Development of the Operations and Maintenance Manual for the Mk-18A Onsite Transfer Cask

Kathryn Karius and Bradley Loftin, Savannah River National Laboratory

Abstract:

The Mk-18A Onsite Transfer Cask was developed by the Savannah River National Laboratory Research and Development Engineering organization to facilitate the safe transfer of Mk-18A target fuel assemblies from the Savannah River Site L-Area Basin to the SRNL Shielded Cells Facility. The cask design allows for use of existing equipment in both facilities and allows for a safe and efficient transfer along SRS roads. The cask is operated via sequential, detailed instructions. These operating instructions incorporate the unique aspects of each facility's existing infrastructure and allow for safe, straightforward closure of the cask to allow for compliant onsite transfer. This paper will briefly discuss the design and manufacturing of the cask and transfer trailer and it will focus on the operating instructions that have integrated the facility requirements into the SRS onsite transfer program to allow the Mk-18A targets to be transferred onsite at the SRS.

Background:

The Savannah River Site (SRS) operated five production reactors in support of United States nuclear defense programs producing mainly plutonium and tritium. However, there were a few cases where multi-year irradiation campaigns placed special targets in the core of production reactors for scientific research programs and in some cases for extended periods of time. One such campaign, which began in 1969, was a high-flux campaign to irradiate ^{242}Pu to produce ^{252}Cf. The initial irradiation ended 15 months later, but 65 of the Mk-18A targets remained in the reactor core until discharged in 1979.

The extended high-flux irradiation of the Mk-18A targets resulted in various rare isotopes being produced in the target. Some of these isotopes include ^{244}Cm, ^{246}Cm, ^{248}Cm, and ^{244}Pu. Of particular interest is the ^{244}Pu since it is virtually impossible to replicate this production, at this same scale, using existing high-flux reactors. Additionally, the reactors at SRS have not been in production nor operated since the early 1990s. Thus, it was decided to explore options for recovery of these targets to preserve the valuable isotopes contained within them.

Transportation of radioactive materials completely within the boundaries of the SRS is referred to as a transfer. Transfers are completed within the requirements and parameters outlined in the SRS Transportation Safety Document (TSD). The TSD provides relief from the requirements for transportation of radioactive materials found in 49 CFR and 10 CFR based on restricted access to the SRS and is specifically allowed via Department of Energy (DOE) Orders. The Mk-18A targets contain more than 1 A_2 of contents per 49 CFR and would be required to be shipped, in commerce, in a Type B package. The relief given by the TSD allows radioactive material to be transferred at the SRS in packaging that does not incorporate some of the design requirements and parameters found in 49 CFR and 10 CFR.

Per 10 CFR 71.73, a Type B radioactive material package is required to be tested to withstand an 850°C fully-engulfing pool fire. Since this fire event can be mitigated via controlled access and roadblocks at the SRS, onsite packagings may be designed without thermal insulating materials in order to save on costs, weight, size, etc. Additionally, 49 CFR 173 and 10 CFR 71 require packages to meet certain dose requirements for shipment in commerce. These requirements are typically met in order to keep harmful radiation from the public. Per the TSD, the SRS radiological control manual provides the dose and

contamination requirements that must be met for onsite transfers. Type B packages are required to withstand a 30-foot drop test. Lightweight packages (less than 500-kg) are also required to withstand a 30-foot crush test, however, many fuel casks are too heavy to require a crush test. 10 CFR 71 also specifies a maximum leakage rate that must be maintained after the accident sequence in 10 CFR 71.73. At the SRS, there is not a credible drop of 30 feet. Thus, while in transfer, vehicle speed is limited to reduce any impact that would equal the energy from a 30-foot drop. Additionally, release of materials onsite is based on DOE release criteria. The TSD allows these reliefs from the CFR, thus designs for onsite-only packages can be significantly less intricate and much more inexpensive than a package designed to the requirements found in 10 CFR 71.

Complexities associated with onsite transfer must still be met by the design. The main two criteria for this onsite design are (1) limiting the dose to the worker, and (2) low energy accident conditions, such as a roll-over. However, onsite transportation comprises only part of the design requirements for the onsite cask. Both the shipping and receiving facilities (L-Area and SRNL) requested that the cask design operate seamlessly with existing equipment found in the respective facilities. Those parameters added additional complexity to the package and transportation design.

The Mk-18A target assembly is stored in the L-Basin in a double J-Can configuration. The double J-Can holds the target in a vertical position in the basin. The transfer bay in L-Area is not deep enough to load the target vertically into a cask while maintaining adequate shielding from the water. SRS has been using an SRS cask design, the 70-Ton Cask, for target transfers from the reactors to the separations facilities for decades. L-Basin has existing infrastructure for loading targets into the 70-Ton Cask horizontally. The Mk-18A Onsite Transfer Cask (the Cask) has, therefore, been designed to load a target horizontally in a similar fashion to how the 70-Ton Cask operates. Additionally, L-Area requested that the Cask not contain closed areas where water could accumulate thus allowing basin water to drain out of the Cask when removed from the basin.

It was decided that a cylinder, split longitudinally, would be able to operate similarly to the 70-Ton Cask and that once at SRNL, end plugs along the central axis could be removed to allow for insertion in to the shielded cells. This was the basic design for the central shield. However, a framework structure needed to be constructed to allow the package to rest on the superstructure within L-Basin that holds the lid of the 70-Ton Cask and will hold the upper portion of the Cask.

The Mk-18A Cask Shield design incorporates concentric layers of stainless steel and 5% borated polyethylene. The stainless steel is used for structural integrity and for the shielding of gamma radiation. The 5% borated polyethylene is used for the shielding of neutron radiation. The entire shield is encapsulated in stainless steel and each end of the trough where the J-Can assembly sits in the shield is capped with a plug consisting of 5% borated polyethylene and lead (for gamma shielding) encapsulated in stainless steel. The structural framework is constructed of stainless steel. The overall size of the framework is approximately 20’(l) X 5’(h) X 4.5’(w). The shield weighs approximately 8.5 Tons and the Cask (Frame and Shield) weighs approximately 13.5 Tons. The Cask is shown in Figure 1 and a representation of the Cask suspended within the L-Basin is shown in Figure 2. The Mk-18A Target Shield Assembly, the portion of the Cask where the Mk-18A target rests during transfer, is shown removed from the Cask Frame in Figure 3.

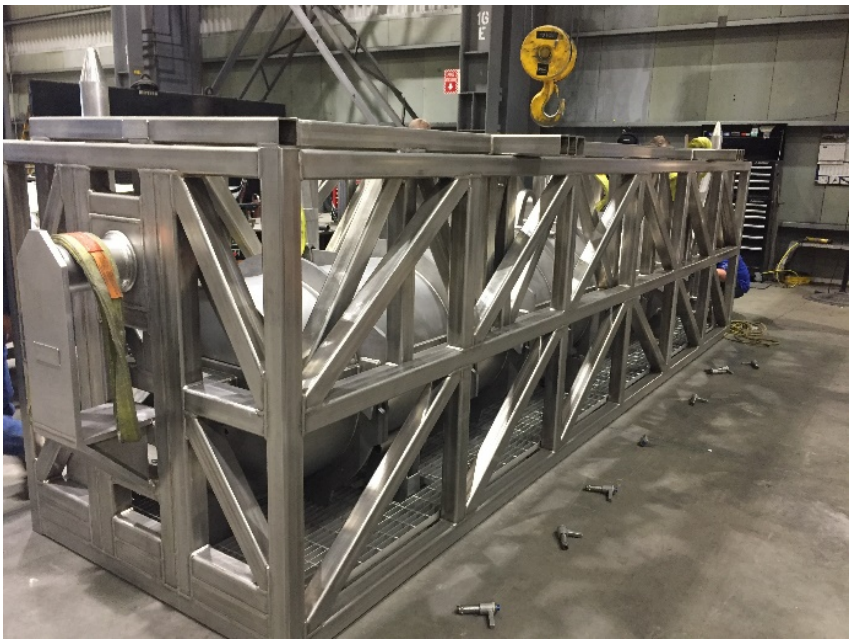

Figure 1: Mk-18A Cask (As Built)

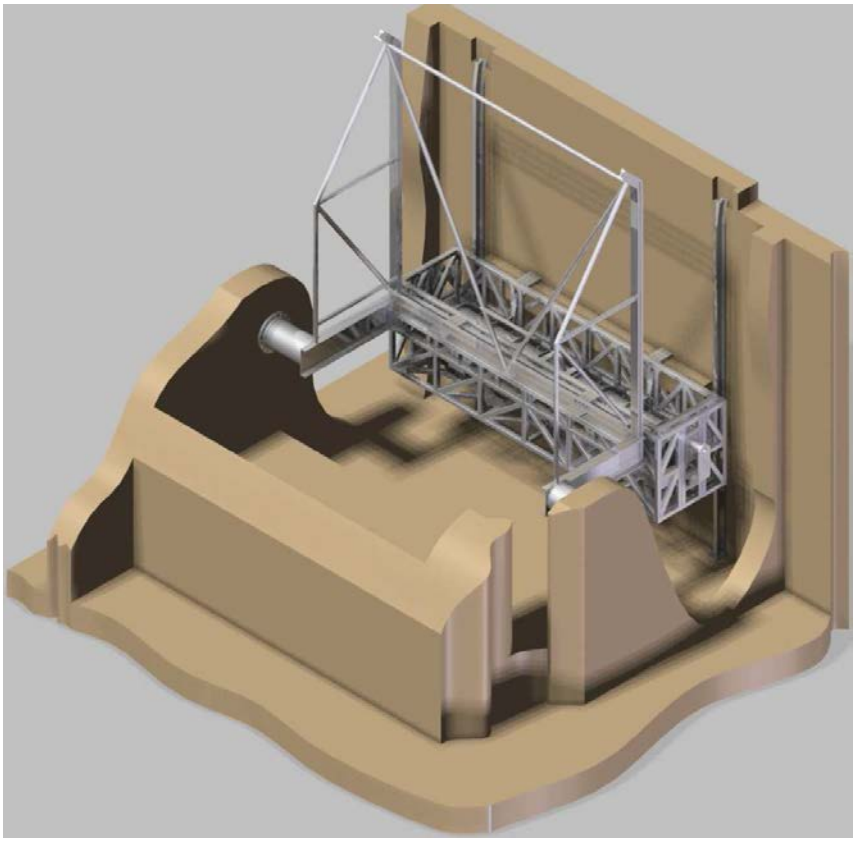

Figure 2: Mk-18A Cask Suspended on the L-Area Superstructure (Representation)

Figure 3: Mk-18A Target Shield Assembly Removed from the Cask Frame

Documentation Necessary for Operating Packages at the SRS:

Operating a radioactive material shipping package at the SRS requires specific instructions to ensure that each loading and unloading of the radioactive material is completed in a safe and secure manner in accordance with DOE Orders and site manuals. The instructions for operating the package are prepared by the subject matter experts and then approved for use by the site Package Review Committee (PRC). Once approved the instructions along with facility specific operating instructions are placed on the SRS Radioactive Package Approval Log (RPAL). Radioactive material packages are not allowed to be transferred onsite unless they are listed on the RPAL for each facility that intends to use the package.

The instructions for the Cask have been prepared and are being reviewed for strict facility compliance. One unique aspect of the Cask is that it only has one content type, the Mk-18A target assemblies. Since it only has this one content, the operating instructions have been accompanied by a supporting calculation that shows the worst-case Mk-18A target assembly has dose, fissile gram equivalence, and overall curie values less than the maximum values that are allowed for transfer under a specific onsite safety assessment, S-OSA-G-00025, *Onsite Safety Assessment of Select SRS Packagings*. Further, to be utilized under S-OSA-G-00025, the Cask needed to be qualified onsite to be equivalent to and meeting the intent of general design requirements for Class 7 Radioactive hazardous materials packaging as outlined in 49 CFR 173.410. A compliance summary was completed at SRNL detailing that the Cask was indeed qualified as meeting the intent of a general design package as outlined in G-TRT-G-00034, *Compliance Summary for Mk-18A Target Transfer Cask*. Thus, the Cask can be utilized for onsite transfer of the Mk-18A target assemblies once it has been placed on the RPAL by the transferring facility.

Mk-18A Transfer Cask Operating Instructions:

Figure 4 shows a representation of the Mk-18A Transfer Cask and Catch Pan assembly. Operating Instructions have been prepared for the Mk-18A Onsite Transfer Cask and are summarized below:

Pre-shipment Verifications:

Since the Cask is placed within a dedicated Mk-18A Trailer and Catch Pan assembly, it will be stored and covered in the L-Area yard at the SRS. Prior to loading of the target assemblies, the Cask will need to be inspected. This inspection includes visual verification that the entire Cask is assembled, inspection for major damage, inspection for visual corrosion that would prevent the Cask from performing its functions for shielding, accumulation of water in the catch pan, visual inspection for debris on the Trailer, catch pan, and/or the Cask. Once those inspections are completed, the Cask will be connected to a tractor (truck) to allow the Trailer and Cask to be moved into the L-Basin facility Transfer Bay area for preparations for loading of the Cask. The Trailer was designed to have two rear axles to ensure that the Trailer can meet the federal bridge requirements for maximum weight on any axle while traveling over a bridge. However, due to facility combustible loading requirements, the rear-most axle of the Mk-18A Trailer is removable to prevent the additional rubber tires from entering the facility. Prior to moving the Cask into the L-Area Transfer Bay, the rear axle will be removed from the Trailer and staged for reconnection once the Cask has been loaded with the target assembly.

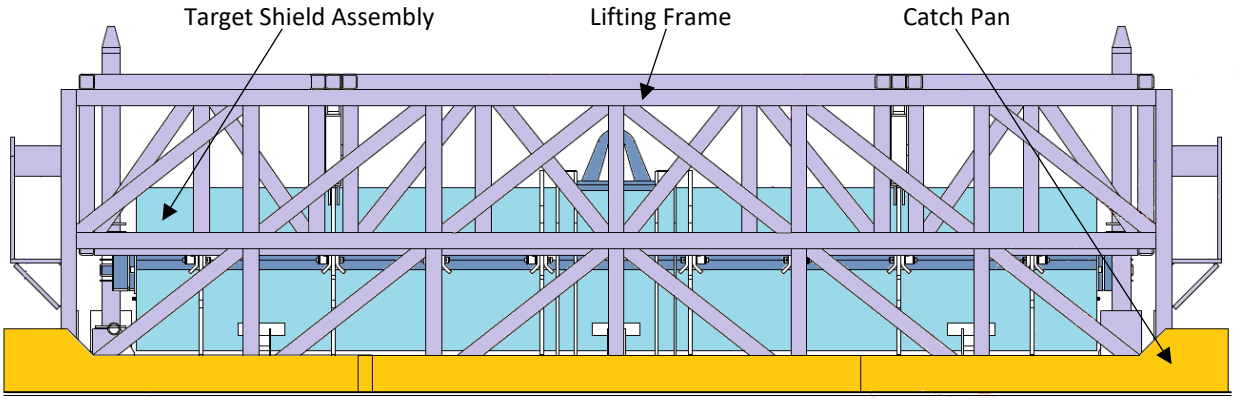

Figure 4: Components of the Mk-18A Cask

Loading Operations:

Once the rear axle has been removed, the Cask will be moved into the L-Area Transfer Bay. The steps involved with this move include opening the outer doors of the bay, backing the Trailer into the bay, disconnecting the Trailer from the tractor, moving the tractor out of the Transfer Bay, and closing the door.

Once the Cask is inside of the facility and the outer doors closed, the radiological control bags placed around the Cask are removed to allow access to the Cask. The Cask is then connected to the 85-Ton Crane located within the Transfer Bay. The 16 pins holding the Target Shield Assembly together are removed to allow the Bottom Shield Weldment and the Top Shield Weldment to separate when the Cask is lowered into the L-Area Basin. With the four pins attaching the swing arms on the Upper Body Lifting Frame to the Top Shield Weldment in place, the two End Plugs installed and secure, and the drain tubing attached to

the quick disconnects below the End Plugs, the Cask is readied for lowering into the basin. The Cask is lowered into the L-Area Transfer Pit . The Cask separates as it is being lowered. The lower portion of the Cask is positioned to allow the Mk-18A target assembly to be loaded into the Cask.

Once the Mk-18A target assembly is placed into the Cask, the Cask is positioned and raised out of the Transfer Pit where, upon raising, the Cask is reassembled and nested back as a full assembly. The Cask is then raised out of the basin and allowed to drain. Once the Cask has adequately drained, the Cask is placed back onto the Mk-18A Trailer. The 16 pins are installed, and the drain tubing is disconnected from the ends of the Cask. The 85-Ton Crane is then disconnected and the radiological control bags are closed around the Cask. The transfer tractor is then backed into the Transfer Bay, connected to the Trailer, and then moved out to the L-Area yard to have the rear axle reinstalled. Once the rear axle is reinstalled, the loaded Cask is transferred onsite to the SRNL E-Wing facility.

Unloading Operations:

Once the Mk-18A Trailer has been transferred to SRNL, the rear axle is again removed due to both fire loading restrictions and due to length limitations within the SRNL E-Wing truck bay. Once the axle is removed, the outer door is opened and the Trailer backed into the truck bay. Once the Trailer is backed in, the tractor and the "gooseneck" portion of the Trailer are disconnected, and the tractor is pulled out of the truck bay. The outer door is then closed. Then the radiological control bags are opened allowing access to the Mk-18A Target Shield Assembly. The 4 ball-lock pins attaching the Upper Body Lifting Frame to the Top Shield Weldment are removed. This "frees" the Target Shield Assembly and allows it to be removed from the Frame. The SRNL 10-Ton crane is attached to the Target Shield Assembly and the Target Shield Assembly is lifted out of the Frame. With an interior door opened, the Target Shield Assembly is moved over in front of the E-Wing Shielded Cells onto the Mk-18A Cask Table. The End Plugs are remotely removed, and the Mk-18A target is removed from the Target Shield Assembly into the Shielded Cells.

Once the Mk-18A target is completely removed, the End Plugs are installed, the Target Shield Assembly is moved back onto the Trailer within the Frame, the 4 pins are reinstalled, the 10-Ton Crane is removed, and the radiological control bags are again closed around the Cask. The inner door is closed, the outer door is opened, and the tractor is backed into the truck bay, reconnected to the Trailer, and pulled out into the SRNL yard where the rear axle is reconnected. The Cask, now empty, is then moved back to the L-Area yard to await the next Mk-18A target assembly transfer.

Conclusions:

The Mk-18A Cask was designed to be safe, to maintain compliance with all DOE and SRS requirements, and to incorporate existing facility equipment and environments all while maintaining worker dose to levels As Low As Reasonably Achievable (ALARA). Even though the Mk-18A Cask is quite simple to operate, great care was taken in the design to allow the operation of the Mk-18A Cask to ensure that it will be viable for the entire mission of recovering the valuable isotopes from the Mk-18A target assemblies.