UK Low Level Waste Repository Ltd – Standardising the Design and Transport of Packages to Contain Low Activity Radioactive Wastes in the UK – 11459

Martin Walkingshaw, LLW Repository Ltd, United Kingdom
Mark Flynn, Low Level Waste Repository, United Kingdom

INTRODUCTION

The Low Level Waste Repository, near the village of Drigg in Cumbria, is the UK's only authorised Low Level Waste disposal facility and is operated under contract to the Nuclear Decommissioning Authority (NDA) by LLW Repository Ltd. Volumetric capacity at the facility is limited and there is insufficient capacity at the site to meet the future needs of UK consignors of low level waste without treatment and diversion of waste. Analysis of the latest UK Radioactive Waste inventory forecast waste arisings indicate that a potential capacity gap of 3.5 million m^3 exists between the maximum capacity of the LLWR site and the volume of waste currently identified for disposal. The current focus of the LLW Repository is to prevent disposal capacity being taken up at LLWR by waste types which lend themselves to alternative treatment and/or disposition routes. Proposed alternatives include offering metallic and combustible waste treatment services and diversion of Very Low Level Waste (VLLW) to alternative disposal facilities. The aim is to ensure that only appropriate wastes, which require an engineered barrier for environmental or personnel protection, are consigned to the vaults at the LLW Repository site. Application of the waste hierarchy in this way ensures that the aims of the UK Government's Policy for the long term management of solid low level waste in the United Kingdom are achieved. The establishment of these alternative waste treatment routes is expected to extend the working life of the current LLWR to support the UK's nuclear decommissioning strategy. A wide range of services is being developed in parallel to facilitate this approach. This paper describes how the LLW Repository's package designs are adapting to the waste hierarchy, to meet the demands of the business, to facilitate making best use of the LLWR site and as a result extending its operational life in line with UK National Strategy.

RADIOACTIVE WASTE

Radioactive waste is defined as material that has no further use and is contaminated by, or incorporates, radioactivity above levels defined in UK legislation. Radioactive wastes forms vary from wastes that contain high concentrations of radioactivity to general industrial and medical wastes that are only lightly contaminated with radioactivity.

Radioactive wastes are produced in the UK as a result of the generation of electricity in nuclear power stations and from the associated production and re-processing of the nuclear fuel, from the use of radioactive materials in industry, medicine and research, and from military nuclear programmes.

In the UK radioactive wastes are classified in terms of the nature and quantity of radioactivity they contain and their heat-generating capacity, as High Level Wastes (HLW) Intermediate Level Wastes (ILW), Low Level Wastes (LLW) or Very Low Level Waste (VLLW). The packages described in this paper are primarily designed to transport VLLW and LLW for treatment or disposal.

REGULATORY REQUIREMNTS FOR PACKAGES CONTAINING LOW ACTIVITY WASTES

Very Low Level Waste

Unlike the LLW Repository, VLLW Land Fill operators have no package acceptance criterion. The facilities merely must be able to handle the package designs safely when unloading and disposing.

VLLW land fill sites each hold individual Environmental Permits which stipulate their activity restrictions which can vary from site to site. Experience has shown that the majority of VLLW is the UK is transported under the IAEA category of Excepted Packages or Industrial Packages IP-1. It is common for some VLLW contaminated with low toxicity radionuclide's, for example; solid waste contaminated with Tritium only, to be exempt from the requirements of the transport regulations due to TS-R-1 [1] being often, more flexible than UK Land Fill sites conditions for acceptance. But conversely for VLLW contaminated with higher toxicity radionuclide's such as uranium, TS-R-1 [1] is often more restrictive and the VLLW will require packaged in either Excepted Packages or Industrial Packages Type IP-1.

Excepted packages and IP-1 packages are not required to be subjected to any IAEA regulatory testing [1]. However designs must meet the basic criterion in TS-R-1 Paragraph 606 – 616 [1] (Air transport is not considered for VLLW). The assessment against package integrity and compliance sits with the individual waste producers.

Low Level Waste

Due to the LLW Repository's acceptance criteria for raw LLW or the return of the residue waste from treatment facilities *broadly* aligning with the LSA-II criteria in TS-R-1 [1]. All LLW Repository package designs are required to meet the requirements of an IP-2 package. Fissile LLW meeting the LSA-II Fissile criteria is considered further in the conclusion to this paper.

IP-2 packages must be designed such that they can demonstrate containment under Normal Conditions of Transport (NCT). In the regulatory spirit this is demonstrated by subjecting the package to both a free drop test and a stacking test. There are a number of alternative requirements, TS-R-1 paragraph 624 – 628 [1] which, if satisfied remove the need to subject the designs to additional testing to demonstrate integrity to the same criteria (NCT). The LLWR/TC02 package took advantage of these alternative requirements which were introduced by the IAEA's 1985 Safety Series No. 6 regulations [2] and remain in current regulations TS-R-1 paragraph 627) [1].

Para 627 - Freight Containers with the characteristics of a permanent enclosure may also be used as Type IP-2 or Type IP-2, provided that

- *(a) The radioactive contents are restricted to solid materials.*
- *(b) That satisfy the requirements for Type IP-1 specified in para 601.*
- *(c) They are designed to conform to international Organisation for Standardisation document ISO 1496/1: Series 1 Freight Containers, - Specifications and testing – Part 1: General Cargo containers for General Purposes, excluding dimensions and ratings. They shall be shall be designed such that if subjected to the tests prescribed in that document and to the accelerations occurring during routine conditions of transport they would prevent;*
  - *(i) Loss or dispersal of radioactive contents; and*
  - *(ii) More than 20% increase in the maximum radiation level at any external surface of the freight containers*

Experience shows that paragraph 627 can be interpreted inconsistently, for this reason the UK has developed guidance by both the Competent Authority "DfT Guide to the Approval of Freight Containers as Type IP-2 and Type IP-3 Packages [3] and the UK industry forum Transport Container Standardisation Committee (TCSC) "TSCS 1090 "The Design, Manufacture, Approval and Operation of an ISO Freight Container for use as an Industrial Package Type 2 (IP-2)" [4]. TCSC 1090 is intended to influence design consistency and achieve an international standard regulatory interpretation of the containment requirements

for IP-2 ISO Containers. The majority of UK industry follows such guidance by subjecting all IP-2 ISO freight prototype designs to gaseous pressure fall leakage tests; before, during and after specific ISO 1496/1 type tests [5].

The LLW Repository existing fleet of IP-2 ISO container designs and the new TC02 Design are fully compliant with the above guidance documents [3] [4].

EXISTING PACKAGES TO TRANSPORT LOW ACTIVITY WASTES

Very Low Level Wastes
As implied above there are various designs of packages used to transport VLLW, the most common being drums at varying capacity, no standard system has ever been introduced in the UK to specifically transport and dispose of VLLW

Low Level Wastes
LLW Repository waste acceptance criteria restricts waste producers to using the LLW Repository IP-2 ISO containers to ensure integrity and longevity of the vaults is maintained. To offer waste producers maximum flexibility the LLW Repository operates a fleet of 9 x height driven design variants of their specially designed top opening IP-2 ISO Freight Containers. All but one special design (to transport super compactable waste) are designed as single use packagings due to the historic nature of their intended use. Although recently the twin seal designs have been subjected to various trials and engineering assessments, which has expanded their operational life to three cycles. Enabling the current fleet to be utilised for segregated waste treatment until the TC02 design is in full service.

All existing design variants are fabricated from weldable structural carbon steel of similar grades and strength to that used in commercial ISO freight containers. The external surfaces of the packages are coated with a paint system to provide corrosion resistance for 5 years of normal use and the inner surfaces of the packages remain unpainted. The packages consist of a bolted lid arrangement with a lattice base and associated grout port on the lid and a vent port on the end wall to facilitate the waste encapsulation requirements of the LLW Repository Ltd.

Retention of contents within the LLW Repository's IP-2 ISO containers is provided by the totally sealed welded construction of the body and lid, by single or twin lid seals and gaskets are fixed to the associated grout and ventilation ports. The integrity of the package containment system is ensured by a manufacturing container body leak tightness test prior to painting and additionally where designs incorporate twin lid seals, an isolation pressure fall test to lid seal interspaces.

No internal content restraint system is offered in any of the existing LLW Repository designs. The packages are intended to be fully loaded with any waste optimizing packing efficiency, reducing voidage and preventing any free movement of contents within the package cavity during normal conditions of transport. LLW Repository does offer a bespoke restraint design/fabrication service, for wastes/items requiring restraints for example; cylindrical shielded flasks to be transported for metal treatment (melting). Such requests are subject to Design Authority Approval on a case by case basis.

LLW REPOSITORY PACKAGE DESIGNS ADAPTING TO THE WASTE HIERACHY

The objectives of the LLWR Operational Strategy are to transform the LLWR from a storage and disposal site to a fully integrated waste management operation, providing a full service across the broad spectrum of waste management activities in support of LLWR and consignor initiatives.

The strategy is centred around application of the waste management hierarchy, making best use of existing NDA assets and opening of new fit-for-purpose waste management routes, with minimum impact on customers sites operations and where possible introducing standard compatible equipment. A UK Nuclear Industry LLW Management Plan has been developed to sit alongside the strategy which provides detail on a number of tactical solutions required to implement the significant opportunities presented by the proposed strategy.

LLW Repository in its role as National LLW 'integrator' has a key role in the implementation of the strategy. In order to facilitate implementation of the waste hierarchy (see Figure 1), LLW Repository has been developing a suite of new package designs to provide more options and flexibility for waste producers. The remainder of this paper is focussed on the development of two new package designs to accommodate the transport of metallic segregated waste for treatment, transport of combustible waste for incineration and the transport of VLLW for storage and/or disposal, with minimum impact to customers sites which are designed around existing LLW Repository Package designs .

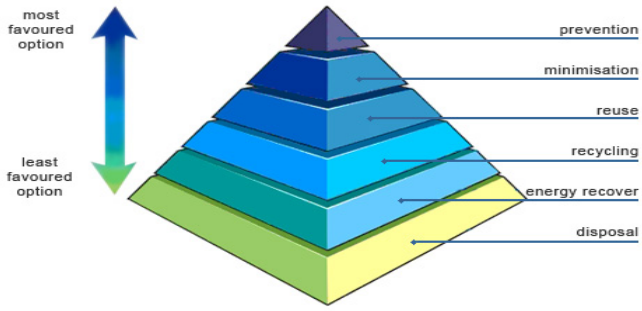

Figure 1 Waste Hierarchy

DEVELOPMENT OF THE LLWR/TC11 DESIGN

Taking in to account that no standard/specific system has ever been offered, the LLW Repository carried out international research to identify what package designs are already in use for very low activity wastes being transported on a large scale. The key parameters of the research focused on a low cost system that was compatible with existing transport infrastructure. The research unfortunately did not identify existing systems that satisfied all requirements.

The US patented soft sided packaging system was carefully considered as a VLLW package (see Figure 2), although the design integrity to satisfy UK environmental conditions was challenged, as was the compatibility with existing transport infrastructure. To address these challenges the LLW Repository contracted a well known US manufacturer of Soft Sided Packaging to carry out some non regulatory testing to demonstrate that the units could maintain leak tightness during routine conditions of transport, when transporting a range of contents. The testing in summary compiled of vibration table test with increased air flow at varying pressure with internal tracer dust applied to enable the external detection of any release of particulate during the test at set intervals.

Figure 2 Soft Sided Packagings

DESIGN, MANUFACTURE PROTOTYPE AND TEST THE LLWR/TC11 DESIGN

The design concept was developed to utilize the soft sided inner packaging as an inner unit to an external transport frame that was adaptable to existing UK transport infrastructure (see Figure 3). The inner unit would form the containment barrier and the outer frame form the transport system, together forms the “Package”. This configuration presents further opportunity to develop this design to IP-2, by using the structural integrity of the frame to qualify the design against the regulatory normal conditions of transport tests (drop test and a stack test). The outer frame has been designed around the footprint of a traditional LLW Repository designed half height IP-2 ISO container. The design will facilitate VLLW to be transported on the UK rail and road networks utilizing identical transport infrastructure as that for transporting LLW, identifying logistical cost saving opportunities, with future possibilities for the design to be used for transporting campaigned LLW’s, subject to contents restrictions.

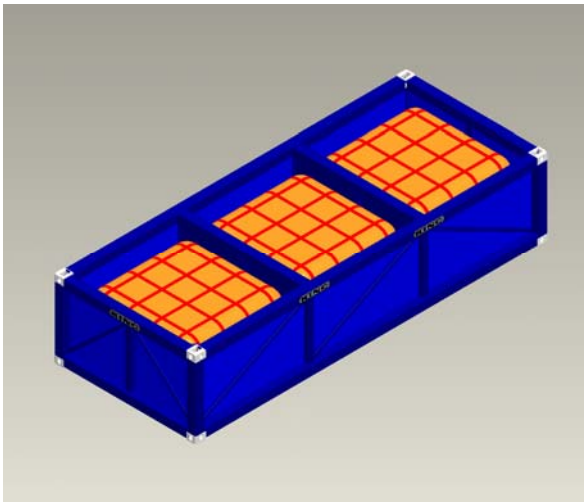

Figure 3 LLWR/TC11 concept design

DEVELOPMENT OF THE LLWR/TC02 PACKAGE

Adapting to the waste hierarchy has incurred changes to the waste process, the main change is that LLW is no longer only packaged, transported, grouted and disposed of at the LLW Repository. LLW needs to be unloaded from containers for treatment processing. The current fleet of containers designed some 10-20 years ago, do not incorporate an internal contents restraint system, for reasons discussed above and unloading waste at treatment facilities can be challenging.

A new package designs was required to adapt to the waste hierarchy for metal waste treatment services. The design scope was to design an IP-2 ISO container that was compatible with existing NDA sites container handling infrastructure, that could be loaded with waste contained in inner non qualified containers restrained into the TC02 and subsequently unloaded from the container in a safe manner without any need for man access to the container cavity. Other key requirements are listed below;

- Reusable with a 10 year design life;
- Capable of operating at -40C to +38C;
- Incorporate a system for prevention of internal pressure build up.

DESIGN, MANUFACTURE AND PROTOTYPE TEST OF THE LLWR/TC02 DESIGN

The new package design was allocated design number LLW/TC02 and has been designed and manufactured in accordance with Ref 1, 3, 4 & 5 as a re-usable IP-2 ISO Freight Container. The design comprises of a specially designed half height ISO freight container fitted with a bolted top lid, the stainless steel containment boundary has been taken inboard of the container structural boundary to assist in protecting the containers from sea freight handling operations and ease of decontamination. Pressure build up is managed by the installation of a HEPA filter and the structural steel is manufactured from low temperature steel allowing this container to be transported internationally. The container is rated at 35te and incorporates an internal restraint system using the base assembly, which is capable of restraining a 30te stillage. The key features of the design can be seen from Figure 4 below. The integral internal load restraint system uses 8x quasi spaced twist lock fastenings to the base assembly with removable stillages which are mechanically locked in place from the top of the stillage posts, facilitating all content restraint operations from outside of the package cavity. The system can accommodate a range of contents, from inner boxes as illustrated in Figure 4 to non pre-containerized items such as large redundant contaminated plant equipment.

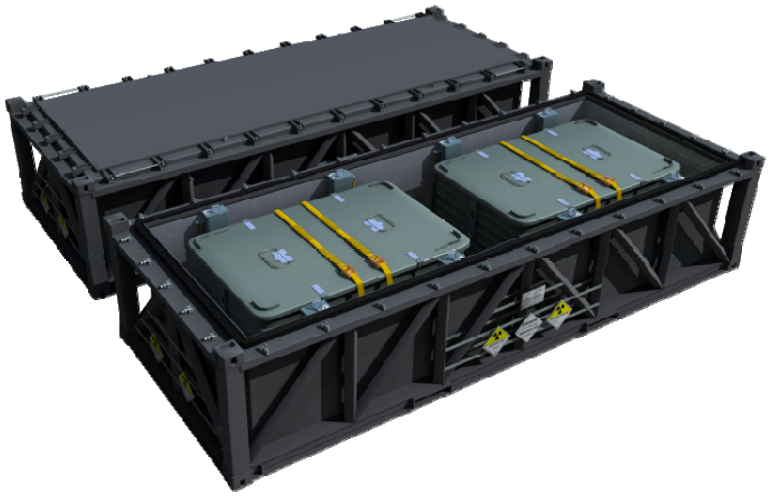

Figure 4 LLWR/TC02 Package Design

CONCLUSION

The changing nature of the radioactive waste industry has invoked many new challenges. The LLW Repository has risen to the challenge of adapting waste package designs to the demands of the waste hierarchy and demonstrated vigilance to IAEA package requirements and industry expectations, whilst ensuring all designs are compatible with existing infrastructure. The LLW Repository is able to offer the UK a standard compliant system to

transport waste for treatment or land fill satisfying UK National strategy to preserve the longevity of the UK's only authorized bulk LLW disposal site, assisting to sustain the future of the UK Nuclear industry for the next few decades.

REFERENCES

1. TS-R-1), "Regulations for the Safe Transport of Radioactive Material", IAEA Safety Standards Series, (2005 edition).
2. IAEA Safety Standards No.6 Regulations for the Safe transport of Radioactive Material 1985 Edition.
3. A DfT Guide to the Approval of Freight Containers as Type IP-2 and Type IP-3 Packages, DfT/RMTD/0002 (Freight Containers) Issue 2 July 2005
4. TCSC 1090 Code of Practice "The Design, Manufacture, Approval and Operation of an ISO Freight Container for use as an Industrial Package Type 2 (IP-2)" March 2009
5. ISO Standard. Series 1 Freight Containers - Specification and testing - Part 1: General cargo containers, (ISO 1496/1-1978), ISO, Geneva (1978).