Proceedings of the 19th International Symposium on the Packaging and Transportation of Radioactive Materials
PATRAM 2019
August 4-9, 2019, New Orleans, LA, USA

The Pros and Cons of using legacy RAM Transport Packages and Equipment for the transport, storage and disposal of nuclear material it was not originally designed for.

Ian Grainey CEng MIMechE
Acting Head of Engineering, International Nuclear Services

ABSTRACT

INS is tasked with transporting RAM as part of the NDA's safe and efficient clean-up of the UK's nuclear legacy.

In a time of austerity and in a period where the UK nuclear industry is being scrutinised for its expenditure, it is easy to think that using existing and legacy equipment saves time and money. But is this really the case?

This paper explores the practicalities, and the pros and cons, of using legacy equipment for the transport of RAM, and shows how important it is to have a robust asset and Design Authority handover.

It investigates how to licence existing equipment for alternative uses, and how novel and non-standard approaches may be required to meet the licensing regulations.

It explores how existing and different contents and package use can influence disposal route and conditions for acceptance for the consigner and the consignee.

It evaluates how the waste and its package compatibility, with specific sites/plants and how these can influence changes to the existing package design and handling equipment.

It examines how the lifespan of legacy equipment can be extended and what challenges can occur when using old and outdated Standards, the ongoing maintenance challenges, replacement parts and spares. And finally, what happens to the equipment when it is no longer required.

BACKGROUND

The designs of transport packaging tend to be driven by specific contents. The need to *demonstrate* regulatory compliance [1] requires a detailed knowledge of this content, which, along with operational considerations, directly influences the subsequent design.

Industry likes to maximise the use of its expensive physical assets and this is no different when applied to transport packaging. All assets are designed with specific, substantiated roles in mind, but is re-purposing of such an asset a viable option? What should the owner consider in arriving at a decision to re-purpose and what are the advantages and associated challenges of such re-use?

This paper investigates these issues, based upon an example of an existing transport packaging design repurposed for a content and operating environment it was not originally designed for. It should be noted that this is just one example of a number of repurposing projects that this particular transport package has enabled.

1 The INS 1648C

The 1648C, a Type B(M) design, was originally operated at the Magnox Chapelcross site in Dumfriesshire, Scotland and used to transport specific waste streams from this site for long term storage at the Sellafield site in England. During its operational use at and between these sites, INS's Engineering and Licensing teams provided the packages Design Authority (DA) role.

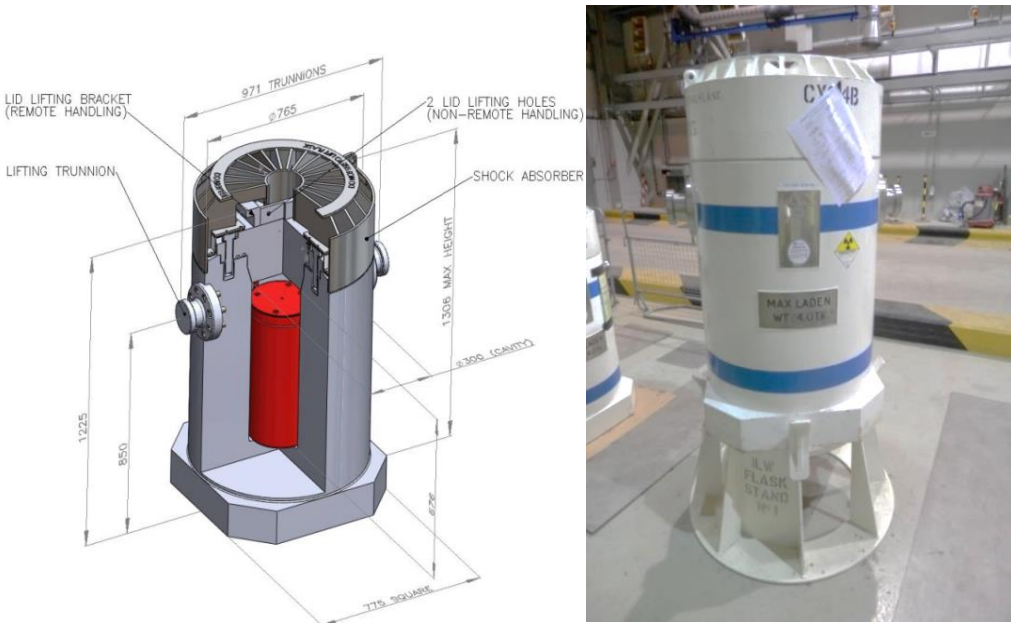

Figure 1: 3D sectional view of the package and a 1648C on a plant stillage.

Following completion of the work at Chapelcross, the 6 off 1648C's became redundant and Magnox intended to dispose of the assets.

1.1 Asset hand-over

The INS team recognised that the 1648C presented a simple, relatively light-weight (4000kg) design that could potentially be re-purposed for other transport uses within the UK's Nuclear Decommissioning Authority (NDA) Group and possibly, further afield. Agreement was reached via the NDA to transfer the transport packages from Magnox to INS and asset registers were duly updated.

As INS already acted as the DA, the team had direct access to the current and past issues of the Package Design Safety Report (PDSR) and the associated engineering substantiation. This, coupled with first-hand knowledge of how the design was operated, provided the INS team with a thorough understanding of the designs original intent and importantly, the limitations imposed by the design envelope and current licence conditions.

Any organisation considering taking on the DA role for a transport package, (leaving personnel qualifications and experience aside) must ensure it fully understands both what a design is and as far as possible, why it has been designed in that way. Failure to fully understand these how's and why's can lead to incorrect assumptions being placed upon the capabilities of the design. At best, this could lead to unwanted delays in the substantiation process for repurposing and at worst, may lead to potentially dangerous practices.

The amount of time and effort required to become an effective DA should not be underestimated. These factors will increases significantly if an organisation has little prior knowledge of the transport package design in question.

1.2 Repurposing for alternative use

The 1648C was designed to carry waste contents that had been generated in the four Magnox reactor units at the Chapelcross site. The contents were either (1) irradiated steel thermocouple wires in conjunction with irradiated steel scrap, or (2) graphite, with a degree of steel contamination.

1.2.1 Licensing Considerations

The 1648C transport package provides significant levels of beta-gamma shielding, due to its thick-walled, steel construction. This, coupled with a testable seal equipped package lid of comparable thickness, provides the opportunity to transport similar quantities of radionuclides, in an asset that facilitates handling options during transport and at consignor/consignee sites.

As mentioned, the content (radionuclide inventory, A2's, thermal output, etc.) and its physical attributes (physical state, dimensions, mass, integrity, etc.) are central to any transport packages design. Any change to the content must take credence of the original design intent, with a number of immediate questions to be considered e.g.:

- Is the radionuclide inventory bounded by, or similar to, the original content?
- Are there fissile materials in the content?
- Is the physical state (solid, liquid, gas) of the content the same as the original?
- Is there potential for a change of state, for pressurisation effects, or degradation?
- Does the amount and type of shielding appear adequate?
- Is the mass of the content bounded by previous substantiation?
- If relevant, is the thermal output bounded by previous substantiation?

Such considerations enable a design to be initially assessed in respect of suitability for repurposing against a new content. Assessing these factors early enables the risks associated with such re-substantiation to be understood, before detailed studies and associated costs are committed.

Evidently, such questions need consideration in the concept design phase of any transport package for the original content. The difference during re-purposing is that these points now need to be considered against the physical constraints and design intent presented by an existing asset.

Where knowledge gaps or unknowns exist e.g. if the new contents mass exceeded that substantiated in previous Accident Conditions of Transport (ACT) assessments, this will require new substantiation work. The sum of the required assessments will help define the total programme of work. Understanding the extent of these assessments will provide part of the review assessing if re-purposing represents a cost effective transport solution.

1.2.2 Operational Considerations

In parallel to the content review, the use of the transport package in facilities other than those it was originally designed to interface with needs careful consideration. Handling options at new sites need to be reviewed and following this, an appraisal made of the existing transport package operating equipment i.e. can it be used immediately, could it be modified, or is new equipment needed to ensure safe operations are achievable? These assessments need to address both radiological and conventional safety aspects.

The original use of the 1648C required transport between two specific plants at Chapelcross and Sellafield. These plants were appropriately equipped to handle the package and its content to ensure safe and effective operations could be completed.

At the export plant, the 1648C package was designed to interface with a shielded process cave via an access tunnel, which transferred the package into position via a bogie system. The package lid was remotely removed, following closure of a tunnel shield door. This enabled package loading, using in-cell manipulators through a cave floor aperture. Following package regress and the necessary checks prior to transport, the package was loaded into one of three gravity well structures on a bespoke covered road transporter. These systems are captured in Figure 2.

Figure 2: Remotely operated lo porter.

An identified re-use of the 1648C was to transport material from a number of the UK's Source Collection Agency (SCA) sites to a final storage facility at Sellafield. The SCA companies operate from small industrial units and do not have the types of equipment e.g. manipulators, overhead cranes or shielded cell facilities the package interfaced with at Chapelcross. The SCA's perform a critical role in support of operations within the UK's National Health Service (NHS) and the loss of access to existing storage facilities meant alternative storage needed to be identified. The Sellafield store used for the original 1648C content could accept the new waste stream, which removed issues with the package/plant interface during receipt. However, it would place specific conditions on the SCA content, which are further discussed in §1.3.

Operation of the package therefore needed be cognisant of the operational restrictions imposed by the SCA sites and also the receipt facility with respect to the content, whilst maintaining compliance with the PDSR. As well as operational handling, content loading and dispatch processes at the SCAs, 1648C inspections would also need to be considered. For example, a need to replace the 1648C lid containment seals prior to shipment requires an ability to safely handle and manipulate the circa 400kg package lid. After consideration of the SCA facilities and equipment, a number of new items were designed and manufactured by INS to enable 1648C operations. These included a new package lifting beam that could interface with fork-lift trucks, tooling to handle the contents and the lid seal inspection stand.

Figure 3: 1648C lid seal stand, new lifting beam and co

In addition to this ancillary equipment, some SCA sites did not s for the road transporter shown in Figure 2. This transporter was designed to manoeuvre below an overhead crane at Chapelcross, enabling a 1648C to be lifted and lowered into one of its three

gravity well positions. As not all SCA sites have cranes, another method of handling the loaded package was required. The solution to this was to design and manufacture a gravity well structure that copied one of the three positions on the original transporter. This was designed to be secured to the bed of an appropriate road vehicle using chains and tensioning units. Using the new lifting beam and a fork lift with appropriate reach, a single 1648C could now be secured for transport, in full compliance with the PDSR.

Figure 4: A single 1648C in the secured gravity well.

The operational assessments at the SCAs and the subsequent need to design and manufacture new operating equipment are examples of other cost elements that need consideration as early as possible in the repurposing project.

1.3 New disposal routes and Conditions for Acceptance (CfA)

Similar to the constraints placed upon the content by the design of the transport package discussed in §1.2.1, a new receiving facility can also place restrictions on the package contents i.e. following its removal from the transport package for long term storage.

These considerations will include further reviews of the types and quantities of radionuclides in the content, to ensure they comply with the identified store limits. For the 1648C content arriving from the SCA's, the identified store placed limits on the amounts of polymer present in the waste streams, due to the potential for hydrolysis and also, restrictions on the amount of inactive material in the content.

At Sellafield, these storage plant restrictions are identified in a 'Conditions for Acceptance' (CfA) document. Store CfAs, or other site equivalents, need to be considered in parallel with the packages own design limitations to ensure an optimised content is identified.

1.4 Lifespan Extension Challenges

A further consideration for the DA assessing extending the life of an asset for new use, or potentially taking over a fleet of transport packages from a third party, is to fully understand

the physical condition of the assets. Transport packages are required to have detailed operating and maintenance regimes in place and a review of records may reveal issues that could affect the cost effectiveness of re-purposing.

An example may be the condition of receiver threads on a transport packages lifting trunnions. These require maintenance checks, using thread wear gauges at specific intervals. Such checks ensure the threads continue to provide a secure joint and hence, safe lifting. Reviewing maintenance records may reveal individual receiver threads are becoming excessively worn, requiring either re-substantiation work (i.e. new calculations) or if severe enough, an imminent need for physical repair. If records reveal a trend of increasing issues with such features over time, it may indicate it is reaching the end of its natural life, where re-work becomes increasingly uneconomic. It is therefore important that the DA reviews the condition of the physical assets as early as possible. This will ensure these aspects of cost are factored into the repurposing question. Similarly, a review of the technical standards specified during maintenance is a sensible task, to ensure current standards are being applied. This is especially important when taking over the DA role from a third party, as the asset could have been in storage for an extended period.

Another consideration during the repurposing of older designs can be Regulatory expectations. The 1648C containment seal assembly was originally pressure tested with a manual pneumatic pump and an analogue bourdon gauge, reading the pressure drop over a specific time period. For the SCA content transports, INS decided to specify a digital pressure test unit in the operating procedures. This equipment provided calibrated results, which could be electronically stored and printed out, whilst also compensating for environmental conditions.

During the various repurposing projects for the 1648C design, further work has also been completed, using current analysis techniques to further substantiate the 1648C design. Some of this work is discussed in an associated PATRAM paper [2].

Reviewing and improving analysis work and operational processes as appropriate provided the Regulator with examples of INS using current best practices in repurposing the 1648C.

1.5 Maintenance and Spares

Repurposing an asset that has been taken over from a third party requires the new owner to consider maintenance requirements and spares availability. The range of checks performed during turn-round, yearly and at subsequent intervals (which can be driven by frequency of use) need to be reviewed, to ensure that any new facility has the appropriate space and equipment to conduct maintenance programmes effectively and safely.

An important consideration during maintenance is the availability of spares. Transport packages have replaceable components, ranging from fasteners which may degrade due to wear or corrosion, to elastomer containment seals, which have time bound shelf and operational lives. Taking on the DA role from a third party may include taking on such operational spares, which will need integrating into a suitable Quality Management System (QMS).

Spares sourcing will also need review i.e. is the original supplier on the DA company approved list and are there any commercial issues that need to be clarified if the supplier is selling to a different organisation?

Without robust maintenance and spares regimes, the availability of an asset cannot be guaranteed. Implementation of appropriate systems and processes therefore need to be considered in parallel to the other aspects of repurposing a transport package design.

1.6 Final Disposal

If the repurposed transport package is already owned by the organisation, its future disposal will have been included in financial liability reviews. However, where a package is inherited or purchased from a third party, final disposal costs (including potential decontamination requirements) should be assessed as part of the economic considerations.

CONCLUSION

Repurposing of existing transport package designs can provide an alternative route for the transport of RAM than that originally envisaged. This can reduce both lead times and the costs involved with developing a transport package design from conception.

Such re-use requires the owner to fully understand the existing design envelope, to ensure all required deviations from the original intent are fully understood and appropriately substantiated. This extends beyond the package licensing; understanding how the package would be operated on differing sites might require processes and equipment so novel that it renders the re-purposing uneconomic.

If the design is being taken over from a third party, the additional costs involved with operating, maintaining and ultimately disposing of the transport package should also be recognised.

A thorough review of the total costs involved is needed to identify if repurposing presents an economic benefit. However, as is ever the case, greater programme benefits may outweigh such immediate cost considerations.

If these reviews and considerations are completed appropriately, transport package re-use can increase the economic worth of a specific transport package asset. Repurposing may in some areas present challenges i.e. in respect of applying modern practices to potentially older designs. However, it can also expand knowledge of the design envelope, due to the need for further substantiation work. This increased knowledge can lead to further opportunities for re-use.

Repurposing can shorten the transport programme timescales from feasibility to transport, thus realising plant decommissioning, security and associated cost benefits.

REFERENCES

[1] Regulations for the Safe Transport of Radioactive Material, SSR-6, IAEA, 2012 Edition.

[2] Validation of the FEA 1648A Model with Drop Test Data and Comparison of the 1648C FEA Model. Report Number INS/ENG/R/16/273. R. Boag, International Nuclear Services.

ACKNOWLEDGEMENTS

Thanks to the following organisations, for allowing use of some of the images in this paper:

- Magnox Chapelcross
- Eckert & Ziegler Environmental Services Ltd
- Active Collection Bureau (ACB) Ltd