WORKING IN PARTNERSHIP WITH THE UK NUCLEAR INDUSTRY TO PACKAGE WASTE - 16263

Ann McCall, Martin Cairns
Radioactive Waste Management Limited,
Building B587, Curie Avenue, Harwell Oxford, Didcot
Oxfordshire, OX11 0RH, United Kingdom
ann.mccall@nda.gov.uk

ABSTRACT

Radioactive Waste Management (RWM) is a wholly owned subsidiary of the Nuclear Decommissioning Authority (NDA), which is responsible for managing the effective clean-up of the UK's nuclear legacy.

RWM is responsible for delivering a geological disposal facility and providing radioactive waste management solutions. To this end, RWM provides advice to waste owners to help them retrieve, condition and package waste now in ways that make them suitable for disposal later.

To facilitate planning decisions and hazard reduction, RWM operates the Disposability Assessment process. This is used to provide advice to waste producing organisations on approaches to waste packaging and interim storage of packaged wastes. This advice is intended to ensure compatibility with future geological disposal requirements, as far as this is possible in advance of the availability of Waste Acceptance Criteria for a Geological Disposal Facility (GDF). As such, it is an enabler for early hazard reduction on UK nuclear sites through the facilitation of packaging.

This paper explains how RWM is working with waste owners through the Disposability Assessment process to deliver optimised waste packaging solutions through proactive and early engagement. This includes specific examples of how the process has been used in a flexible way to contribute to accelerated and sustainable hazard reduction at UK sites using a partnership approach.

INTRODUCTION

As a pioneer of nuclear technology, the UK has accumulated a legacy of higher activity radioactive waste and material. This has arisen over the last 60 years and is being stored on an interim basis at around 30 nuclear sites across the UK. Additional higher activity radioactive waste will arise as existing facilities are decommissioned, and through the operation and decommissioning of new nuclear facilities. A new 16 Gigawatt (electrical) nuclear power programme, such as that currently envisaged in the UK, would contribute around 12% to the total packaged volume of waste which will require geological disposal.

Higher activity radioactive waste comprises a number of categories of radioactive waste – high level waste (HLW), intermediate level waste (ILW) and that portion of the UK's low level waste (LLW) that is not suitable for near-surface disposal. In addition, there are some radioactive materials that are not currently classified as waste but would, if it were decided that they had no further use, need to be managed as wastes through geological disposal. These materials include spent nuclear fuel, plutonium and uranium.

The UK Radioactive Waste Inventory is updated regularly to present the latest assessment of the radioactive wastes and materials expected to arise in the UK. Based on the latest national inventory and an assumed 16 gigawatt (electrical) new build programme the currently estimated volume of all the waste and materials which will potentially require geological disposal is around 650,000 cubic metres [1]. A breakdown of the potential UK radioactive waste inventory is summarised in Figure 1.

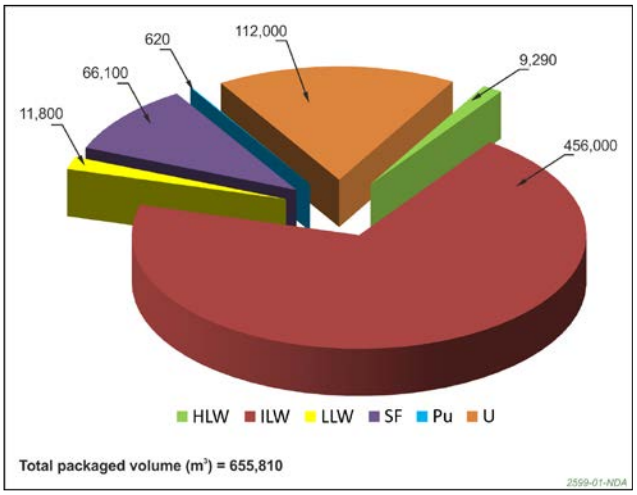

Figure 1: Potential UK Inventory for Geological Disposal

The NDA is responsible for planning and implementing geological disposal of this inventory of radioactive waste. The NDA has established RWM as a wholly owned subsidiary specifically for this purpose.

RWM currently operates a generic, non-site specific, work programme to develop disposal concepts and designs, demonstrating the safety of geological disposal through a generic disposal system safety case [2] and developing the science and technology necessary to underpin geological disposal, building on relevant international experience. This generic work programme, which considers a range of potential geological settings and disposal concepts, will in due course inform the production of site specific programmes as the site selection process moves forward.

A key role for RWM is to support waste producers in developing optimised plans for the management of their higher activity radioactive waste. To this end, RWM provides advice on the packaging of waste through the Disposability Assessment process, underpinned by the generic work programme, to ensure there is a high degree of confidence that packaged wastes will be suitable for disposal in a future GDF.

DISPOSABILITY ASSESSMENT PROCESS

Disposability Assessment is a mature process that has been applied by RWM and its predecessor organisations since the 1980s. The process was originally developed primarily as a means to assist site operators to convert intermediate level wastes (ILW) into safe and disposable forms. Since its inception, the process matured to a point that the underlying assessments were established on a more structured footing with detailed advice being issued to waste packagers, highlighting further information needs or a need for further development and/or research before a Letter of Compliance (LoC), signifying endorsement of the proposals, could be issued. The process has also evolved to align with waste producer plans for implementation of the packaging plant project programmes, with staged interactions occurring during planning, pre-construction and, finally, before active operation of any packaging plant.

The status of the Disposability Assessment process was strengthened in 2003, when support was provided by UK nuclear regulators and it was recognised within regulatory arrangements for nuclear licensed sites [3]. Since this time, joint regulatory guidance has been issued in connection with various aspects of the management of higher activity radioactive waste at nuclear licensed sites. The UK regulators recognise RWM as the

appropriate body to advise site licensees on the packaging and conditioning for geological disposal of higher activity radioactive wastes, with such advice provided through the Disposability Assessment process.

This process is recognised by both the NDA and the UK regulators as an approach to mitigate the risk that the UK investment in packaging wastes today will result in a new nuclear legacy being created. RWM's Disposability Assessment process provides visibility of the issues and risks in dealing with the UKs wastes.

The Disposability Assessment process provides an additional benefit in the development of plans for the implementation of geological disposal in the UK. This arises because it permits the consideration of waste packages and their performance to be made against the safety cases for transport and the operational and post-closure periods of a GDF.

As the implementer and future operator of a GDF, and therefore as the ultimate receiver of waste for disposal, RWM will be responsible for the production of waste acceptance criteria (WAC) for the facility. While plans for the construction of a GDF remain at an early stage, the information necessary to define WAC is not available. In the meantime, and as a precursor to the WAC, RWM produces packaging specifications so wastes can be converted into passively safe and disposable forms as soon as is reasonably practicable. These specifications define the bounding features and performance requirements for waste packages that would be compatible with the anticipated needs for transport to and disposal in a GDF, as set out in the documented disposal system concept and safety case [2]. Thus, the packaging specifications provide a baseline against which the suitability of plans to package higher activity waste for geological disposal can be assessed.

The application of the Disposability Assessment process in this way helps RWM, nuclear site operators and regulators gain confidence that waste packages manufactured today will ultimately be compliant with requirements for transport and disposal in a future GDF in the absence of site-specific WAC. More detail on the Disposability Assessment process is available [4].

It can take several years to complete the full Disposability Assessment process with all the supporting technical work. Waste producers often need a quicker response, particularly at early stages in the development of a project, to allow risk-informed decisions on the options for waste packaging. As a result of early engagement with waste packagers on a number of specific projects during the past year a new approach has been developed, which provides an early 'Expert View' from RWM ahead of the full disposability assessment. This early opinion is based on input from experienced, competent RWM staff on the issues and challenges potentially raised by the proposals. Based on these inputs, the key risks to disposability associated with the proposals are established, and an outline 'path to closure' is mapped out. Actions under this 'path to closure' are assigned to the waste packager and RWM as appropriate.

This paper goes on to describe two specific examples of how RWM is working with UK waste owners through the Disposability Assessment process, where technical challenges have necessitated the adoption of novel approaches to waste packaging. The first example explains how the 'Expert View' process was adopted to provide fast-tracked advice to a waste owner on its proposed novel approaches to packaging high-hazard wastes. The second example describes how RWM has worked with the owners of decommissioning power stations to implement novel containers for packaging wastes, where there was an identified benefit from adopting changes to the currently available waste container specifications.

EXPERT VIEW PROCESS AND ITS APPLICATION TO HIGH HAZARD WASTES

There has been significant interest in the 'Expert View' approach since it was launched in 2014. One early success relates to the proposed retrieval of high hazard wastes from a historic storage facility at Sellafield known as The Magnox Swarf Storage Silos (MSSS). The MSSS facility dates back to the 1960s and comprises 22 16-metre-deep silos containing fuel cladding from Magnox fuel reprocessing. The MSSS design was based on wet storage of the waste and therefore the composition, condition and age of the wastes in this facility are variable, consisting of corroded Magnox fuel swarf (much of the waste now corroded to sludge), irradiated or contaminated Miscellaneous Beta Gamma Waste (MBGW) which is mostly containerised, and a mixture of swarf and MBGW in the layers within the silos. This facility is one of the highest hazard facilities on the Sellafield site.

The MSSS was originally conceived in the 1960s as a disposal solution for reprocessing wastes and was therefore not designed to facilitate retrieval of the waste. The site operator, Sellafield Ltd, has been working for many years to develop a solution to safely retrieve the waste from the silos so that it can be sentenced for conditioning and final disposal in a GDF. RWM has been working closely with Sellafield Ltd during this period to develop a solution for packaging the retrieved waste based on conditioning by immediate encapsulation using cement in stainless steel boxes. This approach has over a long timescale achieved a reasonable level of maturity.

In the last year or so, Sellafield Ltd has identified opportunities to accelerate retrieval of the waste from the MSSS based on deferred conditioning. The new opportunity would result in the waste being retrieved up to 5 years ahead of the original schedule with associated significant cost savings.

The revised proposal would involve the waste being retrieved mechanically from the MSSS silos and deposited in a disposable skip. Filled skips of waste would be designated as either not requiring disruption of the contents or as requiring further treatment including disruption of items or containers potentially containing void space and/or free liquor. Skips designated as not requiring disruption would be transferred to a facility where the skips would be checked for adequate water cover and lidded. These lidded skips would then be placed into stainless steel boxes, which would themselves then be lidded and routed for interim storage.

Skips of waste designated as requiring disruption would either be transferred for immediate disruption in the planned disruption facility, once available, or recorded as requiring disruption but disrupted at a future finishing plant following a period of interim storage.

The waste would be stored in this unconditioned state for an extended period of time (estimated to be 50-100 years) with the interspace between the skip and box remaining empty. In so doing, any expansive corrosion that may occur in the skip would not impinge on the box walls which could otherwise lead to unacceptable deformation of the outer container. The stored packages would be subject to a condition monitoring and inspection regime which will inform the plans for final conditioning to meet the conditions for disposal.

The current plan is that following the period of interim storage, the packages would be sent to a future finishing plant where lids would be removed and the contents grouted. The skip lids would be refitted and a final grout pour would be made to fill the interspace between the skip and box. The box lid would be re-bolted forming the finished package for disposal. A cross-sectional illustration of such a finished waste package is illustrated in Figure 2.

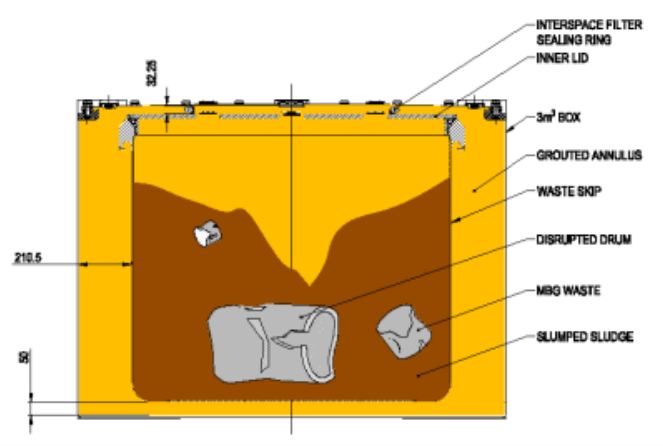

Figure 2 Illustration in cross-section of a finished $3m^3$ box waste package containing MBGW and sludge from MSSS conditioned using cement grout (illustrated in yellow)

In order to provide an initial response to these proposals, RWM used the Expert View process to identify the key risks to disposability and any other associated risks, and to provide an approach to continue working in co-operation with Sellafield Ltd. to develop the proposals in preparation for the formal disposability assessment of these revised proposals. The Expert View process identified that the main risk from the proposals relate to making a sufficiently robust container that is resistant to corrosion, particularly to the outer skin of the stainless steel boxes. Further risks related to the generation of an adequately infiltrated product that has low voidage, elimination of free liquids and criticality compliance. In particular, these risks were perceived as being more significant for those skips whose contents require some form of disruption (e.g. those containing sealed cans). Overall, it was concluded that the proposals should eventually generate a robust package design with multiple physical barriers to the release of materials during handling, and emplacement at a GDF. This outcome was predicated upon a more detailed consideration of the identified risks using the full Disposability Assessment to confirm that the packages would evolve and perform as required.

Following on from the Expert View, Sellafield Ltd responded with further evidence to address some of the risks identified in the Expert View. The more comprehensive Disposability Assessment was then initiated on these revised proposals, based on the new supporting information. The Disposability Assessment concluded that the proposal could be supported conceptually so RWM endorsement was provided in the form of a conceptual stage LoC. It was emphasised that the risk of not being able to produce disposable packages increases as the period of storage, or period prior to disruption, increases. Therefore, RWM strongly encouraged Sellafield Ltd to complete early disruption such that the initial period of storage would be minimised to manage this risk. The assessment also identified key actions required to further progress this important work to reduce the risk in this high hazard facility at Sellafield. The completion of RWM's Disposability Assessment work has enabled Sellafield Limited to bring forward the plans for the retrieval and packaging of the waste from the MSSS facility and accelerate the plans for early hazard reduction on the Sellafield site.

IMPLEMENTATION AND USE OF NOVEL CONTAINERS

The second example is that of wastes arising from the decommissioning of the UK's fleet of nuclear power stations.

The disposal concept developed by RWM for ILW is based around multiple containers stacked in vaults, backfilled using a cementitious backfill. The majority of the packaged ILW in the UK is typically encapsulated using cement and packaged in thin-walled stainless steel containers. Many thousands of such packages have already been generated and are held in interim storage pending disposal.

While RWM has developed standards and specifications for a standard suite of waste packages, innovative novel proposals that fall outside of these standards are considered by RWM on a case by case basis. Where sufficient justification can be provided for a novel approach to waste packaging, such changes are evaluated by RWM. This involves understanding the implications for the GDF concept and underpinning work programme. Where necessary, the GDF change control process is implemented to adopt the innovation into the disposal system design, safety cases and waste packaging specifications. One significant example of the implementation of innovative packaging proposals is the use of robust shielded containers proposed by Magnox Ltd.

In the past few years, RWM has been responding to the changing needs of waste producers to implement novel waste containers that promote greater operational flexibility. In particular, there has been a lot of interest in robust shielded containers to provide the necessary safety functional requirements through the robustness and resilience of the container. These containers typically possess high wall thicknesses such that shielding requirements are also met thereby reducing the need for remote operations and highly engineered packaged waste stores. Waste producers have indicated that such containers would provide them with a more flexible approach to waste packaging, reducing the costs of significant development work and hence promoting accelerated hazard reduction and reduce overall costs on sites being decommissioned.

The nature of the containment provided by robust shielded containers means that the required performance of the waste package will derive largely from the properties of the waste container. This is in contrast to more typical waste packages where the overall performance is achieved through a combination of the (typically grouted) wasteform in conjunction with a thin-walled waste container. The properties required of the waste package contents (i.e. the wasteform) for robust shielded containers are therefore principally limited to ensuring that they cause no significant deleterious effects on the performance of the waste container and, as a consequence, on the performance of the waste package as a whole. Robust shielded waste containers are therefore potentially suitable for the conditioning of waste with or without the use of an encapsulating medium.

RWM has developed two outline specifications for robust shielded container; a 500 litre drum-type [5] and a $3m^3$ box-type [6], which are illustrated in Figures 3 and 4 respectively.

Figure 3 – Robust shielded drum waste container

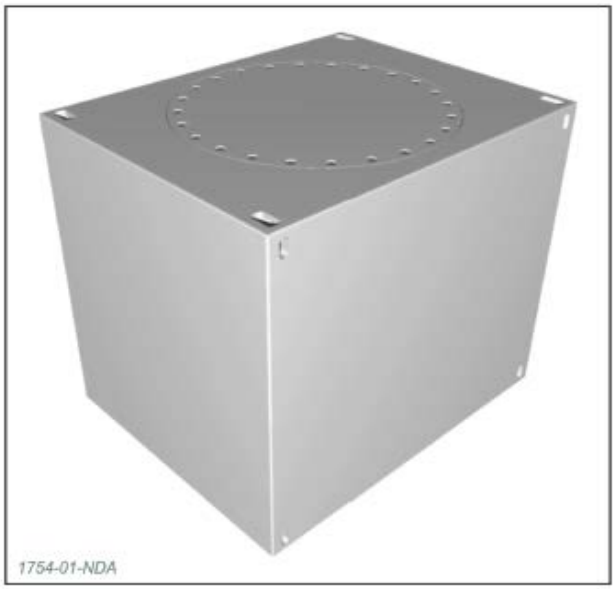

Figure 4 – Robust shielded $3m^3$ box waste container

Waste packages manufactured using the robust shielded $3m^3$ box waste container would be transported through the public domain within a protective transport container the design of which will be based upon that of an ISO freight container. The combination of waste package and transport container would be capable of satisfying the requirements defined by the International Atomic Energy Agency (IAEA) Regulations for the Safe

Transport of Radioactive Material [7] for Type IP-2 transport packages. This will limit the contents of the waste packages to materials which can satisfy the requirements for low specific activity (LSA) material or surface contaminated objects (SCOs).

Waste packages manufactured using the smaller robust shielded drum waste container would be overpacked to meet Type B requirements for transport.

RWM has been working closely with waste producers since 2010 to take the proposed adoption of robust shielded containers into the standard suite of approved waste containers for geological disposal. This has included significant changes to the disposal system specification, design and underpinning safety cases, culminating in the production of the waste package specifications for the two types of robust shielded container [5,6]. With these new specifications now in place, waste producers have been able to develop their plans for packaging specific wastes to a high level of maturity based on the use of these new container types. RWM is currently evaluating a number of specific waste packaging proposals using the robust shielded containers, encompassing the following types of waste from nuclear power station decommissioning activities:

- Ion-exchange materials
- Fuel element debris, including Magnox cladding and graphite structural components
- Sludge
- Miscellaneous contaminated items
- Miscellaneous activated components
- Fuel element debris dissolution secondary wastes.

It is anticipated that the first formal final stage (LoC) would be provided early in 2016. This will be used to demonstrate to UK regulators that wastes packaged using these containers should be compliant with the requirements for geological disposal as currently foreseen by RWM. This will support the licensing process for new waste packaging plant and interim package storage.

SUMMARY

RWM plays an important role in supporting hazard reduction at UK nuclear sites through the provision of waste packaging advice, which is formally delivered through the Disposability Assessment process. The process is applied in a flexible fashion to respond to the needs of waste producers and to facilitate decommissioning activities and early hazard reduction on UK nuclear sites. Close co-operation and improved partnership working arrangements between the waste producers and the implementer of the UK's GDF is realising benefits to meet the needs for accelerated hazard reduction at UK sites.

REFERENCES

1. DEPARTMENT OF ENERGY AND CLIMATE CHANGE, "*Implementing Geological Disposal: A Framework for the Long-Term Management of Higher Activity Radioactive Waste"* (2014)
2. NDA, "*Geological Disposal – An overview of the generic Disposal System Safety Case"* (2010)
3. HSE/EA/SEPA, The management of higher activity radioactive waste on nuclear licensed sites, Joint guidance from the Office of Nuclear Regulation, the Environment Agency, the Scottish Environment Protection Agency and Natural Resources Wales to nuclear licensees, February 2015
4. RWM, Geological Disposal: An Overview of the RWM Disposability Assessment Process, WPS/650/03, April 2014

5. RWM, *Geological Disposal: Waste Package Specification for 500 litre robust shielded drum waste packages to be transported in a SWTC-150*, WPS/380/01, February 2015
6. RWM, *Geological Disposal: Waste Package Specification for 3 cubic metre robust shielded box waste packages for transport as part of a Type IP-2 package*, WPS381/01, February 2015
7. International Atomic Energy Agency (IAEA), Regulations for the Safe Transport of Radioactive Material, 2012