

**THE APPLICATION OF COMMERCIAL THERMAL DRYING TECHNOLOGY IN  
THE PROCESSING, TRANSPORTATION, AND DISPOSAL  
OF THE WASTE PITS AT FERNALD**

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**ABSTRACT**

The Fernald Closure Project (FCP) is the site of the former Department of Energy (DOE) Feed Material Production Center, which operated from 1952 to 1989 producing high purity uranium metal products. The liquid and solid wastes that were generated by the various chemical and metallurgical processes were disposed in the Waste Pits area of the facility. The 759,440 cubic yards (580,634 m<sup>3</sup>) of material contained within the Waste Pits area was designated for excavation, thermal removal of free water, and transportation to an off-site commercial disposal facility.

This paper will provide an overview, technical description, and current status of progress in the application of a commercially financed, constructed, and managed facility installed at Fernald to process and transport the Waste Pits material. The facility and process was required to meet multiple performance requirements, including applicable DOE orders, standard industrial codes, Department of Transportation (DOT) regulations, and the off-site disposal facility acceptance criteria. The application of two (2) natural gas-fired rotary calciners, supported by a wet-gas cleaning system, water treatment system, and material handling/railcar loadout facility will result (upon completion) in the successful disposition of over 850,000 tons (771,107 metric tons) of material to an off-site commercial disposal facility. The facility has overcome technical challenges in the execution of the process, including high variability in the characteristics of the material, evolution of organics in the processing of the material, and the control of airborne contamination in the handling of the material. Each of these was met through the prudent application of available technology, operational experience, and open partnerships between contractors and agency interests.

Specifically reviewed in this paper is (1) the use of commercial rotary calciner technology in the drying process, (2) the application of wet-scrubbing, electrostatic precipitation, High-Efficiency Particulate (HEPA) filtration, and thermal oxidation in the gas cleaning process, and (3) the management of airborne contamination in the material handling activities.

**INTRODUCTION**

The Waste Pits Remedial Action Project (WPRAP) contract was undertaken as an Alternative Remedial Action Subcontracting Approach (ARASA), which privatized the treatment facility in an attempt to inject commercial practices, innovation, and operating efficiencies. The design of the facility was guided by a technical specification that established the ARARs (applicable, relevant, and appropriate requirements) including specific requirements from the Record of

Decision, site-specific operational rules and procedures, formal steps for documentation of the facility, and a definition of the relationship between the private subcontractor and the site O&M contractor. In general terms, the scope required the removal and disposition of the waste pit contents using an approved sludge drying technology, best available technology (BAT) to handle off-gas and wastewater treatment, and suitable controls to allow safe handling and transport of the wastes to an offsite permitted commercial disposal facility. The resulting facility incorporated varied commercial processing technologies with proven performance to accomplish the objectives in meeting all requirements. The contract was competitively awarded in 1997 by Fluor Fernald, Inc. to Shaw Environmental & Infrastructure, Inc.

## TECHNOLOGY SOLUTIONS

The Environmental Protection Agency (EPA) Record of Decision and the Technical Specification established requirements for the facility, but did not establish any specifications for the selection of the design. As described in Table I, the requirements bounding the facility design were drawn from the Technical Specifications in the Request for Proposal (RFP), the Code of Federal Regulations (CFR), or the Ohio Administrative Code (OAC).

Table I Requirements from the Technical Specifications (RFP)

Requirement	Origin
Drying technology must meet EPA definition of a sludge dryer	40 CFR 26.10
Process Off-gas Air Emissions	OAC 3745-211-02 40CFR Part 61, Subpart H
Meets Best Available Technology (BAT)	40CFR Part 60.670 Subpart 000
Liquid Effluent Discharge criteria	NPDES Ohio Permit No. 1/000004*ED
Sufficient Throughput/Capacity to Meet Schedule	RFP C.3.2.2.1.7
Meets Waste Acceptance Criteria (WAC) for Permitted Offsite Disposal Facility	RFP C.3.2.2.1.7
Classifies as less than Hazardous Category 3, or “Other Industrial Facility”	DOE-EM-STD-5502-94

The challenge in selecting equipment and processes was to meet or exceed the requirements for treatment and compliance while creating a process that could be operated efficiently in order to meet the capacity and schedule objectives. The materials within the pits were non-homogenous, featuring varying densities and moistures. The essential design assumptions for the process from excavation, thermal drying, and railcar loading are presented in Table II.

Table II Design Basis Parameters for Thermal Drying System

Excavation from the Waste Pits	759,440 cyds (580,634 m <sup>3</sup> )
Design Feed Moisture (wet basis)	20-60%
Design Feed Rate	10-30 tons (9.07 – 27.21 metric tons) per hour
Required Moisture Removal Rate	7.65 tons (6.93 metric tons)/hr H <sub>2</sub> O
Burner Fuel	Nat Gas @ 850 scfm (401 L/s) interruptible
Operating Schedule	24hrs/day, 5 days/wk
Required Material for Loading	865 tons (784.7 metric tons)/day; 4,327 tons(3,925.4 metric tons)/wk
Railcars Loading Rate	8 cars/day

### Thermal Drying Technology

The requirement for the thermal drying technology was to meet the definition of sludge dryer as defined in the Federal Register [1]. Specifically, the EPA defined a sludge dryer as a thermal treatment device used to dehydrate sludge having a maximum thermal input of 2,500 Btu/lb (5,811 kJ/kg) of waste treated on an as-fired (wet-weight) basis. The selected technology was an indirect-fired Rotary Calciner (shown in Fig. 1). The system is fully enclosed and sealed, indirectly fired, with induced draft fans to maintain the system under negative pressure. It has separate chambers so that the combustion gases never contact the material being dried. The primary operating function of the dryer is to dehydrate the material, not to chemically change the composition of the material. To meet the capacity and schedule requirements, the facility would feature two (2) rotary dryers.

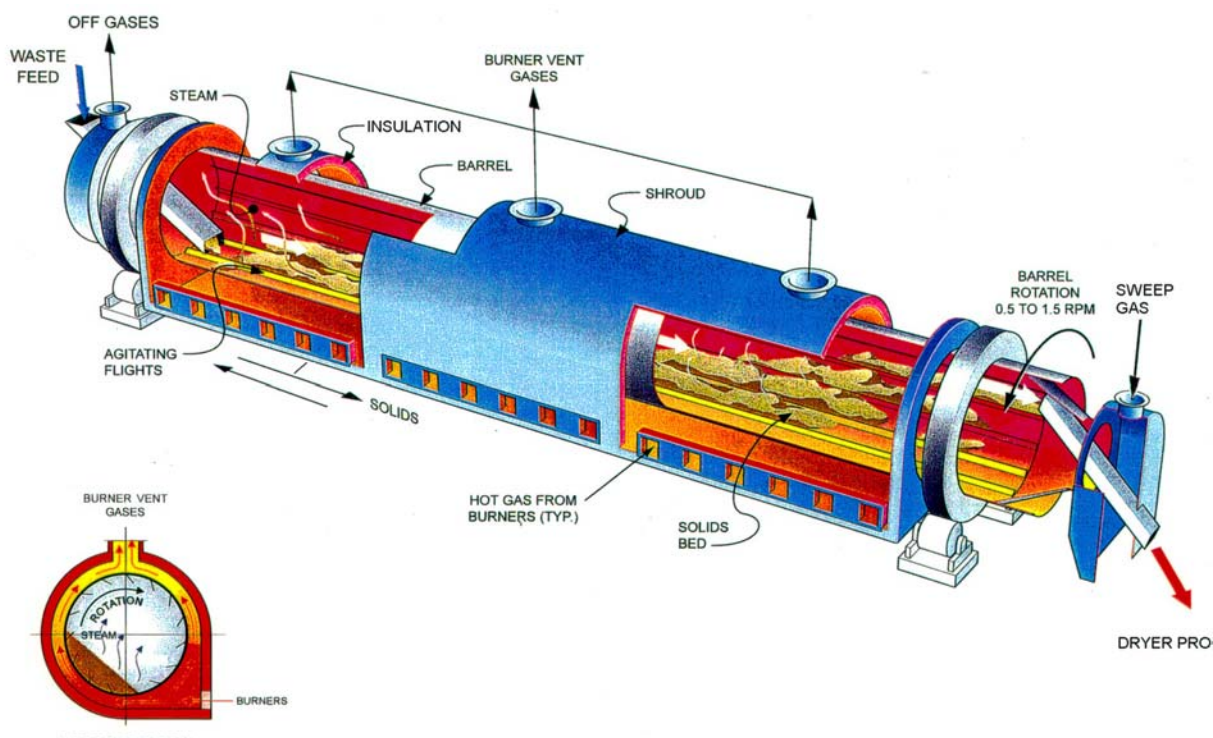


Fig. 1 Diagram of the rotary calciner

Each rotary dryer system consists of a cylindrical shell rotated with a variable speed drive. The rotating shell is heated externally by a zoned-furnace to satisfy heat transfer requirements. Using natural gas as fuel for combustion, heat for the indirect drying is produced in multiple zones by a set of burners in each zone. The burners are operated with adjustable primary air/fuel ratio and secondary air addition to control flame temperature. The burner exhaust gases from each furnace zone are vented directly to atmosphere through multiple vent stacks. Heat energy from each furnace zone is indirectly transferred to the material advancing inside the rotating shell.

The slope and speed of the cylinder's rotation determine the retention time in the rotary dryer. The ability to control this rotation, as well as the control of the zone temperatures, provides the drying system an ability to receive materials of varying characteristics. The drying chamber is sealed and maintained under negative pressure to minimize the release of pollutants. The wet feed material enters the chamber via feed screws, which uses the plug of feed material to serve as the seal at the feed end. The product discharges into a sealed drag-chain conveyor, which delivers the dried material into a pugmill via double tipping valves. The double tipping valves serve to maintain the seal at the discharge-end of the drying process. The pugmill allows the dryer product to be re-moisturized as needed for dust mitigation before discharge.

### **Off-Gas Cleaning Technology**

The dryer process off-gases are drawn through an off-gas cleaning system by the induced draft fan. The off-gas cleaning system (shown in Fig. 2) employs best available technology (BAT) is using wet-scrubbing, electrostatic precipitation, HEPA filtration, and thermal oxidation to meet all requirements for treatment and emissions. The entire gas-cleaning stream is maintained under negative pressure to minimize the release of pollutants to the atmosphere.

The off-gas from each rotary dryer initially passes through high efficiency cyclone separators to remove large, entrained particulate. The recovered solids are transferred to the dryer product conveyors and mixed with the dryer product. The cyclone off-gas is conditioned in the scrubber to cool the off-gas, remove a portion of the entrained particulate, and partially condense water vapor generated by the drying process. The off-gas from the scrubber flows to the subcool quench. Cooling water is recirculated through the subcool to advance cooling of the off-gas and promote full condensation of the water vapor. The subcool off-gas flows into a wet electrostatic precipitator (WESP) for the removal of submicron particulate and water condensate. The off-gas from the wet electrostatic precipitator is re-heated and drawn through HEPA filters. The reheating prevents condensation in the HEPA filters, which are intended to remove any particulate greater than 0.3 microns that may have passed through the WESP. The HEPA filter represents BAT for the radiological concerns in the gas stream. The HEPA filters are followed by the induced draft fans, which exhaust the gas stream through a thermal oxidizer, which provides an effective means for the treatment of remaining volatile organics compounds (VOCs) and carbon monoxide (CO) in the off-gas stream. The off-gas stream is monitored for oxygen, carbon monoxide, and total hydrocarbons at the inlet to the WESP. The stack emissions are continuously monitored for levels of gross gamma/beta particulate and radon gas.

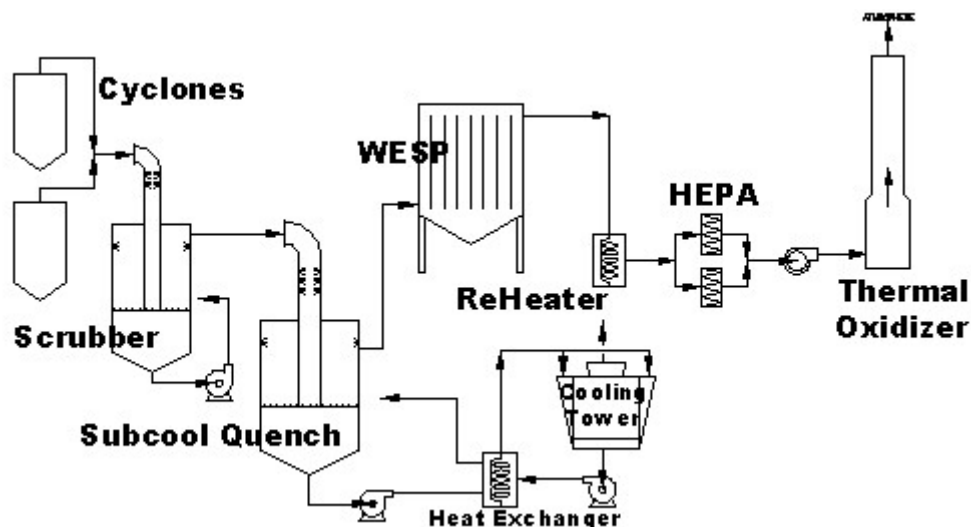


Fig. 2 Off-gas cleaning system diagram

The blowdown water from the scrubber, subcool, and WESP vessels is pumped to the process blowdown pretreatment system, where pH-controlled clarification, sand filtration, and solidification (filter press) promote the removal of solids from the stream. Water recovered is re-used in the scrubbing process or sent to the wastewater treatment system. Collected waters from the excavation, building sumps, and the process blowdown pretreatment system are treated in the water treatment system (WTS). The WTS features an inclined plate clarifier, sand filtration, and ion-exchange filtration units. Polymers and pH control within the WTS allow for the precipitation of metals and solids settling, the ion exchange units allow for the removal of dissolved uranium.

### Management of Airborne Contamination

The project requirements featured restrictions for radiological airborne contamination at the immediate project boundaries. The project used Thorium 230 as the isotope of concern, making airborne mitigation of the uranium and thorium containing waste product an important challenge. The design featured many considerations to contain airborne-generating activities via building configuration or installed dust mitigation equipment. In approaching the design with ALARA (as low as reasonably achievable) for WPRAP, “reasonably” was redefined in terms of worker dose. Although Fernald allowed for worker dose up to 500 mrem/yr, the project elected to pursue 0 mrem/yr. This required the addition of several important features to contain risks associated with airborne generation. The most prominent installation was the Pugmill Ventilation System (shown in Fig. 3), installed in 2001.

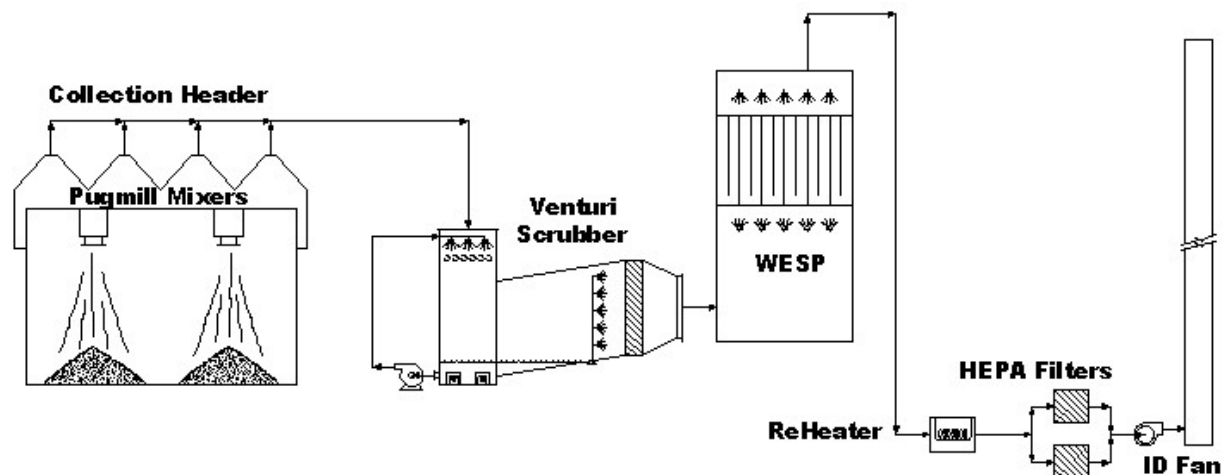


Fig. 3 Diagram of the Pugmill ventilation system

After operating for 12 months, the localized samplers indicated that the pugmill/product discharge bins represented the highest area of airborne contamination generated by the process. Although no project requirements had been compromised, the “zero dose” objective warranted the system be augmented to control the identified source. The pugmill bin was sampled and evaluated to determine the average airborne contents of the product bin.

Table III. Product Bin collected flow to Pugmill Ventilation System

Water Vapor	981 lb/hr (445 kg/hr)
Air	140,307 lb/hr (63,642 kg/hr)
Entrained Particulate	0.4 lb/hr (0.18 kg/hr)

The collection bin was made airtight, and outfitted with a pant-leg vapor collection header. The product bin steam and airborne dust is captured by the collection header and drawn through a venturi scrubber system, wet electrostatic precipitator (WESP), and HEPA filtration. The flowrate of 30,000 scfm (14,158 L/s) is capable of the full capture of the emissions generated within the pugmill discharge/product bin. The venturi scrubber condenses steam and removes large entrained particulate, the WESP removes submicron particulate, and the HEPA provides BAT for the resulting emissions. The stack emissions are monitored continuously for levels of gross gamma/beta particulate. The pugmill ventilation system was constructed and added to the existing process such that the dryers remained fully operational throughout. Observations and testing performed indicate the pugmill ventilation system has been successful in greatly reducing the airborne contamination levels at the product discharge area.

## CONCLUSION

The application of commercially proven technologies and processes contributed to the unexpected success of the Waste Pits Remedial Action Project at Fernald. The many stakeholders involved in the closure of the Fernald facility, including representatives from the agencies and the public, did not believe the privatization initiative could be successful. Those internal to Fernald doubted the commercial practices could be successfully implemented into the historically rigid site conditions. Instead, through the selection of very straightforward and

adaptive technologies, the process was made simple. The nature of the non-specialized equipment in the process simplified the design, shortened the duration of construction and commissioning, made better use of the existing skills of the captive workforce, and allowed the operation of the facility to be executed safely and efficiently.

The construction of the \$30 million facility was completed in 18 months, completely financed by the subcontractor. The selection of more common industry process equipment packages, assembled together to create the full WPRAP process facility, eliminated the slow learning curve often experience in the installation of a more customized process facility. The requirement placed on the subcontractor to produce a suitable design for the process allowed for certain elements of design-build strategy to be employed, which expedited the design review process and allowed construction to commence as the design was completed. The same facility constructed under the historical contracting arrangements, where DOE would impose high levels of review and oversight, might have cost two to three times as much and required three to five years to complete.

The startup and testing of the facility was also simplified through the implementation of more commercially common practice. The phased design-construct schedule provided for commissioning and testing to overlap the completion of the facility. The operability testing involved the facility workers to incorporate on-the-job-training while adjusting and tuning the operational settings. The expedited pace of construction and commissioning allowed the project to meet all of the early agency milestones for the first loading of material and the startup of full drying operations.

The technology choices employed in the process have produced great efficiency in the ongoing operation and maintenance of the process facility. The standardized nature of the equipment has provided for a commonality in training on similar pieces or processes. Similarly, the standardization of components throughout the process equipment has simplified warehousing and preventative and corrective maintenance. The non-project specific nature of the WPRAP equipment lessens the impact of worker turnover by offering simpler processes and enhances the workers skills by providing exposure to process equipment common to commercial petroleum, chemical, and agricultural processing facilities.

Perhaps the largest advantage of the ARASA approach, which incorporated privatization and commercial practices into WPRAP, was the incentive to make the process as efficient as possible. Only through privatization of the design, construction, ownership, and operation of the process facility could Fernald expect any efficiency. The subcontractor's fixed price contract strongly encouraged the minimization of capital investment, the careful consideration of operational efficiency during design, the accelerated construction schedule, and the strong performance culture necessary to complete the project on schedule. The utilization of standard industrial technologies and proven commercial practices for both construction and operations was paramount to this success.

As of December 31, 2003, the facility had excavated 501,639 cyds (383,530 m<sup>3</sup>) of material from the Waste Pits, processing the material to produce 678,997 tons (615,975.7 metric tons) of material for shipment to the offsite disposal facility. The efficiency of the process facility has

enabled the expansion of the scope, processing additional quantities of materials from other areas at Fernald. The facility will complete operations in November of 2004, a full six (6) months ahead of schedule, having loaded more than 120% of the original contracted quantity.

## **REFERENCES**

- 1 Federal Register, Wednesday, July 19, 1990; Volume 55, No. 138, p29230.