Supporting the Largest D&D Project with Innovative Waste Management Approaches Oak Ridge, Tennessee - 14628

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ABSTRACT

Supporting the largest D&D project requires innovative waste management approaches that involve evaluating all aspects of the D&D Program to identify methods to reduce cost, save time, and gain efficiencies. Looking outside the norm provides for opportunities to improve the process. Even small changes, multiplied by the huge scope of a D&D project, result in a significant benefit.

INTRODUCTION

The crown jewel of the URS | CH2M Oak Ridge LLC (UCOR) contract is the K-25 plant. The K-25 plant, located on the southwestern end of the Oak Ridge Reservation, used the gaseous diffusion method to separate uranium (U)-235 from U-238. Based on the well-known principle that molecules of a lighter isotope would pass through a porous barrier more readily than molecules of a heavier one, gaseous diffusion produced (through myriads of repetitions) a gas increasingly rich in U-235, as the heavier U-238 was separated out in a system of cascades. Although producing minute amounts of final product measured in grams, gaseous diffusion required a massive facility to house the hundreds of cascades and consumed enormous amounts of electric power.

Begun in June 1943 and completed in early 1945 at a cost of $500 million, the K-25 plant employed 12,000 workers. The U-shaped K-25 Building measures half a mile by 1,000 feet and is larger than the Pentagon. Construction began before completion of the design for the process. Due to construction needs at K-25 and elsewhere on the reservation, the town of Oak Ridge, originally designed for 13,000 people, grew to 50,000 by the summer of 1944.

Gaseous diffusion was one of three isotope separation processes that provided U-235 for the Hiroshima weapon (Little Boy)—the other two being electromagnetic separation and liquid thermal diffusion. The S-50 liquid thermal diffusion plant, using convection to separate the isotopes in thousands of tall columns, was built next to the K-25 power plant, which provided the necessary steam. Much less efficient than K-25, the S-50 plant was torn down after the war. Gaseous diffusion was the only uranium enrichment process used during the Cold War. K-25 was the prototype for later Oak Ridge plants and those at Paducah and Portsmouth.

The K-25 plant ceased operations in the early 70s, as more modern and advanced plants came on line. The plant laid dormant, except for a few units in the southeast portion of the building. In the later years, its operating upper floors were used for office space and the cell floors were used for storage of excess equipment. The bottom floor vaults were used to store a myriad of wastes. As the building aged, degradation took its toll. Foundations slumped, roofs leaked, and various creatures took up residency in the building, compounding the difficulty of building D&D. Additionally, the K-25 plant processed reactor returns that contained trace amounts of transuranic isotopes and significant amounts of technetium (Tc)-99. Together, these issues created challenges for D&D activities.

Demolition Process Advances

Demolition of a World War II facility that has lacked maintenance and upkeep for the last 20-plus years presented a unique challenge. Removal of the complex process gas equipment (PGE) that was part of the gaseous diffusion process involved significant safety concerns, since the facility itself was unstable. A go/no-go method, using a combination of hand-held NDA instruments and intrusive sampling, was developed to identify different waste streams that required different packaging and disposition paths so the facility could be demolished and these different waste streams segregated after demolition. Waste streams requiring segregation were painted with high-visibility paint and marked with bright colored ribbons. Demolition operators purposely removed some of the larger pieces of equipment by reaching into the building structure and picking the equipment out. Smaller painted items, such as process pipe, were segregated from other demolition debris prior to size reduction. Waste Packaging Specialists are stationed around the demolition face to assist in waste segregation. Assembly line processing stations were established to process each waste stream, ensuring a constant flow of waste to the transportation group. Compressor volutes are loaded into super sacks in the demo field, which allows for higher contamination levels on the exterior of the volute. This small change in the demolition process has resulted in significant efficiencies, since the volutes no longer require extensive decontamination and multiple applications of fixative to exit the contamination area. A large soft-sided structure was erected to store packaged waste items prior to shipment. This structure is essential for items in super sacks to prevent precipitation from inadvertently infiltrating the package. This structure also enables loading of conveyances in inclement weather.

Innovative Approaches

Because of the various challenges in performing the building D&D, the project conducted evaluations that resulted in improvements to the process. One example of an evaluation and improvement is the Non-Destructive Assay (NDA) Program. This was one of the main bottlenecks for the project, since almost all of the waste must flow through this program to determine radiological inventory prior to disposal. The project utilized basically one system—the Uranium Neutron Counting System (UNCS)—to perform this duty. Although efficient and reliable, the system had no backup in the event of failure or calibration issues. Subsequently, additional systems have been brought on line to compliment the UNCS, such as an *In Situ* Object Counting System (ISOCS) and a Neutron Slab Counter (NSC). These various systems are needed to support the timely disposition of the large volumes of packaged waste, which will be generated in the demolition field. Project Management determined the UNCS would need to be operating 24/7 to process these waste volumes and any downtime would impact project completion. The NCS is basically an UNCS hybrid, but required certification and commissioning to meet DOT requirements and the NNSS WAC. This was accomplished by working closely with DOE Oak Ridge Office Waste Management, Nuclear Criticality Safety, and NDA subject matter experts. One key element of the certification process was the manufacture of a mock compressor volute with cavities where a radioactive source could be placed to replicate the waste (volute) and allow known areas of contamination to be measured in a controlled environment. Additionally, a compressor volute was measured at UNCS and at the NSC to further prove the reliability of the NCS to measure contamination levels. All of these systems have their advantages and draw backs. Having multiple NDA capabilities allow the project to select the system that best fits the waste needing assayed and the information output needed. Additionally, if one system goes down, the project still maintains NDA capability.

Another example of an evaluation and improvement is in the way waste is packaged for disposal. Historically, waste is put into a one-time-use packaging, which is disposed of with the waste. When dealing with fissile material, packaging can get quite expensive for just a one-time use. Reusable packaging has been the norm for Type B and certificate of compliance Type A packaging, but was a rarity for DOT 7A Type A Fissile Tested packaging. When a 4- by 4- by 6-ft fissile tested metal box can cost in excess of $2000, an opportunity presented itself to rethink this packaging. Additionally, compressor volutes would not fit in one of these standard-size boxes without size reduction. UCOR challenged their packaging manufacturers to design, test, and certify a reusable DOT 7A Type A Fissile Tested metal box that would accommodate these irregularly shaped items. By packaging a specific waste stream on a wooden pallet in an inexpensive super sack, the waste is transported for disposal within the reusable metal box, but only the pallet/super sack combination is disposed. A box roughly twice the price of a one-time-use box is able to be used more than 50 times. Quick opening and closing latches, permanent mounting to conveyance, and side access allows for a quick turnaround. These design features enable the loading and unloading to be much quicker than with conventional boxes (see Figures 1 and 2). Inflatable paper dunnage bags, used extensively in the railroad industry, are inflated above the super sack pallet combination to stabilize it during transport within the reusable container. Even the dunnage bags get multiple reuses. DOT marking and labeling are put on rigid white plastic sheets that slide into holders mounted on the reusable box. The disposal facility flips the plastic sheets to display the return DOT marking and labeling. Return shipping papers are provided to the driver to relieve the disposal facility of any extra burdens. These reusable containers will be used to transport compressor volutes during the D&D of K-27 and could be made available to other users in the complex to transport similar, or possibly other, wastes required to be packaged in a Fissile Tested package.

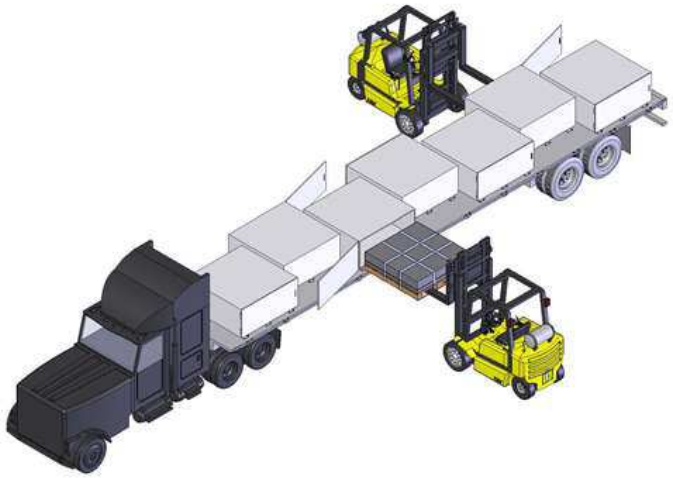

Figure 1. Illustration of a reusable DOT 7A Type A Fissile Tested metal box.

Figure 2. Reusable DOT 7A Type A Fissile Tested metal box.

Some waste presented unique packaging issues. An integral part of the gaseous diffusion process is the converter. Several thousand converters are needed for the gaseous diffusion process. These are large tank-like items for which packaging is limited. Through an intense inspection process and an evaluation of the internal workings of these components, along with input from personnel that operated these converters, a position paper was developed that showed that the converters met low specific activity (LSA)- and surface-contaminated object (SCO)-type material, and could be shown to be DOT fissile excepted. This designation allowed for an IP-1 super sack-type packaging, which is strapped to a robust pallet and placed on flatbeds inside a soft-sided weather-resistant cover. This packaging configuration allows for easy loading at K-25 and unloading by NNSS. This evaluation and technical basis document allowed for uncontested approval by the DOE subject matter experts, resulting in one of the biggest and complex waste items being disposed in fairly inexpensive packaging, saving the project a significant amount of money.

The massive volume of waste destined for on-site disposal required rethinking the logistics for transporting these wastes. A dedicated seven-mile Haul Road was constructed from the demolition field to the on-site disposal cell to take the vast majority of the waste out of commerce. Two major secondary highways needed to be crossed. Temporary two-lane steel bridges were constructed to bridge these highways. The K-25 D&D Project has reaped huge benefits from being able to ship PGE under controls and limits stipulated by a Transportation Documented Safety Analysis (TDSA), rather than under DOT limits. Without the Haul Road, dump trucks of PGE would have been limited to 15 grams of U-235, rather than the 350 grams currently allowed by the TDSA and the on-site cell WAC. This likely would have forced the project to size-reduce, box, and ship much of this material to NNSS.

UCOR and its subcontractors recently celebrated reaching a notable milestone of making 20,000 round-trip dump truck shipments with zero safety incidents. Additionally, a paperless radio frequency identification transport system was implemented to track and log these waste shipments. Electronic interrogators were stationed at various points to let the project know the specific location of conveyance. This initiative and technology was developed in conjunction with Department of Energy's Packaging and Transportation Group specifically for transporting waste onsite at the Oak Ridge Reservation. The smooth flow of hundreds of over-the-road long hauls was accomplished by having the transportation vendor certify multiple trucking companies

with the proper security credentials. By “sharing the wealth,” shipments were not delayed due to waiting for the availability of drivers or equipment.

Demolishing a one-of-a-kind facility that processed enriched uranium meant there was some waste that exceeded the fissile material limits that are allowed to be shipped in commerce. The DOT fissile material limits are quite sufficient for the majority of generators. However, when transporting the large, bulky items with enriched uranium, the fissile limits are constraining. DOT has a process for which relief from the regulations is possible if an equivalent safety justification can be met. DOT may issue a “special permit” to allow exceeding the limits specified in the regulations. Several years ago, the Oak Ridge DOE applied for and was granted a DOT special permit to exceed the fissile limits for equipment in order to transport some large fissile-contaminated equipment at the Y-12 National Security Complex (Y-12). The K-25 D&D Project has utilized this special permit to disposition a significant amount of fissile-contaminated equipment that would not normally be able to transport in commerce. Waste package size and number of packages per conveyance restrictions were imposed as part of the special permit. Even with these restrictions, this special permit has been an extremely valuable tool. The special permit dictates that no more than two packages can be placed on a conveyance. Because the definition of a conveyance means each trailer, tandem “pup” flatbed trailers were procured to allow for one tractor to pull two trailers, doubling the number of packages shipped each time under the special permit (see Figure 3).

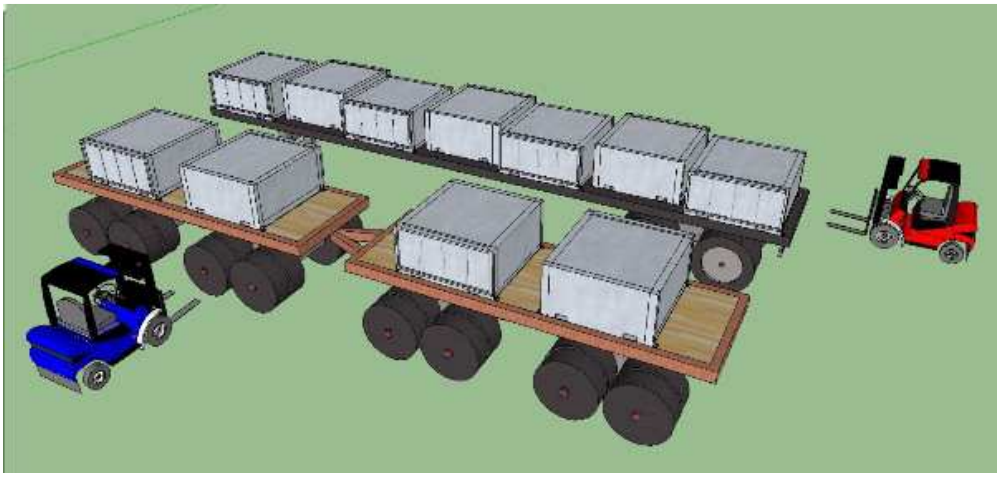

Figure 3. Pup flatbed trailers.

CONCLUSIONS

Because of project evaluations that led to innovative changes in the process of performing D&D activities at the K-25 plant, there have been notable benefits. Waste management evaluated all aspects of the D&D program and identified methods that included changes to the radiological inventory system, the development of reusable packaging, unique packaging configurations, the construction of a haul road, the implementation of a paperless tracking/logging transport system, and the utilization of DOT special permits. These inventive approaches led to the completion of 20,000 round-trip dump truck shipments (with zero safety incidents)—a significant milestone. Together, these improvements to the D&D process have reduced costs, saved time, and increased productiveness. Taking into account the ability to transport and dispose of the large volume of waste generated at ETTP versus having to transport and dispose offsite has resulted in cost savings in the hundreds of millions range.