Moab Uranium Mill Tailings Remedial Action Project Assessment of Methods to Minimize Contaminated Material Holdup in Intermodal Containers - 11196

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ABSTRACT

During residual radioactive material (RRM) conditioning and disposal operations on the Moab Uranium Mill Tailings Remedial Action (UMTRA) Project in Utah, operations showed that RRM soil properties vary such that portions of it are sufficiently cohesive to cause retention in the containers used to transport the RRM by rail to a permanent disposal cell. Container retention, or holdup, is unacceptable because it reduces the amount of RRM that is disposed.

To significantly reduce the problem with retention the project took a two-part approach, identifying both preventive and corrective actions. Preventive actions define methods implemented to deter holdup from forming. Corrective actions are methods to remove holdup once it forms. A variety of methods was considered and some tested to determine the most effective options. The project reviewed the preventive measures and corrective actions for effectiveness through visual inspections at both the loading site and disposal cell. By implementing a combination of preventive and corrective measures, the project reduced material holdup in containers to less than 1 percent. The resulting process optimizes preventive actions through painted-on and panel liners year-round, enhanced with plastic liners and release agents during cold weather, and use of the excavator vibrator attachment to remove holdup when it begins to form. These methods are safer for employees because they reduce the need for personnel to work adjacent to heavy equipment and eliminate manual entry into containers.

INTRODUCTION

The U.S. Department of Energy (DOE) Moab UMTRA Project site is a former uranium ore-processing facility located approximately 3 miles northwest of the city of Moab. The Moab site lies on the west bank of the Colorado River and encompasses about 400 acres, of which 130 acres is covered by a mill tailings pile. Mill tailings are what remain after the uranium extraction process. Concerns over potential contamination of the Colorado River has long made the cleanup and removal of the radioactive mill tailings a priority for local Utah citizens, environmental groups, citizens in downstream states who use the river for drinking water, and state and federal government officials.

The project scope includes relocation of the 16 million tons of uranium mill tailings from the Moab site to a permanent disposal cell near Crescent Junction, Utah, approximately 30 miles north of the Moab site. Mill tailings are categorized as RRM. The primary mode of transportation is rail in specially designed steel intermodal containers that are top-loaded and end-dumped. The project began RRM shipments in April 2009 and currently ships about 10,000 tons of RRM daily in a total of 288 containers. Soon after beginning shipments, the project observed that the RRM did not completely empty from its packaging at the disposal site. This material holdup was inefficient for the project and required resolution to eliminate its cost and schedule impacts.

TAILINGS PILE

The Moab mill used both acid and alkaline-leach processes to extract uranium. An enormous quantity of water was used in processing the ore. Tailings from the processes were combined and pumped to a tailings pond. Over the 28 years of milling operations, an 80-foot-high tailings pile was created with a core of wet, fine-grained, clay “slimes” and an outer ring of drier sands. After milling operations ceased, the moisture content of the tailings remained at up to 70 percent in the core portion of the pile. The wet slimes contain free water with a total dissolved solids content over 100,000 milligrams per liter and some have shown a pH between 2.0 and 3.0.

RRM PROCESSING CYCLE

The project implemented a consistent cycle to prepare, ship, and place the RRM. Because the moisture content of the wet slimes is significantly higher than optimal for disposal (about 20 percent), the project excavates tailings from the pile and spreads them in shallow lifts. The tailings are then disked and blended with drier materials until the excess moisture evaporates to the desired moisture content. The conditioned RRM is top-loaded into containers for rail shipment to the disposal facility at Crescent Junction. Containers are of two sizes, 32 cubic yards, which hold about 33 tons of RRM, and 40 cubic yards, which hold about 39 tons.

At the Crescent Junction site, the containers are emptied by opening an end gate and tilting the container, allowing the RRM to release by gravity. RRM conditioning and disposal operations showed that the soil properties of the RRM vary such that portions of it are sufficiently cohesive to cause retention in the containers. This retention issue, while applicable year-round, increased during the winter’s cold weather. Holdup often began in the container corners most distant from the rear door. The amount retained often increased with successive loading and dumping until as much as 50-percent holdup was observed (see Fig. 1).

Container holdup is unacceptable because it reduces the amount of RRM that is disposed. To account for the holdup, the project deducted the tare weight from the loaded container weight and used confirmatory visual observations. This process accurately reflected disposed quantities, but did nothing to resolve the issue.


Fig. 1. Photographs of RRM being emptied from a container (left) and the holdup after emptying (right).

To significantly reduce the problem with retention, the project took a two-part approach, implementing both preventive and corrective actions. Preventive actions define methods to deter holdup from forming. Corrective actions are methods to remove holdup once it forms. A variety of methods was considered and some were tested to determine the most effective options. A complicating challenge was that RRM retention was not anticipated; therefore, planned operations unintentionally restricted access to the interior of the containers, making it difficult to observe and remove the material holdup. Container lids could only be placed and removed at the Moab site in a structure designed for this purpose. Likewise, the rear gate release mechanism for the containers could only be operated from within the trucks at the disposal cell at Crescent Junction. These operational difficulties resulted in limitations as to when and how observations and corrective actions could be made.

PREVENTIVE MEASURES

Preventive measures are the optimal solution because they eliminate retention from starting. The project tested single-use, multiple-use, and permanent techniques to prevent material retention in the containers. These methods each showed varying success rates under different conditions. The successful method would minimize retention, while also being cost-effective.

Disposable Plastic Liners

The project installed 10-mil thick polypropylene liners in containers via the top of the open container. Liners are delivered to the jobsite on rolls and are removed one at a time, similar to a large paper towel dispenser. Employees set a liner in the container bottom and tuck the edges into the top-lifting fixtures to keep the liner in place until the first RRM weighs it down.

By testing a variety of sizes, the project determined that liners must be of sufficient size to tuck into the top corners and cover the bottom of the container. When the liner installation, as shown in Fig. 2, covers the entire bottom of the container, it prevents a bond from forming between the

RRM and the container and allows the RRM to empty effectively. However, this method does not help clear any preexisting holdup below the liner.

Fig. 2. Disposable plastic liner installation in a container.

Because employees must install these liners on the tailings pile after the lid is removed from the container, this process is very vulnerable to wind conditions. Employees work from aerial lifts and stop operations during high winds for safety concerns. Additionally, liners stick to the container walls when the temperature falls below approximately 20 degrees Fahrenheit and the liners are additional waste for disposal.

Spray Release Agents

The project tested three types of spray release agents, Chemlok 640 and 660 freeze conditioning solution, and Soluble-D oil, an emulsifying oil that readily mixes with water. Employees used a hand sprayer from a man lift on one side of the container to apply these solutions on the interior container walls to minimize the potential for a bond to form between the walls and RRM. The application technique limited this approach’s effectiveness because employees could not see, and therefore access, all of the container walls.

Despite the limited ability to fully coat container walls, this technique does aid in releasing RRM from the containers and reduces the potential for plastic liners to stick to walls; therefore, the release agents are used during severe cold. Release agents are also used during high wind conditions when plastic liner application is not feasible.

Painted Coating

The project attempted a graphite-based, painted-on coating that could be applied to containers already in use (see Fig. 3, right photo). Test containers were pressure-washed to remove loose material and the graphite paint applied to the container floor, front wall, and side walls with a paint roller. Though labor intensive, this paint is safe, cost-effective, efficient, and initially effective at reducing the bond between RRM and the container.

However, due to RRM's high abrasiveness and acidity, the paint wore off quickly. Because each container requires pressure washing before application, the project schedule does not allow for repeatedly taking containers out of service for reapplication. This painted coating was, therefore, not applied beyond the test containers.

Spray-On Liner

As a result of additional funding received as part of the American Recovery and Reinvestment Act, the project procured additional containers to support increased shipments. Because the material holdup problem had already been identified, the project had a product applied to the interior walls and floor of the new containers before putting them in service. This product, Sherwin-Williams Corothane 1 Mio-Aluminum B65S14, is a sprayed-on aluminum and micaceous iron oxide-filled urethane coating applied in two coats to a total 5-mil dry thickness (see Fig. 3, left photo).

This coating works extremely well for preventing holdup with excellent durability. However, proper coating installation requires that the surface be prepared through sand blasting, and the application be performed under well-controlled temperature and humidity conditions. Therefore, this coating was not suited for the containers that were already in service, but was applied to 94 new containers.

Fig. 3. Photographs of interiors of containers with a sprayed-on liner (left) and panel liner (right).

Panel Liners

The project conducted tests using two models of ½-inch-thick permanent panel liners consisting of modified ultra-high molecular weight polyethylene (UHMW-PE); a pure, 100% virgin UHMW-PE polymer with two grades of silicone content, Dyna Flo A-1 9000 and Dyna Flo A-1 7000 with 50 percent less silicone; and Dyna-Flo BlackJack 2000, a blend of recycled and virgin UHMW-PE polymers with no silicone content. Test containers received complete floor coverage with varying heights from 12 inches to 4 feet up the container interior walls on a total of 10 containers. The liner is welded to the wall interiors with plates and pins (see Fig. 3, right photo).

All liner compositions and wall heights proved effective. RRM holdup starts in the corners between the floor and the walls, and the panel liners prevented this initial formation resulting in a near complete release when the containers were tilted. Additionally, these liners reduce abrasion and corrosion of the container interiors and increase blunt force impact resistance. These liners were not as effective during severe cold as they are when temperatures are above 20 degrees Fahrenheit.

CORRECTIVE ACTIONS

Corrective actions were performed when buildup of RRM was observed. The project progressively tested four methods for holdup removal.

Forklift Scraper Attachment

The project constructed a forklift attachment to scrape retained RRM from the containers at the Crescent Junction site. The forklift attachment scraped inside the bottom of the container. This method proved inefficient because the setup was not able to put enough force at the base of the holdup, the container could not be held at an angle allowing loose material to fall as it was being scraped, and a second piece of machinery was required to keep the tailgate open during scraping. Tests conducted using this attachment took approximately one hour to sufficiently remove holdup. Though the project believed that increased efficiency was expected with successive use of the attachment, reducing overall time to approximately 20 minutes, this approach remained non-conducive to production.

Mechanical Excavation

The project used an excavator with a flat-bladed bucket attachment to remove holdup from the containers once they were returned to the Moab site and the container lid was removed. Trucks drove the containers to a work location where excavators were positioned to provide the operator maximum visual access to the container interior. The operator used the excavator bucket to break the holdup inside the container, and then scoop the material out of the container.

Though this method is effective for removing significant quantities of holdup material, the problems associated with its implementation reduced its efficiency. Even with a flat-bladed bucket, including a rubber blade, getting the bucket in and out of the container posed a risk of damaging the side walls and upper edge. Additionally, the excavator technique always leaves some holdup in the bottom of each container, particularly between the floor and the walls. This remaining holdup contributed to buildup increasing more rapidly than if the container was completely empty. This method was suspended following several weeks of use.

Water Spray

The project evaluated another technique after the lid had been removed from the container. The open container was tilted up on an articulated truck with the tailgate released and a truckmounted water cannon sprayed into the open top. The water spray washed holdup material from the container and allowed it to fall through the open tailgate.

Even with the container tilted to the maximum degree available the water cannon could not access the entire bottom of the container. The area near the tailgate remained outside of the direct line of spray and the water washing over it from higher in the container was not effective in removing this holdup. Additionally, once the containers were washed out they needed time to dry before more RRM could be loaded because the wet container surface was more adhesive and aided in the start of more holdup. The drying process took too much time to meet the shipping schedule. This method also required handling the waste water coming out the back of the container. While this technique removed much of the retained material, it was not complete and was suspended after a limited test period.

Vibratory Removal

The project attempted two types of vibrators to release holdup. The first vibrator attached to framework on the articulated truck hauling the container. However, this proved ineffective as the vibrations dissipated into the truck's framework reducing effectiveness.

For the second attempt, the project identified an excavator attachment that agitated the container while it was being dumped. An off-the-shelf vibrator was modified with a special pin to fit into the container's corner castings. The container was tilted while on a truck over a dump ramp at the disposal cell, and an excavator operator placed the pin into a corner and activated the vibrator as depicted in Fig. 5. While this technique effectively releases material holdup into the disposal cell dump area, it has the potential for additional wear on the corner castings of the containers. The project worked with the container manufacturer and developed manufacturer-approved methods to reinforce the corner castings. These improvements reduced the impact that the vibration had on container integrity and has become the corrective action of choice for removal of RRM holdup.

Fig. 4. Excavator with vibrator attachment releasing holdup.

CONCLUSION

The project consistently weighed containers to aid in determining the presence of retained material in the containers. Each of the described preventive measures and corrective actions were evaluated for personnel safety, cost, and impact on operations.

By implementing a combination of preventive measures and corrective actions, the project reduced material holdup in containers to less than 1 percent. The project's recommended preventive measure is spray-on micaceous paint for new containers and installation of a modified UHMW-PE panel liner in containers already in use. These spray-on and panel liner methods are enhanced with single-use plastic liners and Soluble-D release agent during cold weather. When holdup is identified in a container, the project uses the excavator vibrator attachment as a corrective action.