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Paper No. 1392**Innovations in Flexible Packaging for Radioactive Wastes****Author**

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Abstract**Innovations in Flexible Packaging;**7A Type A / IP-3 flexible packaging

PacTec has designed, tested, and manufactured a flexible packaging certified as IP-3 / 7A Type A packaging. This packaging is approved for D and D construction debris, soils, DAW, filtration media etc. The packaging is approved as large as 242 ft³ with 5:1 lifting capacity of 22,000 lb.

Macro-encapsulation of LLMW using flexible packaging

Macro-Bag; The Macro-Bag has been designed to meet the treatment standards of the Environmental Protection Agency for Macro-encapsulation of hazardous waste debris by encapsulating radioactive hazardous waste in a user-friendly flexible package utilizing a gas tight zipper and several layers of polymeric materials. The Macro-Bag has provided the Department of Energy over \$30 million dollars in cost savings. It is approved at the National Nuclear Security Site and other radioactive landfills. The process works by simply loading a metal box or drum into the Macro-Bag and closing three zippers

Flexible Packaging for ILW

A high-profile problem area at the Sellafield complex was the difficulty, timescales, and costs associated with the removal of Intermediate Level Waste (ILW) from legacy storage ponds which was delaying the reduction of the associated high risk and hazards and becoming increasingly untenable. PacTec worked collaboratively with the Sellafield project teams and developed several innovative solutions to provide primary flexible packaging suitable for ILW that has resulted in the acceleration of the reduction and removal of the associated high risks and hazards and significantly reduced costs and programme schedules.

Introduction

PacTec are the recognised industry leader in the design and manufacturing of flexible packaging solutions for radioactive wastes. Our packaging is designed and tested to meet the regulatory requirements of US DOT and IAEA regulations for the safe transport of radioactive materials, making them applicable worldwide with underpinning substantiation documentation.

PacTec have been designing and manufacturing flexible packaging for radioactive materials for over 20 years, establishing unprecedented expertise and knowledge of design, materials and manufacturing techniques. Our capabilities extend to providing proactive design and engineering support throughout the engineering and implementation process to ensure 'fit for purpose' solutions are provided to each customer, which is complemented by our experienced nuclear professionals within our team.

7A Type A / IP-3 flexible packaging

PacTec has designed and tested a flexible packaging meeting the IAEA and US DOT standards for an Industrial Package Type 3 (IP-3) and a 7A Type A packaging.

IP-3 / 7A Type A metal boxes have been the standard disposal package for decades and as the cost of carbon steel has increased the cost of the boxes has increased. Today tariffs increase the cost of carbon steel and all associated products.

The PacTec IP-2/7A Type A packaging is based upon PacTec's original patented LiftPac design. This design has been utilized by the nuclear industry for over 15 years and it is the commonality in design which allows customers that are familiar with the LiftPac to easily utilize the new IP-3 / 7A Type A packaging in their project planning.

The IP-3 / 7A Type A packaging is the next evolution in flexible packaging for the nuclear industry. For the appropriate waste stream, flexible packaging offers cost savings in packaging, delivery, storage footprint and maximizes disposal volume per package.

The PacTec IP-3 / 7A Type flexible packaging is available as large as a 242 ft³ packaging with a 22,000 lb capacity. This capacity will allow higher activity waste streams to be packaged in more economical packaging and thereby reducing total project cost or allow more disposal volume with the same budget. The testing protocol included D&D materials, flowable solids, sand, resin and dry active waste and was overseen by an independent 3rd party subject matter expert.

Macro-encapsulation of LLMW using flexible packaging

The United States Environmental Protection Agency, US EPA, requires hazardous waste to be treated prior to disposal in a landfill. This treatment ensures that the hazardous constituent(s) does not leach into the environment after disposal and therefore protects the health and welfare of the public.

One of the authorized treatment technologies for hazardous waste debris is Macroencapsulation. The US EPA description of the technology-based standard of MACRO per 40 CFR 268.42 is “Macroencapsulation with surface coating materials such as polymeric organics (e.g., resins and plastics) or with a jacket of inert inorganic materials to substantially reduce surface exposure to potential leaching media. Macroencapsulation specifically does not include any material that would be classified as a tank or container according to 40 CFR 260.10.” The 40 CFR 268.45 technology description and performance and/or design and operating standard for Macroencapsulation are “application of surface coating materials such as polymeric organics (e.g., resins and plastics) or use of a jacket of inert inorganic materials to substantially reduce surface exposure to potential leaching media” and “Encapsulating material must completely encapsulate debris and be resistant to degradation by the debris and its contaminants and materials into which it may come into contact after placement (leachate, other waste, microbes),” respectively.

Traditionally Macroencapsulation of hazardous debris has been accomplished by using a grout/cement mixture to encapsulate the waste. This method is simple to perform and low tech but the waste loading efficiency is low and the gross weight of the treated waste increases transportation costs significantly. Additionally, generators of the waste cannot typically perform grouting of waste and therefore third-party waste treatment companies are utilized to perform the service. This service adds to the total cost of disposal of the waste.

PacTec Inc. has developed a simple to use packaging that meets both the US EPA requirement for Macroencapsulation and the US Department of Transportation, US DOT, requirement for shipment of hazardous materials. The PacTec MacroBag utilizes a polymeric liner with a gas & watertight zipper closure to encapsulate the waste. This liner provides the required complete encapsulation of the waste and is resistant to degradation by the waste debris and the contaminants. Additional layers to the packaging are provided to meet the US DOT hazardous materials packaging requirements.

The MacroBag has been approved for use at the Nevada National Security Site and the Waste Control Specialist facility in Andrews Texas. Numerous Department of Energy sites are currently utilizing the MacroBag and our presentation will detail the development and benefits of the MacroBag.

Flexible Packaging for Intermediate Level Waste (ILW)

By continually applying an innovative and creative mind-set to what is regarded as an innovative product, PacTec have again worked hard to develop a new innovative solution to support the UK's Sellafield decommissioning mission that has provided significant benefits and was integral to a achieving a key site milestone to remove a 'high risk and hazard' associated with a legacy pond facility.

Underpinning the Solution

Utilizing the PacTec Type IP2 package as a base design we worked closely with the Sellafield project and design teams to provide the underpinning substantiation required to demonstrate that the PacTec containment package was suitable to be used as a primary packaging solution for large redundant plant ILW. It is important to note the package provides a containment function only with no shielding properties. However, some packages were designed with external 'pockets' along the length of the sides of the package. This provided the operators with the capability to insert supplementary shielding if required to reduce the risk of exposure to 'high' points on any specific items.

The ILW items were predominately redundant equipment located in legacy facilities previously used for operations associated with handling spent fuel. These included various items of 'furniture', mechanical handling equipment, rams and various fuel skip containers, all to be removed from a number of legacy facilities. For one specific legacy pond, removal of the equipment and furniture allowed access to remove spent fuel debris located on the base of the pond, thereby reducing the associated high risk and hazard.

The previous methodology and practices to provide a primary containment package to enable the removal of the ILW items from the legacy ponds would have included the design of 'bespoke' steel containers together with the historical practices of 'wrapping' each item in copious amounts of plastic sheeting and tape. The engineering design process of a 'bespoke' containment box taking up to 18 months, and the historical practice of 'wrapping' with plastic sheeting is recognized as ineffective containment management and not conducive with applying the principals of ALARP to prevent and minimize the contamination risk to operators.

Application of the Solution

The application of the primary containment solution was firstly introduced to one specific legacy facility. This was successful and continued resulting in the accelerated removal of several redundant plant items. A further key success was the significant reduction to the predicted operator's radiation exposure, primarily due the reduced time required to remove and package each ILW item.

Figure 1 – Examples of ILW Redundant Equipment being removed from Sellafield Legacy Facilities in PacTec Packaging.

Conclusions

The adaptation of the PacTec packaging for the primary containment of ILW has provided a complete ‘fit for purpose’ and ‘engineered’ solution to facilitate the removal of the ILW items from legacy pond facilities. This has required the operations teams to adopt a ‘decommissioning mind-set’ as opposed to an ‘operational mind-set’ that has encouraged an innovative approach to develop new solutions. Such that the program schedule to decommission and de-water one specific legacy pond has been accelerated by almost 10 years thereby providing the accelerated removal of an unsustainable nuclear high risk and hazard, reduced risk to operators and significant cost savings.

This success has been achieved by adopting a collaborative work ethic between the Sellafield project teams and PacTec, to which PacTec received a Sellafield award for innovation.

Acknowledgments

“PacTec has a really innovative product that has revolutionised the way we package items taken out of Legacy Ponds. PacTec work closely with the operations teams in providing bespoke package solutions; taking into account size, containment and remote handling requirements. The use of PacTec bags has accelerated export of hazardous waste with significant dose reductions for our operators.”

Dorothy Gradden; head of project delivery for the legacy ponds and silos at Sellafield.