

## **The Texas Solution to the Nation’s Disposal Needs for Irradiated Hardware – 13337**

Jay M. Britten\*

Waste Control Specialists LLC, Andrews, TX 79714

### **ABSTRACT**

The closure of the disposal facility in Barnwell, South Carolina, to out-of-compact states in 2008 left commercial nuclear power plants without a disposal option for Class B and C irradiated hardware. In 2012, Waste Control Specialists LLC (WCS) opened a highly engineered facility specifically designed and built for the disposal of Class B and C waste. The WCS facility is the first Interstate Compact low-level radioactive waste disposal facility to be licensed and operated under the Low-level Waste Policy Act of 1980, as amended in 1985. Due to design requirements of a modern Low Level Radioactive Waste (LLRW) facility, traditional methods for disposal were not achievable at the WCS site. Earlier methods primarily utilized the As Low as Reasonably Achievable (ALARA) concept of distance to accomplish worker safety. The WCS method required the use of all three ALARA concepts of time, distance, and shielding to ensure the safe disposal of this highly hazardous waste stream.

### **INTRODUCTION**

During the course of defining an up-to-date business model for modern LLRW waste disposal facility, WCS quickly identified the need to support the national need for a disposal option for commercial nuclear utilities that had been accumulating irradiated hardware in fuel pools since 2008. Irradiated Hardware are typically metal components that are located inside a nuclear reactor that have been “irradiated,” or exposed to intense neutron flux for a period of time and have subsequently become “activated,” or radioactive themselves. The prevalent isotope Co-60 (Co-59 is used extensively in power plants) emits hazardous, high-energy, high penetrating gammas. These penetrating gammas are often difficult to shield.

The transportation cask currently available and utilized by US commercial utilities is the TN-RAM cask. This cask is transported on a triple axle trailer in a horizontal orientation during shipment of irradiated hardware liners. Commercial utilities remove the cask from the specially designed trailer, orientate in a vertical position, and place the cask into the fuel pool to load the cask with a loaded liner. Upon completion of liner loading the cask is removed from the fuel pool in the vertical position, gross de-watering is performed, exterior decontamination is completed, and the cask is placed back onto the trailer for transport to the disposal facility.

Early research of previous disposal methods revealed that irradiated hardware shipments disposed of at the Barnwell, South Carolina facility utilized a “slit trench” method with a horizontal cask orientation. This method required the removal of the primary cask lid while still horizontal and the irradiated hardware liner was physically pulled out of the cask with a dozer coupled to wire rope slings attached to the liner inside the cask. The liner was physically pulled into a trench and immediately covered with soil with an additional piece of heavy equipment for dose rate reduction. Although this method was proven to be highly effective for disposal of irradiated hardware, the WCS landfill design and disposal requirements did not allow for this

method of disposal. In addition, the horizontal offload technique employed at the Barnwell site created a supplementary gross contamination hazard due to the manual, abrasive method for offload.

WCS immediately set out to find a solution and disposal method that would address all issues associated with irradiated hardware disposal at its Andrews, TX facility. In general, all identified potential issues were inherently related to landfill design, disposal requirements, highly hazardous radiation levels, and radioactive contamination risks.

## **DESCRIPTION**

The landfill design at the WCS site is comprised of a 91.5 cm re-compacted clay liner, High Density Polyethylene liner layers, a 61 cm protective granular cover layer, and a 30.5 cm reinforced concrete layer. An elaborate leachate collection system was installed to handle storm water that comes into contact with waste within the disposal cell. With long term landfill stability being of primary concern, Modular Concrete Canisters (MCC) were designed to contain Class B and C containerized waste. Cylindrical and rectangular designs were built into the license application in an effort to support the miscellaneous needs of the LLRW waste generators.

The MCC is a robust disposal canister, and an engineered component of the entire disposal cell system required for long term stability. The CWF primarily utilizes cylindrical canisters to accommodate waste streams received from commercial generators. Irradiated hardware is packaged into a liner specifically designed to accommodate the TN-RAM cask Safety Analysis Report (SAR) and site MCC design requirements.

Class B and C waste received for disposal at the WCS site is placed inside of an MCC during the offload process and the void spaces between the MCC and waste liner/container are filled with 2.1 g/cm<sup>3</sup> (minimum strength requirement) grout. This activity occurs at surface grade and the MCC is eventually transferred to the disposal unit utilizing a modified reach stacker with specialized lift attachment or a Goldhofer® heavy crawler unit (217 metric ton capacity).

As stated earlier, the state-of-the-art, comprehensive liner system at the WCS facility precluded the application of historical off-load and disposal methods for waste liners containing irradiated hardware. A new and innovative approach to the handling and disposal was developed, with a heavy emphasis on safety, ALARA, and environmental stewardship. Due to the inherent radiation hazards, an enhanced disposal canister was also needed to ensure site ALARA criteria were met. Initial licensing documents gave minimum criteria for MCC fabrication and these requirements were integrated into a specific High Density MCC (HD-MCC).

The HD-MCC is an enhancement of the standard MCC. The enhancements are engineered with increased ALARA requirements and handling considerations for the safe movement and disposal of irradiated hardware liners. As an engineered component of the disposal cell system, the HD-MCC design parameter allowable variations were very limited. The HD-MCC design maintained the same dimension and specifications as the standard MCC with the addition of supplementary lift anchors for safe handling of heavier loads. A pre-poured high density grout (nominally 3.45

g/cm<sup>3</sup>) utilizing hematite, crushed aggregate coupled with a 2.5 cm thick carbon steel funnel allowed WCS to have a more robust canister for irradiated hardware that met site ALARA goals and fulfilled grouting / void space requirements.

Initial design criteria allowed the HD-MCC/IHTS combination to accommodate liners with dose rates up to  $3.00 \times 10^{02}$  Gy/hr. However, with additional, planned administrative controls, WCS can proactively handle liners with dose rates up to  $5.00 \times 10^{02}$  Gy/hr. Photographs of the WCS HD-MCC are included in Figure 1.

**Figure 1**



HD-MCC attached to the specialized Kalmar reach stacker at the WCS site.



Interior of the HD-MCC showing the poured-in-place high density grout and 2.5 cm carbon steel funnel. Funnel top is fabricated at a 60° angle for ease of liner placement.

The HD-MCC design variation limitations ultimately required that a new, WCS-specific liner be developed, which met the criteria for the SAR of the TN-RAM shipping cask, WCS' HD-MCC limiting dimensions, and IHTS handling necessities. Heavy interaction with customers, cask owner, and potential liner manufacturers was required to ensure that the eventual handling system would accommodate the successful, safe transfer of this high radiation dose rate material.

The solution was found in the development of the Irradiated Hardware Transfer System (IHTS). The IHTS is a self-contained system engineered to support the vertical off-loads of waste liners from the TN-RAM shipping cask to the HD-MCCs for final disposition. The system utilizes both fixed and Pan, Tilt, Zoom (PTZ) cameras for multiple-angle views during the transfer, laser alignment systems, a 25.5 cm thick, rolled steel transfer bell, and remote actuated grapples for waste liner manipulation. Electromagnets were also procured for the installation of 25.5 cm shield disc covers on the top of the HD-MCC to ensure no radiation streaming occurred after liner transfers. The IHTS is suspended from an articulating, 136 metric ton capacity Mobile Gantry Crane (MCC) for movement of the irradiated hardware liner from the shipping cask to the HD-MCC. The entire system is operated from a remote command center with each component have remote operation capabilities.

The irradiated hardware disposal process also required the procurement heavy equipment, including a Mobile Modular Operations Platform for primary lid bolt removal and installation activities, container reach stackers with custom-built tool carrier attachments with specifications unique to the WCS requirements, a remote operated heavy crawler for MCC delivery in to the

disposal unit, and additional reach stacker attachments that aid in cask handling (e.g. TN-Ram Strong back attachment).

Another ALARA technique built into the disposal process consisted of a “boot” installed on the Goldhofer® heavy crawler to aid in movement of the loaded HD-MCC from the transfer location to the disposal unit. This crawler attachment allows equipment operators to load the HD-MCC and transfer the entire unit to the disposal cell without requiring tie down strap mechanisms for traversing a nine percent slope in the landfill. Operation of this piece of equipment can be via an operator cab or remote operation by a qualified operator.

A photograph of the Goldhofer® heavy crawler with “boot” and payload is presented in Figure 2.

**Figure 2**



Goldhofer® crawler unit with irradiated hardware payload. Crawler unit can be operated remotely and has six axles (each axle with 8 tires). The heavy haul unit can carry a payload of 217 metric tons and is self-leveling when traversing down slopes.

The remoteness of the WCS facility presented challenges in the engineering and fabrication of ancillary equipment. Custom Systems, Structures and Components (SSCs) were required to be engineered and fabricated at facilities with appropriate Quality Assurance (QA) programs, unique skill sets, and abilities. Constant interaction between design engineers, steel fabricators, and equipment vendors was required to ensure a delivered system that had all the capabilities that met company design requirements and objectives. The sequence for delivery of each component was essential to support testing requirements, procedural development, future maintenance requirements, and provide for adequate mock up training. Schedule requirements were stringent and twice weekly schedule progress meetings were conducted to ensure timely completion of the project.

Initial delivery to the WCS site was the MGC. Vendor supported erection, testing, and training lasted approximately two weeks. Further training was provided to crane operators in the remote operational facets of the system. WCS has multiple trained, qualified crane operators with over sixty years of combined experience in safe crane operations. This skill set is a very unique

requirement in the WCS waste management system and the collective experience proved to be very beneficial during the training and mockup evolutions.

Another challenge specific to the testing requirements for the MGC included regulatory load testing requirements for the MGC system. WCS was required to design and fabricate a test load with a weight of over 158 metric tons to meet requirements for safe use in the intended application for irradiated hardware transfers. Significant engineering involvement in the design and fabrication was required to ensure the test load dimensions and weight corresponded with hoist dimensions of the MGC. The end result was a load test that consisted of a large six pocket “egg crate” holder. Each pocket was fitted with six, individual concrete blocks with average weights of approximately 23.5 metric tons to 25.8 metric tons.

A photograph of the load test is included in Figure 3.

**Figure 3**



Shown is the constructed load test for the MGC. Test load was over 158 metric tons.

## **CONCLUSION**

In October 2012, WCS received its first shipment of irradiated hardware from a commercial utility in Alabama. This shipment consisted of irradiated control rod blades that had been processed and placed into an irradiated hardware liner. Contact dose rates for the shipment were estimated to be approximately  $1.00 \times 10^{02}$  Gy/hr. The entire process took four days from the time

the shipment arrived until cask departure back to the cask owner. The sequence of events occurred as below:

- Day one: Cask delivery, inspections, impact limiter removal, cask removal from the shipping trailer, removal of primary lid bolts, and placement into the irradiated hardware handling area.
- Day two: Removal of the primary lid in the containment structure, transfer of the liner from the shipping cask to the HD-MCC, re-installation of the primary lid, and cask decontamination activities.
- Day three: Placement of the cask and impact limiters on the transport trailer, decontamination activities of the contamination structure, removal and placement of the HD-MCC from the containment to the Goldhofer® crawler.
- Day four: Transfer of the loaded HD-MCC to the disposal unit and placement into the final disposal array in the CWF.

This entire evolution consisted of a combined, collective crew of over thirty people to include operations, maintenance, industrial safety, waste acceptance, and radiological safety personnel. The safe and compliant disposal of the irradiated hardware shipment was accomplished with a total collective exposure of 2.18 mSv with the highest individual dose being  $1.45 \times 10^{-01}$  mSv. Additionally, contamination levels within the containment structure were generally contained to less than  $1.66 \times 10^{02}$  Bq/100 cm<sup>2</sup>. Historical methods of disposal typically exhibited much higher levels of contamination due to the abrasive method of the liner transfer. These metrics exemplify the preparation and ALARA measures taken by WCS personnel and support groups promoted worker safety, environmental protection, and met a critical customer need.

Photographs of the final disposal operations of the first irradiated hardware shipment are provided in Figure 4.

**Figure 4**



Photographs show the evolution from placement of shielded lid to final placement into the disposal unit.

### **Discussion**

The safe, efficient, and compliant disposal of the first commercial utility irradiated hardware shipment since the closure of the Barnwell, South Carolina facility in 2008 exemplifies the WCS commitment to its customers. Over twenty months of planning, engineering, fabrication, testing, and mockup training led to a successful transfer of this highly hazardous waste stream to its final resting place.

This final disposal of irradiated hardware is a major accomplishment in the waste management industry. Although many facets of the WCS facility required workers to deviate from traditional industry methods for disposal, creativity and innovation helped make this process a safer, less aggressive activity that created manageable dose to workers and less potential for contamination. With solutions to these two critical issues, a solution for a national disposal need was satisfied utilizing methods that created a work environment for increased radiological and industrial safety.