# Legacy Sludge Removal and Treatment From Y-12 Storage Tank -17585

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## ABSTRACT

Atkins Nuclear is a subcontractor to Consolidated Nuclear Security LLC (CNS) to perform Operations and Maintenance Services for the Liquid Waste Management Services (LWMS) subcontract at the Y-12 site located in Oak Ridge, TN. The largest of the LWMS treatment facilities is the West End Treatment Facility (WETF). During the water treatment process sludge is accumulated in storage tanks, before final disposal. Approximately 30,000 gallons of legacy sludge was segregated and staged in one of the large tanks and had the potential to be characterized as a mixed waste.

Atkins was assigned a lump-sum subproject and the responsibility to characterize, remove, treat, transport and dispose of the legacy sludge. A removal and treatment system was designed and installed which successfully treated the sludge to meet Land Disposal restrictions (LDR) for disposal at the Nevada Nuclear Security Site disposal facility. This paper discusses the work planning, system design and procurement, sludge removal and treatment process and final disposal including challenges in completing the subproject.

## INTRODUCTION

The following topics will be covered:

- Project History
- Removal, processing, and packaging option evaluation
- Selected technical approach
- Equipment design, fabrication, and testing
- Equipment and infrastructure assembly
- Sludge removal, processing, and packaging
- Equipment and infrastructure disassembly
- Lessons learned

Below is Figure 1, West End Treatment Facility (WETF) and West Tank Farm (WTF).

Figure 1. West End Treatment Facility (WETF) and West Tank Farm (WTF).

## DESCRIPTION

### Project History

- Work completed by Atkins Nuclear Secured, LLC Liquid Waste Management Services subcontract with Consolidated Nuclear Security LLC
- Legacy sludge from past wastewater treatment operations
- Last transfer into F10 tank was in April 2003
- Approximately 3,000ft$^3$ of sludge in F10 tank
- Sludge concentrated in uranium and heavy metals and designated mixed waste (LLW and RCRA toxicity characteristic)
- F10 Tank has 500,000 gallon capacity, and is approximately 48ft diameter x 40ft height.

Below is Figure 2, inside view of tank prior to removal of sludge.

Figure 2. Inside View of Tank Prior to Removal of Sludge.

## DISCUSSION

### Removal, Processing, and Packaging Option Evaluation

- Both wet and dry methods evaluated
- Wet removal eliminated due to amount of material handling, addition of significant amount of water and generation of excessive volumes of waste
- Estimated that 5 to 10 times the volume of sludge, in water, would have to be added to work sludge into flowable form
- Dry methods evaluated included use of vacuum system and manual shoveling into a conveyor system
- Vacuuming not an option due to sludge physical characteristics (similar to moist, cohesive clay)
- Manual shoveling of sludge into conveyor system using operators inside F10 tank

### Selected Technical Approach

- Manual removal of sludge, with conveyance to packaging area using a 35ft long screw conveyor system with 5hp motor, was selected due to its simplicity and support of the ATLC operators
- Magnesium oxide was added to the sludge inside the tank prior to placement into screw auger to stabilize cadmium and eliminate toxicity characteristic
- A 14,500cfm top horizontal discharge centrifugal fan with 7in static pressure and 30Hp motor used to control airborne contamination

## Equipment Design, Fabrication, and Testing

- Conveyor system minimum feed rate = 100ft$^3$/hour
- Ventilation system minimum air change requirement = 12 air changes/hour in tank and each of the containment structures
- Bidders list included local vendors with extensive material handling and ventilation experience
- Vendor technical representatives provided input for equipment specifications
- Fully assembled conveyor system was successfully pre-tested at fabricator facility before being delivered to project site
- Single ventilation system design with strategically placed air intake structures – Air intake structures included volume control damper, backflow damper, and filter material
- Ventilation system was successfully air flow tested, balanced, and DOP tested after installation

## Plan View of Ventilation System and Containment Structures

Below is Figure 3, a plan view of ventilation system and containment structures.

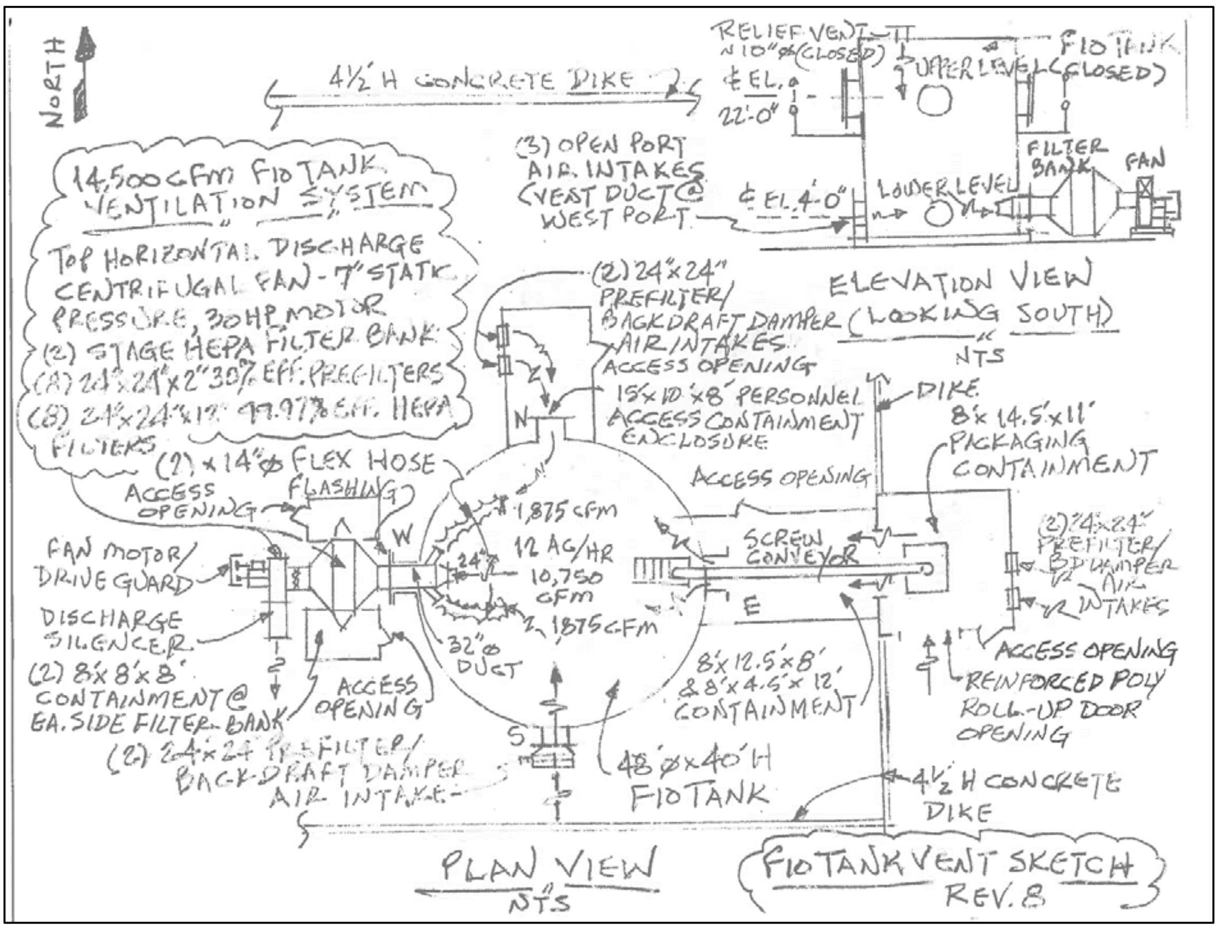


Figure 3. Plan View of Ventilation System and Containment Structures.

**Equipment and Infrastructure Assembly**

- The fully assembled conveyor system was lifted, at its designed incline, under existing process piping and utilities, into a 3ft diameter tank manway
- Power outage required due to close proximity of crane and load to overhead high voltage line
- Major ventilation system components, including the fan and HEPA filter bank structure, were lifted into the tank dike
- Containment structures were built to enclose the packaging area, conveyor system, ingress/egress location, and ventilation system HEPA filter bank
- Containment structures constructed using fire retardant poly sheeting and wood to meet fire protection requirements
- Elevated walkways and platforms were constructed to keep working surfaces above water after major precipitation events

Below is Figure 4, Box containment structure showing auger discharge shoot.

Figure 4. Box Containment Structure Showing Auger Discharge Shoot.

Below is Figure 5, Elevated walkway to boundary control station to allow work when dike contained water.

Figure 5. Elevated Walkway to Boundary Control Station
to Allow Work When Dike Contained Water.

**Auger Conveyor System Construction**

Below is Figure 6, Construction of sludge auger conveyor system.

Figure 6. Construction of Sludge Auger Conveyor System.

## Sludge Removal, Processing, and Packaging

- Conservative production rates were built into the baseline schedule to account for worker safety considerations inside tank such as confined space, heat stress, ergonomics, respirator use, limited lighting, and shorter stay times.
- After implementation of process improvements during 1st 5 boxes, production rate increased from 0.63 boxes per day to 1.4 boxes per day.
- During initial removal activities, the sludge was clogging the screw conveyor near the center hanger bearing, causing the system to be periodically shut down for cleaning.
- Process improvements included further size reduction and stockpiling of sludge inside tank, amending the sludge with polymer, and controlling the rate of feed material into the conveyor system to reduce clogging of the screw conveyor.

Below is Figure 7, Sludge removal inside tank and box filling operations.

Figure 7. Sludge Removal Inside Tank and Box Filling Operations.

### Equipment and Infrastructure Disassembly

- Disassembly took advantage of containment structures and ventilation system to allow majority of items to be size reduced and packaged in the packaging containment structure.
- Major ventilation system components were salvaged for reuse by CNS.
- Conveyor system was size reduced inside tank and containment structures and manually loaded into B25 boxes
- Containment structure walls were double lined with poly sheeting to allow removal of inside layer, decontamination of inside surfaces, and clean demolition of remainder of structures.
- All secondary waste was size reduced and packaged in 11 B25 boxes.

### Lessons Learned

- Positioning of workers in packaging containment structure and tank to minimize breathing zone airborne contamination
- More intensive physical characterization of sludge – More moist, cohesive clay like material than originally estimated.
- Lab testing for stabilization of cadmium – Use of magnesium oxide versus polymer provided significant cost savings to project.
- Evaluation and selection of technical approach, project planning, and execution of work accomplished using input from chemical operators, safety personnel, radiological personnel, technical SMEs, vendor technical representatives, and management
- Early and frequent worker involvement from concept through execution
- Variation in screw conveyor flight spacing to minimize clogging
- Use of metal frame pre-filters

Below is Figure 8, Before and after sludge removal inside tank.

Figure 8. Before and After Sludge Removal Inside Tank.

## CONCLUSION

- Project was completed 2 months ahead of the contract delivery milestone
- Zero safety, security and/or environmental incidents
- All processed waste met NNSS waste acceptance criteria
- All work completed as part of a firm fixed price contract pay item
- Many challenging components to project including hoisting and rigging, confined space, lockout/tagout, respiratory protection, temperature extremes, radiological hazards and controls, and equipment design, fabrication, testing, and installation

Below is Figure 9, Tank inside surface after sludge removal and ready for structural integrity inspection

Figure 9. Tank Inside Surface After Sludge Removal and Ready for Structural Integrity Inspection.

## REFERENCES

None

## ACKNOWLEDGEMENTS

CNS for radcon support, utility outage management and waste certification.