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A LOW LEVEL WASTE TRANSPORT PACKAGING SYSTEM FOR THE 21ST CENTURY

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ABSTRACT

Historically, within the United Kingdom, the majority of solid low level radioactive waste arisings from the nuclear industry have been transported to the national Low Level Waste Repository in Cumbria for storage and disposal. This repository, which is operated by LLW Repository Ltd on behalf of the Nuclear Decommissioning Authority, is the UK's primary low level waste repository and has been in operation for over 50 years. However, although additional vault space has been created and there are plans for future expansion of the repository, the potential capacity is below the forecast volume of future low level waste arisings. This projected shortfall in capacity was one of the reasons the UK Government and its Devolved Administrations announced a new policy in 2007 for the long term management of solid low level radioactive waste that sets out a more flexible, sustainable approach for managing solid low level waste (LLW) in the long-term with the emphasis on managing LLW at higher levels of the waste management hierarchy in order to minimise waste volumes for disposal.

As a result of this new policy, LLW Repository Ltd identified the need to develop a new IP-2 transport packaging system to complement their existing packaging fleet. Unlike the existing packages, which were specifically designed for single use transport to and emplacement within the concrete lined vaults of the repository, the new packaging system (design number LLWR/TC02) has been designed as a re-useable packaging system specifically for transporting waste to treatment and recycling facilities.

This paper describes the components which make up the TC02 IP-2 packaging system and highlights the key design features and the various configuration options of the packaging system.

INTRODUCTION

The United Kingdom's national low level radioactive waste repository (LLWR) is located on the West Cumbrian coast six miles South of Sellafield near the village of Drigg and is operated by LLW Repository Ltd on behalf of the Nuclear Decommissioning Authority (NDA). It is the UK's primary repository for solid low level radioactive waste arisings and has been in operation since the 1950's.

The Repository is regarded as a key national asset: its continued availability is considered vital to both nuclear and non-nuclear UK industry low level radioactive waste producers. However, with the marked increase in decommissioning activities within the UK nuclear industry, radioactive waste forecasting figures highlighted the repository was being filled at an unsustainable rate. Although additional vault space has been created and there are plans for future expansion, the potential capacity was below the forecast volume of future solid low level waste arisings identified for disposal.

This projected shortfall in capacity was one of the key drivers for the long term management of solid low level radioactive waste within the UK to be reviewed. As a result of that review, the UK Government and its Devolved Administrations announced a new national policy in 2007 [1] that sets out a more flexible, sustainable approach for managing solid low level waste (LLW) in the long term with the emphasis on managing it at higher levels of the waste management hierarchy in order to minimise waste volumes for disposal. Subsequently, to implement the Government's new national policy, the NDA developed and published its strategy for the management of solid low level radioactive waste from the Nuclear Industry [2]. This strategy, summarised in Figure 1, is to apply the waste management hierarchy more effectively by developing new alternative waste treatment and disposal routes. Thus minimising disposal, which historically within the UK, apart from a few notable exceptions, has been the primary waste management route for LLW with the bulk having been consigned for disposal to the repository.

The current focus is to preserve disposal capacity at the LLWR, by ensuring that those waste types which lend themselves to alternative treatment and/or disposition routes are identified and dealt with accordingly. The aim is to ensure that only appropriate untreatable waste forms that require a multiple engineered barrier for environmental or personnel protection are consigned to the concrete lined vaults at the LLWR. The establishment of these alternative waste treatment routes is expected to extend the operational life of the current LLWR to support the UK's nuclear decommissioning programme. Application of the waste management hierarchy (avoid, reduce, re-use and re-cycle) 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.

During the development of the NDA strategy [2], LLW Repository Ltd recognised the need for a new IP-2 transport package to service the alternative waste management routes, particularly those for metallic and combustible waste forms. The existing waste disposal package designs used for transport to and emplacement within the repository vaults were specifically designed for that purpose and are not particularly well suited to servicing waste management routes where the payload needs to be unloaded.

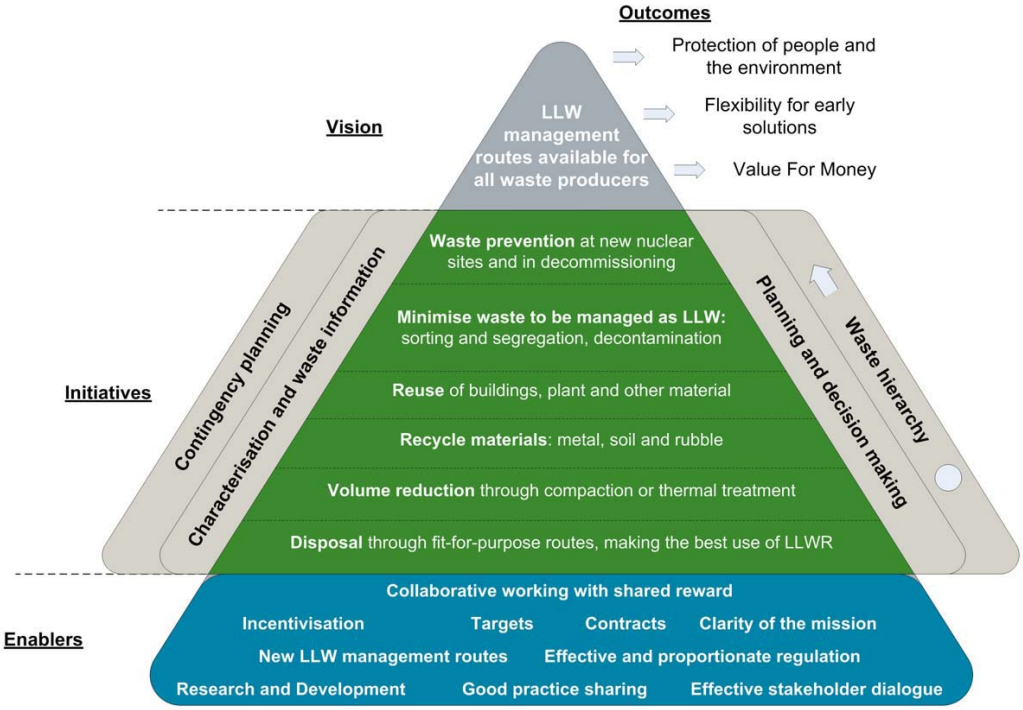

Figure 1: UK Nuclear industry LLW strategy [2]

CURRENT DISPOSAL PACKAGE

The current packages used for disposals to the repository vaults are purpose designed, top opening, ISO freight containers that not only comply with ISO 1496/1 [3] but satisfy the requirements of paragraph 627 of TS-R-1 [4] and are licensed as type IP-2 transport packages. The package designs also comply with TCSC 1090 [5] and satisfy the requirements of DfT/RMTD/0002 [6].

Although there are several package design variants: the principal variation being the height, all are based on the 20 foot ISO freight container footprint, with the most common variant in use being a half-height variant. These packages were all specifically designed as single use 'one trip' packages for disposal to the repository vaults and, as such, incorporate specific design features to facilitate grouting on receipt at the repository and minimise the internal voidage present after grouting. The features include an inverted base structure which eliminates the under floor void that exists in commercial ISO freight containers.

Although the disposal packages are designed for single use some have been re-licensed as re-usable packages following successful trials. However, these packages are not particularly well suited to that role. Features incorporated into the design to satisfy the repository disposal requirements can hinder the operability of the package in re-use, with the most significant hindrance to re-use being the exposed steelwork lattice of the inverted base structure shown in Figure 2. This particular feature not only presents a hazard for personnel accessing the container cavity to conduct radiological monitoring of the container internals at turnaround or to effect tie-down of payload; it can also present challenges when unloading items of payload due to the potential for items to snag on the exposed steelwork lattice.

A further challenge to unloading operations is the top flange detail which surrounds and overhangs the top opening of the container cavity. Items being unloaded can snag the underside of the flange causing damage to the flange and lid seal carrier, which is mounted on the topside of the flange, rendering the package unserviceable.

Figure 2: Exposed internal steelwork lattice of disposal container base structure

NEW RE-USABLE PACKAGING SYSTEM

TC02 Packaging System Overview

The new packaging system is assigned the design number LLWR/TC02 and was specifically designed, manufactured and tested for use as a licensed type IP-2 package to service the new alternative waste treatment routes, particularly those for metallic and combustible waste forms .

In developing the design it was acknowledged that it had to be compatible with the NDA sites and other UK waste producers existing waste handling and transport infrastructure, which are generally based around the 20 foot half height ISO freight container as used for waste disposals to the repository. The design also had to address the shortcomings of the current disposal package in re-use.

The TC02 packaging system consists of a purpose designed top opening, half-height, ISO freight container with a bolted top lid. It is designed to accommodate a range of interchangeable stillages of varying length and capacity on to which the payload is secured for transport. The stillages can accommodate a range of contents pre-containerised in drums or secondary inner boxes, or non pre-containerised items of redundant contaminated plant equipment.

TC02 ISO freight Container

The TC02 container, shown in Figure 3, is comprised of a stainless steel containment vessel mounted inboard of a substantial structural steelwork frame. Mounting the containment vessel inboard of the structural frame not only provides a degree of additional protection to the containment boundary from potential impact during handling operations, it dispenses with the need for corrugated wall panels thus presenting plane internal surfaces to aid radiological monitoring. It also enables the top flange arrangement to be configured to remove the snagging hazard of the flange lip overhanging the container cavity.

Mounted on the floor of the containment vessel are eight equi-spaced twist lock receivers on to which the stillages engage and lock. The lid seal features a twin seal arrangement to facilitate routine testing of the lid seal integrity and the containment vessel is fitted with a HEPA filter to allow equalisation of pressure differentials arising from fluctuations in barometric pressure during transport.

The structural frame is fabricated from a low temperature resistant carbon steel of similar strength to that used in commercial ISO freight containers. However, it differs from commercial ISO freight containers in that the primary structural welds are full penetration butt welds thus providing a superior fatigue life to that of commercial ISO freight containers, which are generally of all fillet weld construction.

The external surfaces of the package are coated with a paint system to provide good corrosion resistance for 10 years of normal use in a coastal environment. The internal stainless steel surfaces of the package are unpainted.

The weight and overall dimensions of the TC02 freight container is given in Table 1.

Table 1: TC02 ISO container weight and dimensions

	Tare weight (kg)	Maximum Gross Rating (kg)	Maximum Payload Capacity* (kg)	Overall Dimensions (mm)
TC02 Container	4100	35000	30900	6058 x 2438 x 1350

Figure 3: TC02 Package

TC02 Stillages

The TC02 packaging system has three stillage variants designated type S1, type S2 and type S3. All are fabricated from carbon steel and are coated with a similar paint system to that used on the external surfaces of the container.

Each stillage is comprised of a base structure and a superstructure. The superstructure incorporates a number of upright channel sections which include features for engagement with a dedicated lifting frame and also house manually operated twist locks that engage with the receivers mounted on the floor of the container to secure the stillage within the container for transport. The twist lock mechanisms are positioned to enable operation from outside the package cavity and are engineered to prevent the lifting frame being engaged when the twist lock mechanisms are in the locked position. The base structure of each stillage incorporates anchor points around the periphery for securing webbing ratchet straps used for securing the payload to the stillage.

A dedicated lifting frame is used for loading each stillage into and unloading it out of the TC02 ISO freight container. For the type S1 stillage, a type L1 lifting frame with a working load limit of 5000 kg is used and for the type S2 and S3 stillage a type L2 lifting frame with a working load limit of 30000 kg is used. Each lifting frame incorporates four clevis blocks which engage with the upright channel sections on the stillage superstructure. Fitted to the top of each of the four clevis blocks is a triple swivel load ring, which are connected to the individual legs of a four leg chain sling for connection to a single crane hook. As an alternative to lifting with a crane, the four leg chain sling can be unlatched from the lifting frame and substituted with a purpose designed fork lift adaptor to enable the stillage to be lifted with a fork lift truck. Table 2 provides a summary of the stillage weights and load space dimensions.

Table 2 : Stillage weight data and load space dimensions

	Type	Tare weight (kg)	Payload Capacity (kg)	Load space dimensions Length x Width x Height (mm)
S1 Stillage	Half length	700	4300	2420 x 1680 x 890
S2 Stillage	Full length	2500	27500	5060 x 1680 x 930
S3 Stillage	Half length	1200	14000	2420 x 1680 x 930

Type S1 Stillage

The type S1 stillage, which is shown in Figure 4 with secondary inner waste box loaded and lifting frame attached, is a half length stillage designed to carry secondary inner boxes or individual items of contaminated plant equipment. This stillage is fitted with adjustable chocks for restraining payload. It has a tare weight of 700 kg and a maximum payload capacity of 4300 kg. Up to two type S1 stillages can be accommodated in the TC02 package.

Figure 4: Type S1 stillage with secondary inner waste box loaded and lifting frame attached

Type S2 Stillage

The type S2 stillage, which is shown in Figure 5, is a full length stillage which is used to carry individual items of contaminated plant equipment and can be adapted to accommodate bespoke payload specific restraint systems. The stillage has a tare weight of 2500 kg and a maximum payload capacity of 27500 kg. Only one S2 stillage can be accommodated within a TC02 package.

The superstructure of the type S2 stillage features eight upright channel sections (four per side) each housing a manual twist lock mechanism. The central group of four uprights (two per side) incorporate the stillage lifting features on to which the lifting frame engages. The superstructure also includes supplementary steelwork used to anchor removable payload restraint assemblies.

Figure 5: Type S2 stillage with lifting frame engaged

Type S3 Stillage

Like the type S1 stillage, the type S3 stillage is a half length stillage but with a tare weight of 1200 kg and an increased payload capacity of 14000 kg. The S3 stillage has two configuration options: a drum payload configuration, as shown in Figure 6, where the stillage can be used to transport up to eleven standard 210 litre drums; and an optimum capacity configuration where the stillage is used to transport secondary inner boxes or items of contaminated plant or equipment. The TC02 package can accommodate up to two type S3 stillages.

Figure 6: Type S3 stillage configured for drum payload

FUTURE DEVELOPMENT

The TC02 packaging system is currently licensed as a type IP-2 package and currently two packages have been manufactured: the fleet size is expected to increase to ten in the short term. Consideration is also being given to making an application for licensing the package as an Industrial Fissile (IF) package to transport uranic bearing fissile wastes to UK repositories.

CONCLUSION

The development of new alternative low level waste treatment and disposal routes in support of the UK strategy for the management of solid low level radioactive waste highlighted the need for a new transport package. The LLWR/TC02 IP-2 packaging system provides a flexible solution for transporting solid low level waste forms to waste treatment facilities, particularly those dealing with metallic and combustible waste forms.

REFERENCES

1. Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom, By Defra, DTI and the Devolved Administrations, March 2007.

2. UK Strategy for the Management of Solid Low Level Radioactive Waste from the Nuclear Industry, Nuclear Decommissioning Authority, August 2010.

3. ISO Standard. Series 1 Freight Containers - Specification and testing - Part 1: General cargo containers, (ISO 1496/1-1990), ISO, Geneva (1990).

4. IAEA Safety Standards, Regulations for the Safe Transport of Radioactive Material, 2009 Edition, Safety Requirements No. TS-R-1, IAEA, Vienna (2009).

5. TSCC 1090, The Design, Manufacture, Approval and Operation of an ISO Freight Container for use as an Industrial Package Type 2 (IP-2). Transport Container Standardisation Committee, March 2009.

6. DfT/RMTD/0002 (Freight Containers), A DfT Guide to the Approval of Freight Containers as IP-2 and IP-3 Packages. Issue 2, Department for Transport, London (July 2005).