Proceedings of the 15th International Symposium on the Packaging and Transportation of Radioactive Materials
PATRAM 2007
October 21-26, 2007, Miami, Florida, USA

PACKAGING AND TRANSPORTATION OF RADIOACTIVELY CONTAMINATED LEAD

Eugene Gleason
MHF Logistical Solutions, UK, Limited

Gerard Holden
Gravatom Engineering, Limited

ABSTRACT

INTRODUCTION

Gravatom Engineering Systems Limited (GESL) and MHF Logistical Solutions (UK) Limited (MHF-LS) have developed, tested, and implemented a safe, innovative packaging system for the transportation of radioactive lead. The packaging system includes three components: a PDSI 0149 package marketed in the United Kingdom by GESL; a customized twenty-foot ISO side-loading cargo container with a locking system capable of holding a 5 PDSI 0149 package; and an internal lift system for ease of lead removal from the package developed by MHF-LS. The system has been used during the past year to package radioactive lead from the Sellafield decommissioning project in the United Kingdom for transport to the United States and Sweden. The following paper provides information on the context for the development of this packaging system and a description of the technical details associated with the design and implementation of the system.

NOMENCLATURE

United Kingdom Decommissioning Program

With the establishment of the Nuclear Decommissioning Authority (NDA) in April 2005, the United Kingdom launched an ambitious twenty-five year program to clean up the nation's nuclear legacy. The facilities covered by the NDA program include nuclear sites and facilities operated by the United Kingdom Atomic Energy Authority (UKAEA) and British Nuclear Fuels plc (BNFL); the Magnox nuclear power stations designed and built in the nineteen fifties, sixties and seventies which were operated by BNFL on behalf of the British government; the Magnox fuel reprocessing plants; and facilities at Sellafield. The NDA is responsible for thirty-nine nuclear reactors, five nuclear fuel reprocessing plants, three nuclear fuel fabrication plants, one nuclear fuel enrichment plant, and five nuclear laboratory complexes.

Limited radioactive waste disposal capacity, combined with favorable government policies, among other things, have created a climate within the UK nuclear decommissioning program that endorses the recycling and re-use of waste materials. Ferrous metals, including stainless steel, carbon steel, aluminum, copper, brass and lead, are among the primary candidate waste streams capable of being recycled and re-used based upon existing technologies and facilities. Implementation of the NDA program will result in the generation of more than two million tonnes of radioactive waste material. Ninety percent of the waste material will be low level radioactive waste. According to the NIREX inventory, approximately 450,000 tonnes of the low level radioactive waste will be metals. A significant portion of the metal will be radioactively contaminated lead.

Lead has been used for decades in UK nuclear facilities to provide protective alpha and gamma shielding for workers and the environment surrounding nuclear facilities. Several buildings at Sellafield, for example, contain

thousands of tonnes of radioactive lead which has been used in laboratory, reprocessing and other types of commercial and experimental environments. Although radioactive lead is found in various geometries, the most common shapes are flat two- and four-inch lead chevrons.

The infrastructure to decontaminate and/or melt radioactive lead and other ferrous metals does not exist in the United Kingdom but, rather, at facilities in Germany, Sweden, and the United States. British Nuclear Group has been conducting a series of trials to establish baseline benchmarks for measuring the cost and other variables associated with the recycling and re-use of radioactive lead and other ferrous metals.

GESL and MHF-LS developed packaging systems that have been successfully deployed during the radioactive lead trials at Sellafield, as discussed below.

Figure 1 is an interior picture of the GESL/MHF-LS ISO container with three PDSI 0149 packages installed.

Figure 2 is an exterior photo of the side-loading ISO container.

Figure 3 shows the packaging system being transported by MHF-LS' partner in radioactive transport, W.H. Bowker Group

Figure 4 is a photo of the PDSI 01949 package with lift liner installed and filled with radioactive lead chevrons from the Sellafield site in the United Kingdom.

INTRODUCTION

The packaging used to transport the lead was provided by a United States-based company called PDSI. GESL developed a derivation of an existing PDSI design to meet both European standards and BNG requirements. The package was subsequently retested. The necessary testing required for IP-2 certification was performed at the manufacturer's facility in the USA. The Design Safety Report and associated documentation for this package was developed by GESL and was found to be suitable for acceptance by the British Nuclear Group.

PDSI 01949 PACKAGE

The PDSI 01949 package is approved for the transport of solid LSA II/SCO II radioactive materials by road, rail, sea, or inland waterway. The package is a derivation of a design used in the United States as a one-way package and storage container

known as the BRM CO18. The package is a square box of 940mm with an overall height of 740mm. The major differences between the PDSI 01949 and the CO18 are:

- Minimisation of contamination traps (by seal welding where possible and a gap sealing elastomer such as RTV/silicone where welding would compromise the impact absorption of the design).
- A reinforced lid to ensure pressure tightness post-impact.
- Use of studs and nuts to secure lid.
- Combined lifting and tie-down points (necessitating additional reinforcement at the box corners).

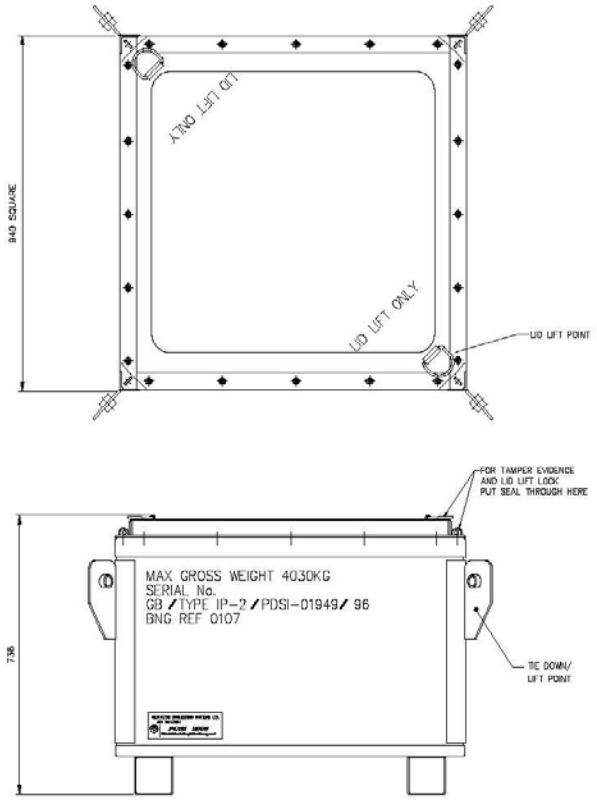

Figure 5 shows the design dimensions of the PDSA 01949 package.

The containment boundary is carbon steel sheet, the corners and joints of which are fully welded and have been justified for the lowest ambient temperature of -40°C. The lid is sealed to the box by a closed-cell silicone gasket with vulcanised joints and is secured to the body by twenty M10 nuts and studs. The gasket material has demonstrated low temperature flexure without cracking at -40°C.

For ease of handling, the base is raised on two sealed steel sections (risers) to permit lifting by a fork lift truck. Four lifting lugs are welded to the corners for vertical lifting with a spreader frame. The lifting lugs may also be used to tie down the package to a conveyance during transport.

The lid lifting features are prevented from being used during transport by passing a seal through the lid lift points and upstands on the box corners -- which also provides tamper evidence, if required.

The maximum mass of the laden box is 4030kg, with an empty weight of 193kg, giving a payload of approximately 3830kg.

Testing

Compliance of Package Design PDSI 01949 with the regulatory test requirements was demonstrated by a free drop test and a stacking test. A fully loaded (6045kg) specimen of Package Design PDSI 01949 was successfully subjected to a free drop test from 1.2 m. The PDSI 01949 was drop-tested in December 2006 at the BRM test facility in Clinton, Tennessee, USA. The package also was loaded with test dust near the point of impact. After the drop test, the seal faces were examined under black light to ensure that the seal face on the box body was free of contamination by test dust. Also, the package was pressurised to 5 psi: no evidence of leakage was observed. A stacking test had been conducted on a CO18-TA design from which PDSI 01949 was derived and was used to justify the PDSI 01949.

ISO CONTAINER TRANSPORT SYSTEM

The twenty-foot ISO container used for the transport of PDSI 01949 packages is a side-loading ISO container with a unique blocking and bracing system that is designed to safely hold up to five (5) PDSI 01949 packages containing up to 15.5MT of contaminated lead. The blocking and bracing system has been designed to meet the requirements for all modes of transport. The empty tare weight with the blocking and bracing system included is 7,445 kg. The loaded gross weight of the individual ISO container is 24,000 kg and can be handled both in Europe and the US without being considered as an over-weight shipment.

With the use of the side-loading container and the unique blocking and bracing system, the individual PDSI 01949 packages can be directly loaded into the containers using a fork lift while the ISO container is still attached to the trailer. This significantly reduces the loading time for a shipment of this type.

LIFT LINER SYSTEM

To facilitate the ease of retrieving the radioactive lead chevrons at the processing facility, MHF-LS fabricated a specially designed Lift Liner™. The MHF-LS Lift Liner™ is a patented woven product with appropriate lifting straps that enabled the radioactive lead to be safely and efficiently removed from the PDSI 01949 package. With the use of the appropriate dunnage inside the PDSI 01949 package, the loaded Lift Liner™ can be directly removed from the package and handled at the processing facility. This feature minimized the stay time for the package system at the processing facility. Because the Lift Liner™ also is rated as an IP-2 package, the lead can be stored in these Lift Liners™ until a sufficient quantity is available for processing.

SUMMARY

Due to increased desire to recycle waste material from UK decommissioning facilities -- specifically lead -- it has become necessary to develop a system that will allow this material to be transported in a cost-effective

manner. The use of the system developed jointly by GESL and MHF-LS will allow the transport of up to 15.5 tonnes of surface-contamination lead from a UK decommissioning facility to the nearest processing facility for recycling in a safe and economical manner, with minimal handling issues at both the decommissioning and processing facilities.