the surface?

At this early stage in the process it is not possible to specify exactly what a geological disposal facility will look like. The detailed layout and design of the basic geological disposal facility features both above and below ground will depend on its location, as

the actual design will be tailored to the geography (topography and geology) and specific geological structure at the site in question. Potential surface features of a geological disposal facility might include for example construction support facilities, workshops, an encapsulation plant, services, management and administration buildings, buffer waste storage, visitor centre, etc. Planning controls will ensure that these are appropriately structured and landscaped.

How will the geological disposal facility be designed to stop radioactivity returning to the surface?

The waste will be placed in an engineered underground containment facility - the 'geological disposal facility'. The facility will be designed so that natural and man-made barriers work together to minimise the escape of radioactivity. Radioactivity is already all around us in the environment from natural background sources. The disposal facility will be designed to ensure that any radioactivity that escapes and eventually reaches the surface would be insignificant compared to naturally occurring background levels.

Will waste be retrievable and, if so, for how long?

The decision about retrievability and whether to keep a facility (or vaults within it) open for an extended period of time can be made at a later date in discussion with the independent regulators and the local community once a site has been agreed. In the meantime RWMD will develop a flexible design for geological disposal that has the potential to be maintained in a retrievable mode and is encouraging to waste packagers to manufacture waste packages with the appropriate longevity.

To some extent waste placed in a disposal facility will always be "retrievable". However, it will get progressively more difficult to retrieve the waste as the facility evolves. If there are thought to be benefits associated with making retrieval easier (e.g. by delaying backfilling) then these benefits need to be balanced against associated risks.

How can you ensure the closed facility will be safe for many thousands of years?

Government's view is that closure at the earliest opportunity once facility waste operations cease provides greater safety, greater security from terrorist attack, and minimises the burdens of cost, effort and worker radiation dose transferred to future generations.

However, the decision about whether or not to keep a geological disposal facility (or vaults within it) open once facility waste operations cease can be made at a later date in discussion with the independent regulators and local communities

Following closure, safety, environmental and security regulation will continue until the relevant regulators are satisfied that regulation is no longer required. A post closure safety case must be approved by the environmental regulator and the site could be, for example, returned to nature or farmed. Records of the location and general contents of the facility would be held permanently by The National Nuclear Archive.

What will happen after the facility closes?

Safety, environmental and security regulation will continue until the relevant regulators are satisfied that regulation is no longer required. A post closure environmental safety case must be approved by the environmental regulator. Eventually the site could be, for example, returned to nature or farmed.

The Radioactive Waste Management Directorate Process

What say will the regulators have in the formation of our programmes and plans?

Government will look to early and continued involvement of the safety, environmental, security, transport and nuclear safeguard regulators throughout the MRWS implementation programme.

Early and ongoing engagement will inform and assist the subsequent formal regulatory stages. Regulatory scrutiny of early work will assist the process of site selection; provide information to stakeholders; build confidence in the safety, security and environmental performance of the proposed geological disposal facility; inform the work required during future stages; and help to avoid unnecessary and costly delays during the formal regulatory stages.

Government will expect us and our delivery organisation, in discussion with relevant planning authorities and the regulators, to develop a coordinated strategy for seeking the necessary planning permission and regulatory approvals, with roles, responsibilities and any 'hold-points' clearly identified.

What influence will the reconstituted CoRWM have on the NDA's geological disposal facility development programme?

Government will have to consider and respond publicly to all substantive advice and both CoRWM's published advice and Government's response will be made available in respective Parliaments/Assemblies. Furthermore, Parliamentary and Assembly committees will also have the opportunity to directly engage with CoRWM and may propose work for inclusion in the Committee's work programme to sponsoring Ministers.

Government has put new NDA governance arrangements in place and a Waste Management Steering Group established to scrutinise all of our long-term waste management planning and development programmes. The CoRWM Chair, along with appropriate members, will be invited to attend some of these meetings.

When will planning and development of the geological disposal facility actually begin?

We are currently carrying out preparatory work in preparation for geological disposal. This includes developing a generic design and generic Disposal System Safety Case.

We are supporting Government with the MRWS process and new build waste acceptance. We are planning for implementation and for the transition towards becoming a Site Licence Company.

On-going work includes our responsibility for packaging assessments, the Letter of Compliance process and support to NWAT. We are also proceeding with needs driven research and development. We continue to engage with a range of stakeholders through our PSE & Communication strategy and plans.

How is this sustainable, and in line with the Government's sustainable development principles?

In developing its recommendations CoRWM developed a number of key Guiding Principles (See CoRWM report www.corwm.org.uk/content-1092). They were actively pursued in all aspects of the Committee's work and reflected the values which the Committee believed were integral to the development of a successful waste management policy. In particular the values of equity (fairness) and sustainability played a vital role in the assessment and recommendation of waste management options.

How are you dealing with CoRWM's recommendation for safe and secure interim storage?

Existing stores for waste packages are typically designed to provide a service life of 50 to 100 years. These stores will have their service lives extended as required, in order to provide sufficient safe and secure interim storage throughout the geological disposal facility development programme. The replacement of stores will be avoided wherever possible, but we will ensure that our strategy allows for the safe and secure storage of the waste contained within them for a period of at least 100 years. We are also reviewing the adequacy of our planned and regulated interim storage programme to ensure sufficiency and longevity of capacity. This covers legacy facilities, more modern stores and also British Energy and MoD wastes not managed by us. The regulators and Government are closely involved in this work and it will be completed later this year. The results will be reflected in our next Strategy document.

Experiences in other countries

What are other countries doing with their waste?

As of 2006 at least 39 countries (including the UK) had significant arisings of radioactive waste. Of those countries, 25 have taken final decisions on a long-term policy and all had opted for geological disposal. These include Belgium, Canada, Finland, France, Germany, USA and Sweden.

A further six have expressed a preference for geological disposal, with the remainder yet to decide.

All countries also have some form of interim storage. But no country has indicated that it has chosen, or is considering, indefinite storage as its long-term waste management policy.

Country specific information:–

The USA has an operational facility which is disposing of transuranic wastes (broadly equivalent to Low Level Waste (LLW) - Intermediate Level Waste (ILW)) and Germany is planning to have its geological facility for non-heat generating wastes operational by 2013.

A number of countries (including Finland and Sweden) are already investigating their preferred sites for a geological disposal facility for spent fuel. Finland and Sweden already have shallow geological facilities for disposal of ILW and LLW. Sweden has been operating the deep geological research facility, testing techniques for disposal of spent fuel, for a number of years.

France is investigating a site at Bure with a view to it becoming the final disposal facility and Canada is developing a deep repository for LLW and ILW at Kincardine.

How has voluntarism and partnership been used in other countries?

An approach based on voluntarism and partnership has been used in a number of countries as part of processes for the siting of disposal facilities for radioactive waste, including in Belgium, Canada, Finland and Sweden.

In Finland for example there was engagement with volunteer communities and environmental assessment to identify a preferred site. In 2000 the Eurajoki municipality approved the construction of the geological disposal facility at Olkiluoto. The Finnish Government approved construction at that site later in the year and the Finnish parliament ratified the decision in 2001. Underground investigations are now ongoing at Olkiluoto and the community is involved through regular interactions with Posiva the implementing organisation. The Community is benefiting economically from the development, for example as Posiva has moved its offices to the area and is using local contractors and a local workforce wherever possible.

In June 2009, the Swedish Nuclear Fuel and Waste Management Company, SKB, selected Forsmark as the site for the final repository for Sweden's spent nuclear fuel.

The site selection process was between two volunteer communities Forsmark in the municipality of Östhammar municipality and Laxemar in the municipality of Oskarshamn.

Both communities had a partnership approach, and were financed to take part in the process. Both communities were involved in the assessment work, and looked in parallel at how to maximise the benefit to the community from the development, in particular from local industry development and skills training.

The selection of the site was the result of close to 20 years of work during which SKB has conducted surveys throughout Sweden and feasibility studies in eight municipalities. These were followed by site investigations in Forsmark and Oskarshamn between 2002 to 2007.