NUHOWS - Storage and Transportation of Irradiated Reactor Components in Large Packages - 13439

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ABSTRACT

Most irradiated reactor components (hardware such as Control Rod Blades, Fuel Channels, Poison Curtains, etc.) generated at reactors previously required significant processing for size reduction due to the available transportation casks not being physically capable of containing unprocessed material. As of July 1, 2008, disposal for this typical waste class (B and C) became inaccessible (for the major part of the nation) due to the Barnwell, SC disposal facility being closed to all but its three compact states (CT, NJ and SC).

Currently in the United States, most facilities are storing their irradiated hardware on-site in the spent fuel pools. Until recently with the opening of the Waste Control Specialists' Texas disposal facility, utilities faced the challenges of spent fuel pool space and capacity management. However, even with WCS's disposal availability, the site currently has annual Curie limitations for disposal, which will continue to promote interim on-site storage until such time as disposal is available.

In response, Transnuclear Inc., (TN) an AREVA company, proceeded with designing a new large Radioactive Waste Container (RWC) that can be used to package irradiated hardware without the need for significant processing. The design features of the RWC allows for intermittent loadings of the hardware for better packaging efficiency, higher packaging density, space savings and reduced cost. This RWC is also compatible with TN's on-site modular vault storage system. Once completely loaded, the RWC can be transported to an on-site storage facility, an off-site storage facility and/or an available disposal facility.

To accommodate the transportation, TN has designed a large transportation cask, the MP197HB. As the original design was for transporting fuel, it contains the necessary shielding to allow for the transport of unprocessed irradiated reactor components, while significantly reducing the amount of irradiated hardware shipments required with the use of the new RWC.

This paper provides information on the unique design features of the RWC, storage module vaults, MP197HB Transportation Cask and cost saving benefits of using the large RWC for packaging, storage, transport and disposal.

INTRODUCTION

Until July 1, 2008, two of three available licensed commercial radioactive waste disposal sites in the United States could accept Class B and C waste for disposal.

Disposal Site	Waste Class Accepted	States with Access Prior to July 1, 2008
Barnwell, SC	A, B and C	All
Richland, WA	A, B and C	AL, HI, WA, OR, ID, MT, UT, WY
Clive, UT	Class A	All

On that date, the Barnwell site closed access to all but the three states in the Atlantic Interstate Low Level Radioactive Waste Compact - South Carolina, New Jersey and Connecticut. While this left a large void for disposal capacity for most of the nation's nuclear power plants, a total cleanout program was implemented in the proceeding years, effectively delaying the issues associated with storing irradiated hardware.

However, it was inevitable that plants would continue to accumulate irradiated reactor components that would require storage in their spent fuel pools, creating potential issues for future used fuel storage space and fuel pool building dose rates. Transnuclear, Inc. (TN) recognized this and started an evaluation program of future plant needs for storage and disposition for this type of waste in order to mitigate the expected spent fuel pool congestion.

Being in the used fuel storage business with the widely adopted NUHOMS® Horizontal Used Fuel Dry Storage System, TN anticipated the need for that a similar technology could easily be adapted as an interim solution. In addition, TN also recognized that Waste Control Specialists (WCS) was making an effort to expand their A, B and C radwaste disposal site in Andrews, TX to allow national access beyond their compact states of Texas and Vermont, which subsequently was brought to fruition.

However, the WCS disposal site has an annual receipt limit of 120, 000 Curies for out-of-compact waste, which can typically be one to two fuel pool cleanout campaigns, thus until this Curie limitation can be increased, interim storage will be necessary.

Thus, TN set a goal to accomplish the following objectives for the storage and future disposition of irradiated reactor components:

1. Viable for extended, interim storage
   a. Extended storage times
   b. Retrievability
2. Safe and simple
   a. Utilize currently developed technology to minimize development costs
   b. Clone current technology
3. Take advantage of previous investments
   a. Usable for future disposal
   b. Utilize current plant studies and in-place procedures
   c. Use NUHOMS® equipment where possible

4. Minimize Risks
    a. Minimize size reduction of the components previously segmented in the spent fuel pools
    b. Eliminate contamination of the storage/disposal liners and cask internals
    c. Minimize personnel radiation exposure during loading and handling
5. Versatility
    a. Transport compatible
    b. Disposal compatible

TECHNOLOGY DEVELOPMENT

TN recognized that its current NUHOMS® used fuel storage technology could be easily cloned for use in high activity radwaste storage. The technology is used more than fifty percent of the used fuel storage in the US and was designed to be:

1. User friendly and easy to use
2. Acceptable for long term interim storage
3. Risk adverse
4. Transportable

Previously, TN's RAM cask was considered the "workhorse" for shipping processed irradiated hardware. Combining this transport technology with our used fuel storage and transport technology was the perfect segue for conversion to radwaste storage.

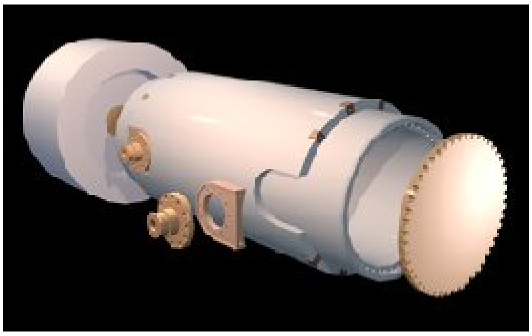

Figure 1, MP 197 HB

TN commenced development of a conceptual design for a storage/disposal liner using the transport cask as the template for dimensions. This template was a result of our efforts to develop and license the MP 197 HB (see Figure 1), a modified MP 197 used fuel transport cask intended for high burn-up fuel, We took the initiative to incorporate irradiated components type radwaste into the acceptable payload criteria for the license, which has been issued by the Nuclear Regulatory Commission under Certificate of Compliance 9302.

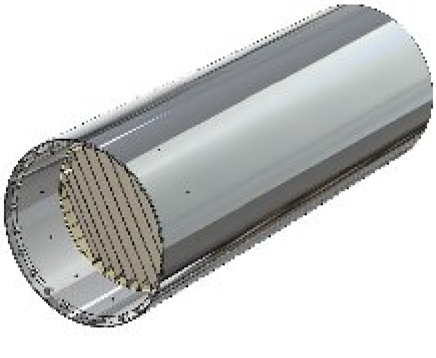

Figure 2, Rad Waste Container

This set the path forward for developing an appropriate Rad Waste Container RWC (see Figure 2) for irradiated hardware storage. The RWC design has approximate dimensions of 63" diameter and 167" long with a variable shell thickness starting at 1 ¾ inches. The outer wrapping is required to be stainless steel for compatibility with use of the MP19HB with the remainder being carbon steel for cost considerations. The bottom of the container is a minimum of 6.5" thick and the top a minimum of 4.5" thick. While this created a container (or liner as commonly used in the low level waste market) that would have been previously considered extremely large for this type waste, (approximately 300 cubic feet versus the RAM Cask liner of 60 cubic feet) the lack of imminent disposal availability made it compatible with current storage needs and future disposal.

Technical Attributes		
Parameter	**RWC**	**RAM liner for Comparison**
Capacity	300 cubic feet	60 cubic feet
Diameter	63 inches	35 inches max
Length	167 inches	111 inches max
Payload	56 Ton max	4.75 Ton max
Thermal limitation	26 kW	300 W
Activity Limitation	8,182 x A2	1,272 X A2

It was estimated that a liner of this size would be compatible for the storage of irradiated components produced over a decade of plant life. Though this size RWC may not have been acceptable at the previously available Barnwell site, discussions with WCS indicated that disposal is probable at their Texas site. In fact on-going discussions are in process to establish the method for future acceptance of the RWC.

Recognizing that plants may take a decade to generate enough irradiated components packaged in the RWC, a simple solution was available by to the cloning of the used fuel transfer and storage technology, which eliminates contamination of the RWC and cask internals. Waste would be packaged into the RWC and transferred to the concrete shielded Horizontal Storage Module (HSM) (see Figure 3) in a contamination free condition. As the retrieval process for a fuel canister had already been developed and proven, this same retrieval methodology could be used for the RWC. Thus the RWC would be partially loaded when required by the specific plant, transferred to the HSM, retrieved when the next loading campaign was necessary, returned to the spent fuel pool, filled with additional material and then returned to the HSM for continued storage. Again, this total process is accomplished while the RWC remains contamination free. These steps can be repeated until the RWC reaches its loading capacity based on volume, transportation limits or disposal site radioactivity limitations.

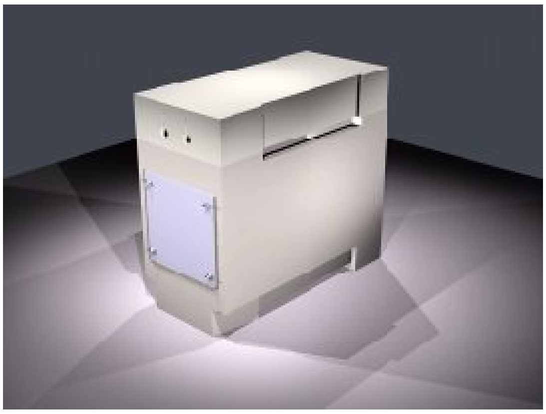

Figure 3, Single HSM Module

Finally, should a future disposal site other than WCS become available and determine an alternate sized liner is necessary; this would not be a significant concern as the RWC is easily retrieved. The RWC can be returned to the spent fuel pool and the components removed for processing to specific disposal site acceptance criteria in an appropriate container. An additional factor of safety is that the components would have essentially been packed unprocessed allowing for future processing accountability. As an example, if a Control Rod Blade had been processed (flattened and cut into smaller pieces) accountability of the individual pieces would be difficult to allow for future packaging and blending of like component pieces and final characterization.

LOADING AND TRANSFER PROCESS

The loading and transfer process essentially identical to TN's NUHOMS® used fuel storage. However, one of the main differences is the RWC internals design versus the Dry Shielded Canister (DSC) internal design which has a fuel basket. The RWC was designed for flexibility depending on the type of irradiated components the generator has produced at the time of loading. Figure 4, Figure 5, **Error! Reference source not found.** and Figure 7 show various internal configurations for whole CRBs, flattened CRBs, CRBs prepackaged in boxes or a mix of the methods respectively. Thus, prior to the packaging process, an internal design can determined for a loading a generator's specific material.

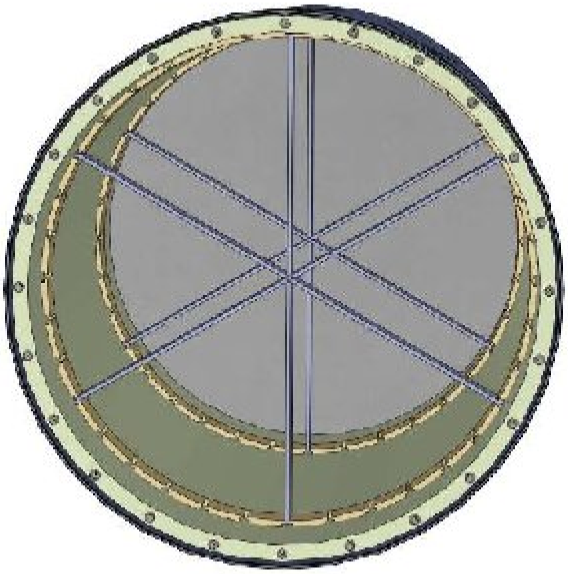

Figure 4, RWC for Whole CRBs

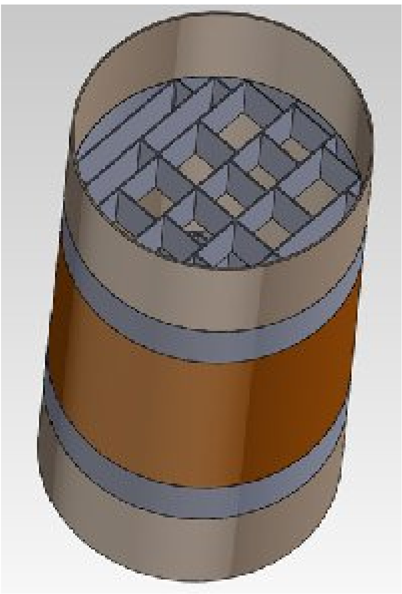

Figure 5, RWC for Flattened CRBs

Figure 6, RWC with Waste Boxes
(Courtesy of Exelon Corporation)

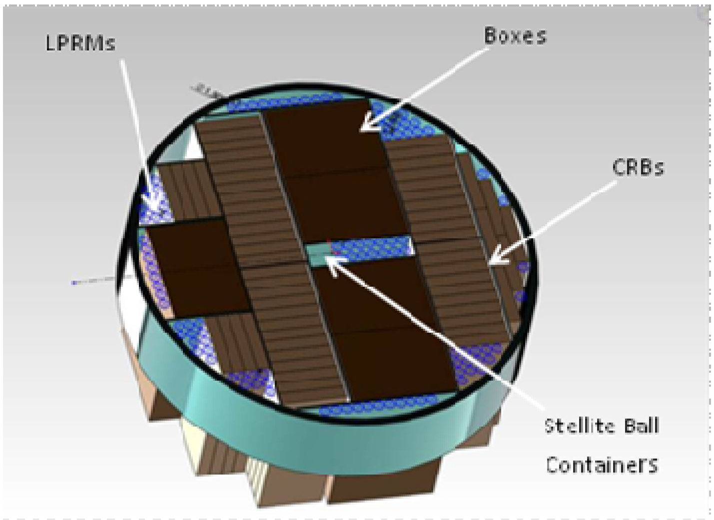

Figure 7, RWC with Waste Boxes and Flattened CRBs

The transfer cask would be brought into the refueling building and positioned in an area such as the decontamination pit for preparation. The RWC would then be placed into the transfer cask and the annulus area between the cask and the RWC filled with demineralized water. An inflatable seal ring is then placed between the cask and the liner to seal the demineralized water from the pool water, preventing liner and cask internal contamination. The cask and RWC are then placed into the appropriate loading area of the pool (see Figure 8) and the selected irradiated components placed into the RWC. From this point forward, the RWC is never lifted directly as it remains in the Transfer Cask until placed into storage.

Figure 8, Transfer Cask in Pool

It is important to note that only the velocity limiters need to be removed from the CRBs so that the CRB can be placed whole in the RWC. This eliminates the previously required underwater crushing and shearing, which eliminates the risks associated with underwater cutting.

Figure 10, Placing Lid on RWC

Once the available waste is loaded, a shield plug is inserted into the RWC for radiation shielding and the cask/RWC is removed from the pool, being decontaminated on its exit, and returned to the original placement location (i.e. decon pit). The liner is then dewatered via standard dewatering technologies and vacuum dried for further assurance. The seal ring is then deflated and removed and the demineralized water removed. The RWC lid is then put in place and typically bolted shut (see Figure 9). With used fuel, this lid would have been welded and, while we do not believe it is necessary, this option remains available if desired. Finally the transfer cask lid is placed on the cask and bolted shut. The cask is now ready for transfer.

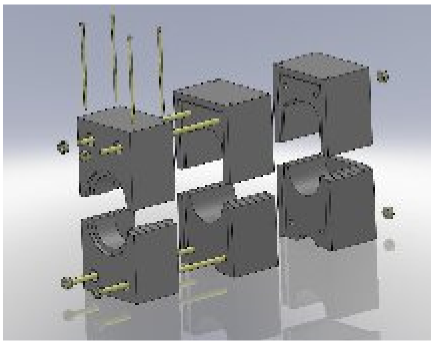

Figure 9, HSM Construction View

The cask is then lifted to its transfer trailer and downended. The cask will remain in the horizontal position for the remainder of the transfer. The cask is transported to the storage area and backed to align with the HSM. The HSM is made of concrete and can be of varying thicknesses (see Figure 10 for one type of HSM) to provide for adequate radiation shielding. The transfer cask is aligned with the HSM via transit positioning to assure the RWC transfer is error free. The cask lid is removed and a hydraulic ram that is part of the transfer trailer pushes the RWC (see Figure 11 and Figure 12) into the HSM and the outer HSM cover is put in place.

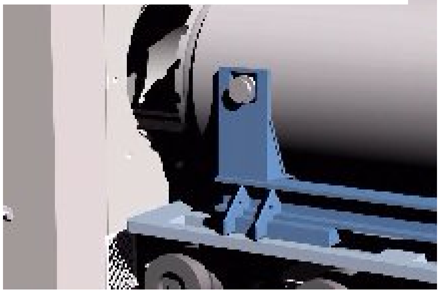

Figure 11, RWC being inserted into HSM

When the RWC is needed for additional loading, further processing or shipping off-site, the reverse of the above loading process would be employed, as the transfer trailer is capable of grappling the RWC and withdrawing it from the HSM. For additional loading, it would be returned to the refueling building and the loading process would be repeated. For off-site shipping, the RWC would be removed from the HSM and loaded into the MP 197 HB transport cask (versus the on-site transfer cask) and shipped to the designated location.

Figure 12, RWC Fully Loaded into HSM

BENEFITS OF THE TECHNOLOGY

As the basic technology has been used for years with used fuel storage, the immediate benefits are readily acknowledged.

TN NUHOWS™	
Features	**Benefits**
Horizontal loading is simpler process • **No stack-up evolution or shield bell required** • **No outside heavy lifts** • **Lower radiation levels**	• **Enhanced human performance** • **Reduced risk** • **Reduced personnel radiation exposure**
• **Most stable system** • **No tip-over analysis**	• **Reduced risk**
Use of horizontal transfer trailer: • **No floor load concerns** • **No interference concerns** • **No road damage** • **No haul path modifications**	• **Reduced risk** • **Reduced cost**
Minimized underwater segmenting	• **Reduced risk** • **Reduced project time** • **Reduced personnel radiation exposure** • **Material accountability**
• **Elimination of liner contamination** • **RWC is sealed**	• **Reduced risk of personnel uptake** • **Reduced risk of contamination spread** • **Reduced cost with no HSM D&D required**

CONCLUSION

Given the uncertainty of site availability for future disposal of irradiated hardware, a storage solution which provides safety, flexibility and reduced risk is an attractive alternative. By combining new adaptable hardware with mature storage technology already in place, the NUHOWS™ system provides an excellent alternative to the traditional storage and transport methods. When the time comes, the

Figure 13, Array of HSMs for Storage

stored RWC can be retrieved and transported to the available waste disposal site without repackaging. This adaptability will be the key to dealing with a changing disposal environment.