LOW-LEVEL WASTE DISPOSITION MILESTONE: CLEARING THE PLANT 1 PAD AT THE FERNALD CLOSURE PROJECT

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ABSTRACT

The Fernald Closure Project is a multi-year project in which Duratek is disposing of more than 1,000,000 cubic feet of low-level, radioactive and mixed radioactive waste. The success of the project hinges on maximizing the existing rail infrastructure using the Waste Pits Project, which was already transporting large volumes of bulk waste to Envirocare via an extensive rail system. Duratek was able to transfer containerized wastes on the Plant 1 Pad to the waste pits where they are then added to existing bulk shipments.

The Fernald Closure Project (FCP) was originally referred to as the Feed Materials Production Center and was later changed to the Fernald Environmental Management Project (FEMP). The project area covers 4,249,000 m^2 of the Federal Reservation in Hamilton and Butler Counties in southwestern Ohio. The Reservation is about 20 miles northwest of Cincinnati, between the villages of Ross and Fernald.

The focus of the closure project is a 550,372-m^2 facility in the central part of the Reservation. This facility was a large-scale integrated feed materials production facility that produced uranium metal used in the fabrication of fuel cores and for target fuel elements for DOE defense programs. Operations consisted of foundry and other uranium ore processing facilities that concentrated and recovered recyclable residues as metals and compounds. In addition to the primary uranium products, small amounts of thorium were also produced. At one time the FCP served as a thorium repository for DOE.

In July 1989, production activities were suspended. The formal closure of the production facility became effective June 1991. At that time, FCP's primary function officially changed from uranium metal production to environmental restoration and site clean-up. Most of the waste generated at FCP originated from CERCLA remediation activities and from construction, maintenance and miscellaneous activities. The production process used a variety of chemicals that included nitric acid, anhydrous fluoride, magnesium metal, cleaning solvents, coolants, and lubricating oils. As a result of the processing activities, various types of liquid and solid matrix waste were generated. These included spent solvents, oils, sludges, filter cakes, process intermediates, and barium chloride salts.

Closure of FCP involves removal of all containerized waste from the Plant 1 Pad. Successful clean up of Plat 1 Pad was a key milestone for the project and involves the characterization, treatment, packaging/repackaging, off-site transportation, and on-site disposal of the low-level and mixed low-level radioactive wastes. This milestone was significant to FCP because it accelerated the cleanup process and provides confidence that the project will meet its goal of completion in 2006.

BACKGROUND

Located about 20 miles northwest of Cincinnati between the villages of Ross and Fernald, the 1,050-acre Fernald site is situated in Hamilton and Butler Counties in southwestern Ohio. The focus of the current project, the Fernald Closure Project (FCP), is a 550,372-m^2 area in the central part of the site where a large-scale integrated feed materials production facility produced uranium metal used in the fabrication of fuel cores and for target fuel elements for Department of Energy (DOE) defense programs. Operations consisted of foundry and other uranium ore processing facilities that concentrated and recovered recyclable residues as metals and compounds. In addition to the primary uranium products, small amounts of thorium were also produced at the site and at one time the facility served as a thorium repository for DOE.

Various types of liquid and solid waste were generated as the result of the processing activities, including nitric acid, anhydrous fluoride, magnesium metal, cleaning solvents, coolants, and lubricating oils. These materials included spent solvents, oils, sludges, filter cakes, process intermediates, and barium chloride salts.

Production activities were suspended in July 1989 and the official closure of the production facility became effective in June of 1991 when the Fernald site's primary function officially changed from uranium metal production to environmental restoration and site clean up. Most of the waste generated at the Fernald site since 1991 originated from remediation activities and from new and ongoing construction, maintenance, and miscellaneous activities.

The hub of waste management activities was the Plant 1 Pad until June 30, 2003, when the entire area was cleared of wastes. During environmental remediation this area served as the primary storage and staging area for site wastes. During production the area had served as the staging area for receiving and storing materials for processing. When materials production ended, the Plant 1 Pad became the primary storage and staging area for wastes. Figure 1 shows how the Plant 1 Pad area looked soon after the production activities ended.

Fig. 1 Plant Pad 1. (Courtesy of Fernald Photography)

SITE CLOSURE

The FCP was originally referred to as the Feed Materials Production Center, which was later changed to the Fernald Environmental Management Project (FEMP). The project received its current name in early 2003.

In November 2000, Duratek, Inc. teamed with Fluor Fernald in signing a multi-year contract to manage the Fernald Closure Project as part of the Fluor Fernald Leadership Team. This contract involves the demolition of all production facilities, and the removal and disposition of radiologically contaminated soil. In addition the contract includes disposal of all the legacy waste that was in storage at the site, primarily on the Plant 1 Pad when production activities were terminated.

In March 2003, the Fluor/Duratek team signed a revised contract with DOE Fernald to accelerate site closure. In addition to accelerating site closure from 2010 to 2006, DOE added work scope to the original contract that included the D&D of the Advanced Wastewater Treatment facility (AWWT) and Silos facilities, as well as other site infrastructure that was previously outside the scope. To support the full scope of the project, DOE

increased the funding from $290M to $324M a year. Based on changes to the original contract, the project plan was significantly modified, including scheduling and sequencing of work.

WASTE MANAGEMENT

Duratek's primary responsibility was the Waste Management Project (WMP), which included the repackaging and disposition of more than 30,000 containers of low-level radioactive waste and mixed waste as of December 2000. Most of these containers were stored on the Plant 1 Pad (Fig. 2) and included containers ranging from 5-gallon drums to 28-m^3 wooden boxes.

Fig. 2 (Courtesy of Fernald Photography)

Initially, the primary waste disposition site was the Nevada Test Site requiring that all waste be repackaged to meet the Nevada Test Site (NTS) Waste Acceptance Criteria as well as Department of Transportation (DOT) regulations. Waste profiles also had to be developed and approved for each waste stream. In December 2000, the process for getting a profile approved took as long as six months. The WMP team worked to streamline and accelerate the process and ultimately reduced the timeframe down to an average of eight weeks. In addition, the team opened other sites for waste disposition including the On-Site Disposal Facility (OSDF) and the Waste Pits Removal Action Project (WPRAP).

The WMP team innovated the waste management process in several ways, making it more efficient and productive. From early calendar year 2001 through the beginning of calendar year 2003, there were many successes. With the revised contract in March 2003, the project team had to accelerate work scope even more in order to clear the Plant 1 Pad and consolidate activities in the other, significantly smaller areas by June 30, 2003. As of April 1, 2003, there were 9,449 containers (8,484 m^3) remaining in the entire WMP inventory (Table 1). The largest volume of waste was low-level radioactive waste followed by uranium waste stored in almost 4,500 containers.

Table 1. Fernald Closure Project remaining waste inventory.

Sub Project	Number of Containers	Volume (m^3)
Mixed Waste	1,934	893
Uranium Waste	4,488	2244
Low Level Waste	3,022	5227
Other Waste	5	120
Total	9,449	8,484

In order to meet the challenge for an accelerated closure, the WMP team had to become even more aggressive in managing new waste streams by changing the disposition hierarchy and opening up additional sites for disposal of waste. The team revisited the initial waste disposition plan to develop an even more efficient plan. Those efforts resulted in the development of the following waste disposition hierarchy for solid waste materials: (1) OSDF, (2) WPRAP, (3) NTS, and (4) offsite treatment. Dispositioning waste onsite at the OSDF was the best solution followed by dispositioning waste at the WPRAP.

The team also determined that the best dispositioning hierarchy for liquids and sludges was: (1) AWWT, (2) Oak Ridge Incinerator (TSCA), and (3) Envirocare. A path for a small portion of difficult-to-treat waste was also opened to Duratek's Bear Creek facility in Oak Ridge, TN. These wastes did not meet the NTS waste acceptance criteria or could not be treated at the TSCA incinerator in Oak Ridge.

The strategy for completing the work was three-fold. First, waste destined for onsite disposition (OSDF, WPRAP, AWWT) was to be complete by June 30, 2003. Second, waste destined for offsite disposition was to be packaged, with the vast majority to be shipped by June 30, 2003. Third, the remaining waste was to be packaged for shipment and relocated to other facilities at the FCP. This strategy would then allow for the clearing of the Plant 1 Pad by June 30, 2003 and thus would get the Waste Management Project off the critical path for the completion of the FCP.

To accomplish these goals, the WMP continued and/or implemented the following:

- Waste was packaged "At-Risk". Packaging "At-Risk" meant making every effort to package a waste to meet both the DOT and NTS prior to completing the waste characterization process and submitting a completed waste profile to NTS. Prior to this approach being used, wastes were not packaged until waste profiles were submitted to the NTS for approval and all NTS and DOT requirements were completely understood. Packaging "At-Risk" allowed fieldwork to proceed on wastes while the characterization and profile development processes continued. In most case, the waste did not need to be repackaged once the characterization was complete and the profiles were submitted to NTS for approval. Rework was only needed for about 5-10% of the containers.

- NTS profile development was accelerated. This resulted in a reduction in the overall schedule for securing a profile with NTS by 3-4 months.

- The amount and types of waste that were treated and disposed of at offsite treatment facilities was greatly expanded.

- Waste management activities and storage facilities were relocated to a pair of warehouse facilities on the east end of the site and into twelve HAZSTOR™ Units.

- RTR Requirements were revisited. For several years, as part of the FCP's NTS waste certification process; RTR was required on all drums and metal boxes of waste being shipped to the NTS. This occurred after NTS certification officials oversaw the waste packaging activities. Typically, RTR identified few containers with issues that needed rework. WMP personnel decided that a significant rollback of the RTR requirement could be accomplished without any reduction in overall quality. Instead of a 100% requirement, only 10% of the containers were randomly selected to undergo RTR. This process improvement reduced costs and saved time.

Once the Plant 1 Pad was cleared, the next milestone for the WMP team was to put itself out of business. By Fluor leadership direction, the WMP was to be declared complete and subsequently closed on September 30, 2003. To accomplish this, waste management site services activities after September 30, 2003 were transferred to other project areas. These activities include the following:

- Packaging waste at the point of generation. This involved having cognizant personnel evaluate all the potential waste streams and determine the proper packaging and disposition pathway.

- Transporting the waste to onsite disposal (e.g., OSDF, WPRAP, AWWT), directly offsite, or to a central facility to be staged until an economical shipment can be made to the appropriate offsite facility.

- Maintaining contracts with various offsite facilities that have the ability to repackage, process, or otherwise treat the waste in order to meet the final disposal site waste acceptance criteria. Those facilities would then transport that waste to the disposal site.

- Size reduction and disposition of rolling stock. Rolling stock included the used vehicles, forklifts and other portable equipment. This equipment had become contaminated while in service at various sites at Fernald. Size reduction and disposal of this material at the OSDF was determined to be far more cost effective than decontamination for reuse by the public. The rolling stock had a volume in excess of 8495 m^3.

PROCESS INNOVATION

When Duratek teamed with Fluor Fernald in November 2000, the entire work control process was undergoing a major revision. A small task team was formed to revise the system. During this process it was determined that the existing procedures were the root cause of many of the known problems. The significant issues were as follows:

- Lack of accountability – No one was responsible for establishing the operation requirements, nor accountable for ensuring that wastes were properly packaged and managed.

- The end users were not adequately involved in the development of the work packages.

- The work packages that were used to instruct field personnel on proper packaging and managing of waste contained an extremely cumbersome level of detail.

- Work permits were issued annually regardless of whether a change in the process had occurred. This had the net effect of all work coming to a halt for the first few weeks every January.

- Waste material and containers were poorly organized on the Plant 1 Pad.

To streamline the process, the entire system was challenged at every level. The significant changes that were made included the following:

- End users were involved in the development of the work packages, which capitalized on the expertise of the workforce (also known as "skill of the craft").

- The work package development and approval process was streamlined. Expedited work packages can now be written and approved in one day (routinely 3-4 days) as opposed to five days before if expedited (routinely 3-4 weeks). Furthermore, the number of reviewers was reduced so that a maximum of five signatures is required now versus a dozen or more previously.

- Radiological and Industrial Hygiene professionals performed an enhanced review of the inventory as part of the work package approval. Work permits are reissued only if a change in the process has occurred.

- Work packages are now routine versus single use.

- The focus of the work package is on those activities and steps necessary to properly package wastes versus the reiteration of paperwork requirements that had existed previously.

- Procedures and work packages for the WMP are now managed by a total of two to three people as opposed to 10 to 12 people previously.

- The way wastes were stored on the Plant 1 Pad was optimized to co-locate wastes that were scheduled to be either shipped or processed in the near future. This helped to significantly reduce container movements, provide project personnel with a visual understanding of the quantity of each waste stream, and allow for additional focus on waste streams that were not easily placed into one of the established waste streams.

DIRECT HAUL PROJECT

The WPRAP is a major subproject within the FCP. The waste pits were used until the mid-1980's to dispose of most of the "off specification" and waste materials generated at Fernald. In 1999, the WPRAP began excavating and treating the waste in these pits. After treatment, the wastes were loaded on gondola railcars and shipped to Envirocare for disposal. After nearly four years of steady operation, the FCP team has shipped 5,931 railcars containing more than 640,1110 metric tons of waste to Envirocare. Linked together, the railcars would extend 64 miles.

The WMP began transferring waste to the WPRAP by way of Soil Pile 7 (SP7) in late fiscal year 2000. This process involved emptying the waste out of the containers onto the pile, followed by loading the waste into dump trucks and transporting it to waste pits where it was dumped and blended in a preliminary manner. It was then reloaded into dump trucks and transported to the WPRAP blending facility. These materials initially consisted of waste generated from former on-site and off-site production processes (pre-1990), and more recently from shutdown, construction, laboratory, and decontamination and dismantling activities, as well as waste treatment activities since the late 1980s. From September 2000 thru March 2002, this process was used to transfer approximately 7079 m^3 of soils and soil-like materials with up to 10% uranium.

In April 2002, the WMP team expanded the project to include additional containers that had significantly higher uranium content (up to 80%). Due to the increase in uranium content, several changes in waste processing had to be made. The most significant of these was that waste could no longer be stockpiled at SP7. Therefore, the WMP began using roll-off boxes to collect waste at the end of each day of processing. This allowed for higher uranium content, but ultimately caused a significant reduction in throughput. In addition to the low throughput, the waste management process still involved multiple handling steps that had been used over the course of the previous two years. After several months of using the process, the WMP team approached the Ohio Environmental Protection Agency (OEPA) and the Fluor Leadership Team about designing and implementing a more streamlined "Direct Haul" concept.

In February 2003, a new contract was put in place for the WPRAP whereby containers were loaded onto flatbed trailers and transferred directly to the waste pits. The containers were then cut up in the pits and the material loaded into dump trucks for transfer to the blending facility. This revised process reduced the schedule by approximately (6) months and helped ensure that the WMP would meet the milestone for clearing the Plant 1 Pad before the end of June, 2003.

KEY WASTE STREAMS

The following discussion provides additional detail about several FCP wastes streams. The discussion highlights various process innovations that were implemented during the project.

OSDF Waste Steams

Asbestos and Transite

As with any facility built prior to the 1980's, asbestos containing materials (ACM) were prevalent in buildings and structures at Fernald. Asbestos insulation was used on large runs of piping and around certain pieces of equipment. In addition, Transite panels were used as siding and roofing material on most of Fernald's process buildings.

In most cases, ACM did not directly contact process materials. The materials were either uncontaminated or minimally contaminated with radiological substances. As such, ACM could be disposed of in the OSDF.

By 2001, most newly removed ACM were transferred directly to the OSDF for disposal. However, there was also an inventory of previously packaged ACM that the WMP team was responsible for properly disposed of. These materials were packaged in drums, metal boxes and sealand containers. A large quantity of Transite was also in storage, but was not packaged.

Initially, the WMP team tried to perform a thorough review of all the documentation associated with the containerized portion of the ACM inventory. The primary purpose of which was to identify containers that met the acceptance criteria of the OSDF without additional handling and/or packaging.

The original inventory consisted of approximately 800 containers. After reviewing the documentation, 50-75 sealands were determined to meet the OSDF acceptance criteria and were subsequently relocated to the OSDF staging area at the end FY 2001. The team determined that the remaining 750 containers (approximately 50 sealands and 700 drums and boxes) required repackaging prior to disposal. This involved opening each container, segregating the wastes according to the OSDF and NTS waste acceptance criteria, and repacking the material in appropriate containers. This process resulted in nearly 30 percent of the waste volume being disposed of at the OSDF and the remainder being sent to the NTS.

Copper
Approximately 170 containers (mostly drums and metal boxes, and several topload sealands) of copper (pipe and wire) were removed from various process buildings and equipment. The copper was initially packaged for sale to a metal recycler but when the DOE placed a scrap metal recycling moratorium into effect the WMP team considered dispositioning at the NTS. But during reevaluation of all FCP waste streams as part of the accelerated rebaseline process, the team determined that copper waste could be disposed of at the OSDF because of the low levels of contamination and because no other issues caused the copper to exceed any of the OSDF waste acceptance criteria. In order to be received by the OSDF, copper had to be removed from the containers and placed in bulk in roll-off containers.

Trash and Debris
As with asbestos-containing waste, most of the trash (dry active waste [DAW]) and construction debris generated after 2001 was being disposed of at the OSDF while an existing inventory (mostly containerized) of this waste was managed as part of the Waste Management Project. Most of the containerized DAW and debris had traditionally been disposed of at the NTS. This effort was labor intensive and required a great deal of oversight to ensure that the NTS waste acceptance criteria, as implemented according to the approved waste profile, were met. The WMP team determined that this waste stream had a significant potential for diversion to the OSDF. The team therefore implemented several procedural changes wherein a significant portion of DAW and debris was unpackaged, placed in bulk containers, and disposed of at the OSDF.

WPRAP Waste Streams

Scabbled Concrete
tream included 753 drums of fine-grained and blocky concrete that had been previously scabbled from the surface of a portion of the former Plant 9 process building. Scabbling the surface of the concrete was not a common practice as part of Fernald D&D, but was determined to be appropriate in this case because of the presence of elevated ^{99}Tc contamination, which prohibited the concrete from being disposed of at the OSDF for fear of ^{99}Tc migration into the environment.

In 2001, the WMP team decided to dispose of ^{99}Tc contaminated concrete at NTS. The FCP's NTS certified program required at least a portion of the 753 drums to be visually inspected. The visual inspection process involved removing concrete from their original drums and repackaging the material in new containers. Real Time Radiography (RTR), which is commonly used to determine ^{99}Tc contamination, was not feasible because

of the concrete's high density. The visual process was labor intensive and had to be performed indoors, limiting the size of the equipment that could be used during processing of the waste.

An alternative was to transfer the material to an outside bulk waste area, that is SP7. At SP7, the material was mechanically dumped from the drums, and blended with coarse-grained material and admixed with water. The material was then transferred to WPRAP where it was loaded into gondola cars for shipment to Envirocare of Utah. This process had significant advantages because it shortened the work schedule and reduced costs by an estimated $237,000.

Uranium compounds
In 2001, the FCP had approximately 1900 containers, primarily drums that were filled with various uranium compounds. These wastes included low-grade residues and related wastes (sump cakes, dust collector bags, soil) and high-grade residues that were "off specification" materials derived directly from the different processing facilities at Fernald. The uranium compounds included U_3O_8 (black oxide), UF_4 (green salt), and UO_3 (orange oxide). The amount of uranium ranged from less than 10 percent to approximately 80 percent. The material included depleted, normal, and slightly enriched (up to 1.25 percent) uranium.

As with many radioactive waste streams at Fernald, the NTS was considered the appropriate disposal site for these wastes. By 2001, some of the low-grade residues (less than 10% uranium) were bulk processed at SP7 and then disposed of by the WPRAP. As the closure schedule was shortened, the WMP team coordinated its uranium waste dispositioning activities more directly with the WPRAP team. This allowed significantly higher concentrations of uranium to be dispositioned at Envirocare of Utah. Approximately 800 containers of uranium-containing waste were transferred to WPRAP and then disposed of at Envirocare with an estimated cost savings of nearly $200,000.

Re-characterized RCRA compounds
This waste stream at Fernald was relatively small (about 400 containers), but an innovative dispositioning process resulted in nearly $500,000 of cost savings to the DOE. Instead of accepting previous waste determinations that considered these waste as RCRA (Resource Conservation and Recovery Act) regulated, the WMP team reevaluated the original documentation and determined that the original waste characterization was overly conservatively. Instead of treating these wastes at off-site commercial facilities, they were transferred to the WPRAP with limited field characterization, which confirmed that they conformed to previous analytical results.

NTS Waste Streams

Co-Packaged Uranium
In addition to the uranium-containing wastes described above, different materials containing uranium compounds were packaged together in the same outer package. In most cases, high-grade residues inside small inner containers (19-, 38-, 113- and 208-liter drums) were placed in metal boxes and the void space was filled with low-grade residues. These co-packaged uranium waste streams presented a special problem at Fernald because of the variety of waste that could be packaged in a single container. When the containers were packaged originally (1996-1997), this practice was considered an efficient method for volume reduction and because the wastes were intended for disposal at NTS the method offered certain advantages over others. Approximately 140 metal boxes of co-packaged uranium wastes were in storage in 2001.

The co-packaged uranium waste stream consisted of many containers with sump cakes and high-moisture content wastes. Unfortunately these containers also contained high-grade residues with uranium contents up to 100 percent, which were unacceptable for receipt by the WPRAP and had to be disposed of at the NTS.

In the spring of 1997, a metal box containing drums of fine magnesium and uranium metal fragments were surrounded by sump cake (a high-moisture content waste). Within hours, moisture inside the sump cake, which was in contact with fine metals caused the box to pressurize because of hydrogen gas buildup. As the

pressure increased, the temperature also increased and eventually the hydrogen gas ignited and burst the box. Although an investigation eventually revealed that this event was a unique circumstance, shipments of similar containers to the NTS were temporarily halted.

And late in 1997, while in route to the NTS one of the FCP metal boxes containing sump cake was found leaking in Kingman, Arizona. A separate investigation determined that without proper pretreatment, sump cakes do not meet the NTS waste acceptance criteria because of the high-moisture content. This caused the WMP team to investigate other sites for the disposal of sump cake. The best alternative became Envirocare by way of WPRAP where the material was dewatered in order to address environmental concerns related to transporting and disposing of this waste product.

After a thorough inventory review, co-packaged waste was segregated into several distinct waste streams. A large portion of the inventory (a bout 100 containers) was determined to be acceptable for transfer to the WPRAP without repackaging. However, the remaining 40 containers with high-grade residues (primarily depleted uranium metal) and high-moisture content required dewatering before they could be disposed of by WPRAP personnel. FCP personnel devised an efficient and safe process for separating the WPRAP/Envirocare-bound streams from the NTS-bound streams. Of the total volume of co-packaged FCP waste, 84 percent was sent to WPRAP for disposal onsite while the remaining portion was disposed of at NTS. The estimated cost savings was about $437,000.

NPDS Uranium

The NPDS uranium waste stream included more than 700 containers (drums and metal boxes). This waste was the end product of the Neutralization, Precipitation, Deactivation and Solidification (NPDS) project, which was conducted in 1996 and 1997. The final waste form was a solidified concrete monolith meeting Land Disposal Restriction (LDR) requirements.

NPDS uranium was another waste stream that was affected by the leaking metal box incident in 1997. Before the incident, this waste stream was being actively shipped to NTS for disposal. Afterwards, NPDS shipments to NTS were suspended causing more than 700 containers of the NPDS uranium waste to be stored outdoors on the Plant 1 Pad. Over the course of the next five years the original containers began to deteriorate and to accumulate moisture from condensation and precipitation, posing an environmental hazard at the site and potential extra project costs.

In order to meet current NTS requirements, all of the containers with NPDS uranium were opened and inspected for the presence of free liquids. Void space also had to be reduced in each container's headspace. After inspection, all of the containers were loaded into sealands and shipped to the NTS. Packaging efficiencies helped save $140,000 by reducing the total number of shipments by 14.

SUMMARY

Progress towards closure at the Fernald site has been dramatic over the past 2 to 3 years. Many significant milestones were reached because of the implementation of innovative waste management and dispositioning procedures and processes. The Waste Management Project's primary milestone and the team's most important contribution to the site's closure was clearing the Plant 1 Pad of all wastes and other materials before June 30, 2003. The success of the project is demonstrated by before and after photographs of the Plant 1 Pad (Fig. 3). All of the structures and containers are now gone from the area, along with the pad itself.

Fig. 3 Before and after photographs of Plant Pad 1. Left photograph was taken early June 2003. Right photograph was taken October 2003. Courtesy Fernald Photography.