# The intergenerational storage and subsequent transport of Dual Purpose Casks (DPC); the creation of a hybrid storage and transport culture

## Abstract

The storage of packaged radioactive material with the intention of transporting the packages at some time in the future for processing or disposal is not a new concept. However, the growing adoption of storing dual purpose casks (DPC) containing spent fuel assemblies, High Level Wastes (HLW) or Intermediate Level Wastes (ILW) for perhaps decades and then to transport the DPCs from the nuclear facility to another facility to process or dispose of the contents, is a practice that continues to gain popularity and adoption. Whilst this strategic choice has operational advantages, there are intergenerational issues that will need careful consideration and planning to ensure that DPC shipments are able to take place decades in the future. This paper describes a hybrid storage and transport safety culture which addresses the compliance of the DPC design with transport regulations, the DPC storage regime required by the DPC safety analysis report (SAR), and other wider issues to be considered when planning the shipment of the DPCs after storage, several generations in the future.

## Introduction

The intergenerational storage of packaged radioactive material is an operational practice that has been carried out for decades. One of the earliest examples was drummed waste; if inspection during storage or before shipment revealed corrosion or damage to a drum, the drum would be over-packed with another larger drum. The only issue would be the preservation of records of the contents and overpacks and perhaps, if considered necessary, sample opening and inspection of the contents to provide confidence in the records created at the time the package was filled and placed in storage.

The continuous improvements in technology and the development of management systems, has further increased confidence in the records of stored radioactive inventories, the assay techniques used and the identification of individual packages stored. For some radioactive materials the generation of gasses during storage and the deterioration of the packaging by ageing effects during storage are likely to be the only issues that affects both the storage facility safety case and the package SAR, assuming gas generation and ageing management were not considered and mitigated in the SAR. However, an ageing management system is now required in the SSR-6 (Rev.1) 2018 edition which was published by the IAEA in 2018 (1), and therefore the effects of ageing on the package will be required to quantified when a package is to be stored before shipment.

## Shipment after storage: A strategy with two components

To provide the necessary assurances that DPCs stored for several decades can be shipped at some future time will require a strategy with two components that demonstrates the package design will remain both within its design envelope defined in the package SAR and compliant with the transport regulations extant at the time of shipment, and that other factors that could possibly constrain shipments in the public domain have been monitored and taken into account to determine the timing of the shipment program.

## NUCLEAR LICENSED FACILITIES AND ACTIVITIES (TRANSPORT)

**Component 1: Regulatory compliance**

Fundamentally, the DPC must be demonstrably compliant with transport regulatory requirements at the time of shipment. The DPC SAR, upon which the transport package design approval is based, must therefore be subjected to a review each time the transport regulations are revised during the storage period. This is achieved if a package design approval is maintained throughout the storage period, as this would require a submission of the DPC SAR to the competent authorities every 5 years, or another period as determined by the competent authority. Maintaining this certification arrangement would be advantageous not only because the DPCs remain approved for shipment at all times during storage, thereby providing operational flexibility, it would also ensure the storage facility operator remains vigilant over the potential decades of storage time to maintain the storage regime required by the DPC SAR.

Regulatory compliance for DPCs consists of three elements:

- During shipment, as demonstrated in the DPC SAR, as approved by the competent authority, which includes the necessary requirements of the storage regime
- The storage facility safety case, as approved by the site license regulator, which incorporates the requirements of the DPC storage regime defined in the DPC SAR
- During storage, the demonstrable effective management of the interface between the storage facility conditions and DPC storage condition requirements

***(a) Transport safety***

National regulatory requirements for transport safety are based upon the regulatory requirements set out in IAEA Transport regulations SSR-6 [(1)].

A significant change adopted in the 2018 edition of SSR-6 is the requirement for the operator to have an ageing management system that demonstrates a package design can tolerate ageing effects during storage and remain within its design envelope and performance criterion, that is compliant with its SAR, the package design approval based upon the SAR, and hence the transport regulatory requirements extant at the time of shipment.

Particular attention is necessary if a DPC is used to decay store its radioactive contents, that is, the DPC does not comply with transport regulatory requirements at the time of loading, perhaps due to the higher package temperatures and/or radiation levels than those associated with a transport regulatory compliant DPC; the intention being that the DPC will become compliant at some future date during storage. Contingency plans should be prepared for the possible need for earlier than planned shipments brought about by changes in strategic policy, facility safety or security concerns.

***(b) Storage facility safety case***

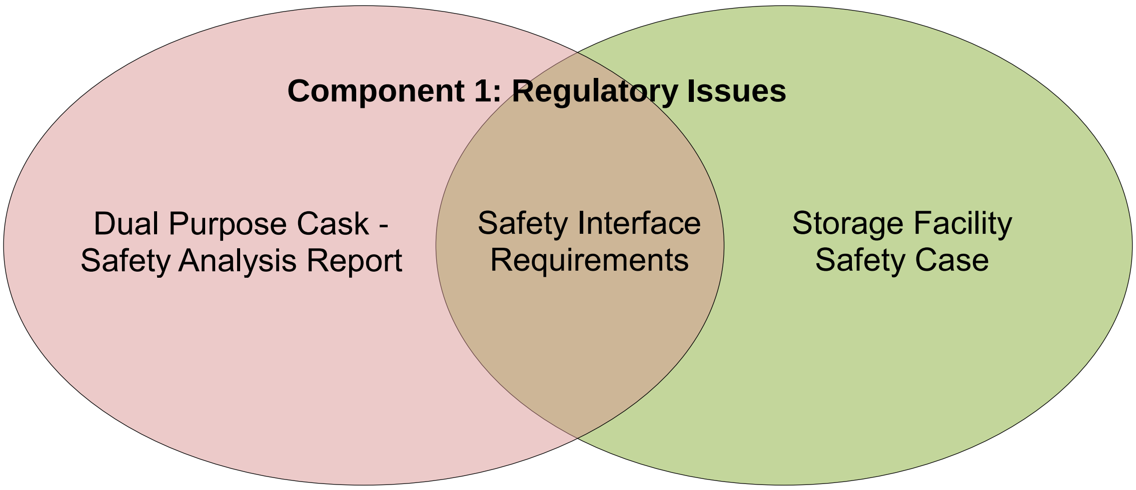
All aspects normally associated with the storage of radioactive HLW / ILW / fissile material will apply to the storage of DPCs containing such material. The management system for the storage facility should require a review of the storage facility operational plan each time a new design approval certificate for the DPC is issued.

***(c) DPC and storage facility interface***

The storage requirements should be clearly defined in the DPC SAR, the storage facility management system and records maintained for the entire storage residency time of the DPC. When periodic inspections are required, deviations from the acceptance criteria should be immediately reported to the design authority / owner of the DPC to enable them to evaluate the effects upon the DPC SAR and take the necessary steps to ensure the DPC design approval certificate remains valid, or to take steps and seek its reissuance as appropriate.

Historically transport and long term storage remained separate activities; close interaction was rare and hence the safety cultures also remained separate. To meet the storage facility safety case a package does not necessarily need to meet the transport regulatory requirements, albeit in doing so it may be beneficial.

However, DPCs are heavy to manipulate in a storage facility and due to the contents would require a hot cell if it was necessary to open, close and leak test. Consequently during the decades of storage of DPCs, the storage facility operator is likely to become more aware of the SAR and to feel increasing ownership of the DPCs and the obligation that would bring to ensure the package can be exported from the facility at a future date likely in the next or a subsequent future generation. This view is an extrapolation of current day trends of increasing awareness of current and potential future environmental impacts combined with a growing acknowledgement and concern of intergenerational issues in many countries. Remember future storage operators and societal values will be those of future generations, which will be either the children of today, their children and grandchildren.




**Nuclear Licensed Facilities**

Regulatory issues also includes regulatory compliance for the shipment of DPCs in the public domain

At this point we have DPCs delivered to a storage facility, stored with controlled storage parameters as required by the DPC SAR. An ageing management programme is in place and storage records indicate no non-conformances have been raised during the storage period that challenge the DPC SAR. Each DPC has an up to date SAR and current package design approval certificates;

The DPCs comply with transport regulatory requirements.

**PUBLIC DOMAIN**

**Component 2: Wider issues**

There is a second component of the strategy, wider issues that need to be recognized and addressed to mitigate the possible effects on future shipment programs.

***Time to complete shipment campaign to empty storage facility***

It is possible that operational planning and discussions will be ongoing when DPCs are being placed in the storage facility and the planned subsequent shipment campaign from the facility is many years in the future. Furthermore, these discussions will likely be focused on the storage facility operations and the ongoing management of the facility, including revisions of the facility safety case, over future decades.

The future shipment campaign to empty the storage facility is likely to be set out in strategic terms with possible detail planning left for future discussion and decision processes by a subsequent generation of the storage facility operators.

However, there is one notable parameter, which will be of importance in the planning of the shipment campaign to remove the DPCs from storage facility; that is the relationship between the number of DPCs in storage and the time required to empty the storage facility. This time interval is important in contingency planning should there be a need to empty the storage facility due to changes in strategy or due to safety concerns. This time interval needs to be incorporated into the monitoring systems that would detect the potential need to remove the DPCs from the storage facility. Plans to reduce this time interval may also be considered desirable to the extent possible to maximize operational flexibility.

***Shipment campaign preparation time***

Transport frames, railwagons, road transport trailers and ancillary equipment for shipment campaigns will require a lead time to procure the necessary equipment as it would unlikely to be available at all times during storage. This may be obvious but can be overlooked, particularly by a storage facility operator who may become the first contact point when shipment planning is initiated.

The campaign preparation time CPT = npx (months)

Where

n = number of sets of shipment equipment (equal to DPCs per consignment)

p = procurement time per set of equipment (months)

x = number of sets used at one time during shipment campaign
(depends on consignment time + time to return shipment equipment for next consignment)

Also, DPCS that are being decay stored may require Special Arrangement Approvals for shipment that will take time to obtain from the competent authorities.

***Time required to empty a storage facility***

It is prudent to calculate this perhaps every 3 – 5 years when the delivery campaigns of DPCS to the storage facility are taking place. This would avoid any surprises to the authorities.

$$T = CPT + (Nt)/n \text{ (months)}$$

Where
T = shipment campaign time to empty storage facility (months)
CPT = campaign preparation time
N = number of DPCs in store
t = shipment time for a single consignment (months)
n = number of DPCs per consignment

From the above, the time needed to empty a storage facility will be depend on the number of DPCs in storage, the throughput capacity of the export facility in the storage facility, the number of DPCs in a consignment and the time period to procure shipment equipment sets for the DPCs.

One other external constraining parameter will be the throughput capacity and scheduling of the facility receiving the DPCs.

***Public perception and acceptance of risk***

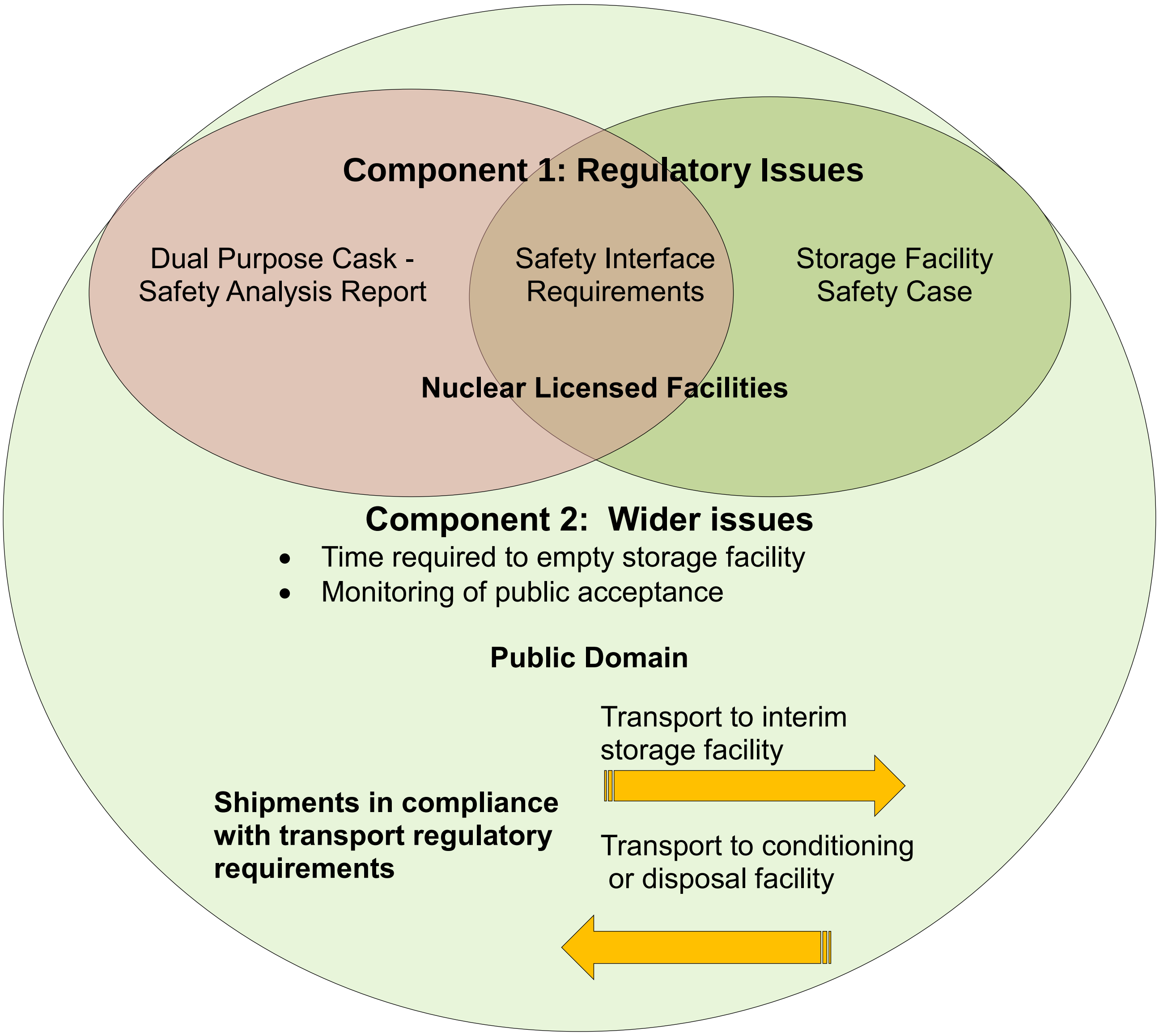
There are other aspects that will affect the 'transportability' of DPCs in future generations. These aspects that are not prescribed in IAEA safety standards or guidance material, nor mandated in regulatory infrastructures; these aspects are public perception and societal expectations that determine public acceptance of risk.

A prerequisite of public acceptance of shipments is compliance with the regulatory requirements, but compliance remains only a basis upon which to build public confidence and acceptance of transporting radioactive material in the public domain. In this case, DPCs that were manufactured loaded and stored for several decades.

There are some notable issues raised by adopting a strategy to store DPCs for perhaps several decades, namely that future generations:

- Are likely to have no experience of, for example, the shipment of spent fuel in the public domain. The current practice in many countries is to store the spent fuel pending government decisions on the next step in the fuel management cycle
- Are likely to have a perception and acceptance level of perceived risk which remains difficult to relate to intended future shipment campaigns, the relationship may only be revealed when shipments are announced
- Are likely to experience, perhaps for the first time, shipments in the public domain, of DPCs that were manufactured, loaded and stored for several decades before being subsequent shipment

It is suggested here that further consideration is given to these issues including the development of mechanisms to monitor public opinion to inform strategic decisions regarding how long can DPCs be stored whilst also providing a window of time to complete the future shipment program.




The shipment of radioactive material is an everyday event with a safety record that is both remarkable and testimony to primarily the training and due diligence of the operators to meet an appropriate set of regulatory requirements, and the effectiveness of the regulatory infrastructures in place.

Nonetheless, the strategy of storing HLW / ILW, and particularly spent fuel, in DPCs, with intentions of several decades of storage before shipment, will necessitate the need for a storage and transport culture between these two, often distinct, activities.

**Transportability of DPCs**

For such long-term storage and subsequent shipment, the issue of a DPC remaining 'transportable' more describes the necessary attribute.

'Transportability' means regulatory compliant and public acceptance of the shipment of the DPC package. Regulatory compliance can be managed, whereas as public acceptance is not so prescriptive and to an extent, involves observation and perhaps changing predictions of its trajectory in the future and planning shipment campaigns accordingly. Certainly there will be no reliable means to foresee decades in the future. Public perceptions can, and do, often change, and with the significant improvement in communications and awareness, it can change in surprisingly short timescales when compared to the past. Monitoring of this issue will require the development of mechanisms to evaluate public perception and acceptance of risk and the effects upon future scheduling for the shipment of DPCs decades in the future.

Where shipment of radioactive material remains an everyday occurrence this keeps the activity of transport in the consciousness and/or sub-consciousness of society and the challenges that may arise are managed accordingly.

When there is a disconnect between an activity and its common occurrence and it is combined with a situation in which the equipment that provides safety is several decades old, there will be other challenges that need to be considered and managed in different ways that evolve over time. Addressing this matter could require ongoing attention and therefore should not be left to a period of time prior to when the subsequent shipment campaign is planned.

The activities and approaches used for transport and storage are significantly different; the domain of the storage facility is the facility, whereas the domain for transport is the public domain. When a DPC is in storage it should be regarded as storage in transit and the challenges posed by subsequent transport, albeit decades in the future, should be continually considered and incorporated in the strategic storage and transport plan which would reflect components 1 and 2 described in this paper.

## References

(1) IAEA Transport regulations for the safe transport of radioactive material SSR-6 (Rev.1) 2018 edition.