ACCELERATED DESIGN AND FABRICATION OF A MOBILE DRUM VENT SYSTEM FOR TRU RETRIEVAL ACTIVITIES IN HANFORD 200 WEST AREA LOW-LEVEL BURIAL GROUND TRENCHES

T. Wickland, L. Anderson
Nuclear Filter Technology

H. Klebba
KNH Technical Resources

M. Cahill, P. Bedell
Dale Black Fluor Hanford

In 2003, Fluor Hanford (FH) was faced with meeting rigorous retrieval milestones which included removing drums from Hanford 200 Area Low Level Burial Ground (LLBG) Trenches. The retrieval process requires performing inspections, radioactive material assay, and venting in preparation for processing drums containing Transuranic (TRU) waste at the Waste Receiving and Processing Facility (WRAP). Waste is subsequently shipped to the WIPP facility in New Mexico. Nuclear Filter Technology (NucFil) was awarded a competitively bid, firm fixed-priced subcontract by FH (subcontract #18985) to design, fabricate, factory test, qualify and deploy a sophisticated Mobile Drum Vent System (mDVS) that meets the venting requirements of this project. Additional contract requirements included that the system be readily mobile between trenches, low cost, safe to operate, reliable, easy to maintain and decontaminate, and have a minimum throughput of three drums per hour with minimum operator interface.

This paper describes the engineering approach, venting process and hydrogen concentration analysis, equipment modifications made after system delivery, operational performance, and some of the managerial tools used to foster a win-win contracting arrangement.

BACKGROUND

There are approximately 30,000 drums buried in trenches in the 200 West Area. Of the 15,000 that are determined to be TRU, it is predicted that 7,000 of them have vent clips, providing sufficient ventilation for transportation within the 200 West Area and are freely released for processing at WRAP. The remaining 8,000 TRU drums are expected to require venting and will be processed through the Mobile Drum Vent System (mDVS).

Drum ventilation is performed by installation of filters that are compliant with the Trampact for TRUPACT II requirements. The filters are installed in the TRU waste drum lids and vent hydrogen and other flammable gases while retaining radioactive particles. The waste consists primarily of contaminated debris enclosed in 55-gallon drums, each of which has one or more layers of plastic wrapping and/or a plastic liner inside the drums. The drums are contact handled (<100 mr/hr). When a drum is determined through inspection to be corroded, contaminated, bulged, have physical damage, contain liquids, or unknown contents, the drum is over-packed in an 85-gallon drum.

Engineering Approach

The engineering approach to the mDVS is based on NucFil's experience in the design and fabrication of four other drum vent systems which are in use at various DOE facilities. Two of these systems are in use at Savannah River Site – one for WIPP headspace gas characterization of TRU drums and one for ventilation of low activity drums with Pu-238 contaminated waste. One system is at the Nevada Test Site performing ventilation and WIPP headspace gas characterization of TRU drums, and one system is at the INEEL Advanced Mixed Waste Treatment Plant performing ventilation and WIPP headspace characterization of legacy TRU drums. Several major differences arose from the previous four systems, driven by cost and schedule constraints, as well as mission requirements, and new design ideas. An effort was made to simplify the inputs required from a programmable logic control (PLC) and a simpler hydraulic oil over air linear drive system was designed. A second difference was one that emphasized controlling deflagration gases as opposed to isolating deflagration gases in a chamber rated for containing pressure up to 15 PSI. The system also incorporated the capability to vent 30-gallon drums, and 85-gallon drums with restraints without changing software. It also provides a conveyor system to accommodate venting up to six drums without reloading the drums.

Mobile Drum Venting and Hydrogen Gas Sampling Equipment

The mDVS is housed in a custom-built commercial cargo trailer that is separated into two areas: (1) A Test Compartment, in the rear of the trailer, where waste drums are vented and; (2) An Operating Area, toward the front of the trailer, where the Control Station and Analytical Equipment are located and operated. The Test Compartment and Operating Areas are separated by a partition wall equipped with gloveports that isolates the Operator from the Test Compartment. In addition, an Equipment Compartment located at the front of the trailer houses the air compressor and the analytical system and Continuous Air Monitoring (CAM) system vacuum pumps (see Figure 1).

Fig. 1. Mobile Drum Venting System

The Test Compartment, located in the rear of the trailer, is where waste drums are vented. Drums are queued onto an incoming conveyor and taken inside of the trailer where the venting and sampling process occurs. "Cold Drilling" uses software to start and stop the drill motor regularly during the drilling cycle to decrease the heat generated during drilling. The Powerhead performs the "cold drilling" and sampling process in an enclosed Seal Housing, preventing the escape of headspace gas. Testing for an adequate vacuum seal is performed prior to drilling. During the "cold drilling" and sampling process, a NucFil-007 series filter is installed. The specific filter length is chosen to penetrate the drum lid and any liner present in the drum (See Figure 2). The patented drum vent filters provide maximum hydrogen permeability and ensure exclusive headspace gas sampling and analysis from within the liner (a WIPP requirement). For drums without liners, a NucFil-007S is installed. The NucFil-007S is identical to the standard NucFil-007 except it has a shorter drill stem. For 85-gallon overpacked drums, the NucFil-007LS (long stem) is used, which penetrates both drum lids as well as any inner liner.

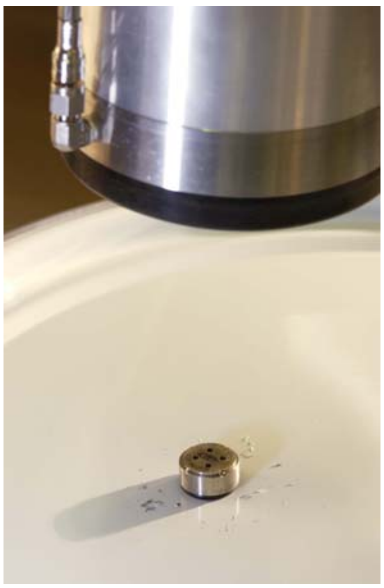

Fig. 2a. Seal Housing and Installed Filter

Fig. 2b. NucFil-007LS, 007, and 007S

The Operating Area consists of the Control Station and Analytical Equipment (See Figure 3). The Control Station includes an Operator Interface Terminal (OIT) and a digital scale display. There is also a Programmable Logic Controller (PLC), used to sequence the drum handling, automatic "cold drilling", and sampling process. The PLC and associated hardware are powered by a dedicated 24 VDC power supply in the main control panel. The device used for analyzing hydrogen concentration in each drum is a Shimadzu GC-14-BPDT Gas Chromatograph.

Fig. 3. Operating Area

After sampling and filter installation, metal filings are vacuumed from around the filter and radiological surveys of the drum, drum lid and filter are performed. Silicone sealant is applied to the filter o-ring and the drum exits the Test Compartment on a second conveyor, completing the drum venting process.

Contracting Approach

A fast-track project has inherent risks and is not the preferred method for these type of procurements. When this is the only option, there are things that can be done to minimize the risk and exposure of both companies. The following is a list of actions taken to minimize risks:

- Make sure that both parties understand the scope and deliverables.
- Enhance regular communication, including site visits and documented telephone conferences.
- Require quick turnaround on decisions/submittals.
- Expect challenges on design/build turnkey projects.
- Consider the experience/expertise of the contractor.
- Perform extensive testing in the shop as well as in the field prior to startup.
- Learn from others (LANL, NFT-SR, INEEL).
- Lock the Safety Basis in as soon as possible. A delay in the mDVS was caused because the Safety Basis had not been finalized prior to the contracting process. (The finalized Safety Basis required a barrier that had not been mandated in the contract, which resulted in having to use a remote unit to vent the drums).
- Instill the attitude of doing work right the first time. Schedule was critical on a project like this. A specific lesson learned involved making certain that design submittals were

accurate and compliant with project requirements to reduce the number of review cycles. Significant time and cost were expended trying to speed through incomplete design submittals.

Hydrogen Concentration Measurement

During the ventilation cycle —after the filter's drill penetrates the drum lid but prior to seating the filter— a sample of gas is withdrawn from the headspace area of the drum. The one-milliliter sample is automatically injected into a gas chromatograph equipped with a thermal conductivity detector, and analyzed for hydrogen concentration. The calibration range is up to 20% hydrogen and the minimum detection limit is 150 parts-per-million. In accordance with the safety basis, drums found to have greater or equal to 15% hydrogen are diffused before further processing. Drums are further diffused to <5% hydrogen to meet a transportation limit.

Equipment Modifications Made After System Delivery

Primary safety functions of the mDVS included minimizing ejection of bulk waste from the drum during venting and protecting the worker from hazards associated with the potential ejection of a drum lid or bottom during venting. The mDVS drum lid restraint system was initially determined to meet the safety functional requirements. After delivery of the system, functional requirements for the mDVS were changed to also require the operator be at least 30 feet from the venting operation or that a safety significant partition wall be provided. A solution was identified by FH engineers that met with all the revised safety requirements. The solution was to have the Operator initiate the drilling sequence from a remote trailer 30 feet away from the mDVS trailer. This was completed prior to startup without becoming the pacing startup item.

Operations and Performance

The mDVS was delivered to the Hanford site in late August 2003, on schedule and only 18 weeks after contract award. In the first twelve months of operation the mDVS has safely vented over 2,200 drums. As of January 24, 2005, Fluor Hanford has removed over 7,600 drums from the burial ground trenches. Contamination events have been limited to a few drum lids found to be slightly contaminated after venting, which were easily decontaminated.

Drum Diffusion

On average, the hydrogen concentration of the 2,200 drums that have been analyzed so far is <2%. The highest hydrogen concentrations have been around 30%, with one drum reaching 51% hydrogen. Other Drum Venting Systems designed and built by NucFil include a routine where an evacuation and nitrogen purge cycle is performed until the concentration of hydrogen gas is below the minimum explosive limit for hydrogen in air. For the mDVS, primarily to simplify the computer interfaces and gas handling manifold, FH opted for a practice of allowing drums to diffuse for a pre-determined period of time given the concentration of hydrogen gas found in the drum at the time of venting. The hydrogen permeability rate of NucFil Filters is well established. Therefore, computations were performed to determine the minimum number of days of staging time which would assure safe drums handling (see Table I below).

Table I. Number of days a 55-gallon drum with a standard type NucFil-007 filter is allowed to diffuse prior to further handling.

Hydrogen concentration at time of venting	Days of diffusion required for safe handling
5% to 10%	6 days
10% to 15%	9
15% to 20%	11
20% to 30%	13
30% to 40%	15
40% to 50%	17
50% to 60%	18

This computation provides a method for estimating the staging times associated with the use of different filter configurations used in venting transuranic waste containers. These staging times also apply to low-level waste drums in situations that require venting. Ten NucFil Filter configurations were analyzed and compared with FH K Basins data and other experience to estimate the staging times associated with each vent filter type after installation. Staging time is defined as the minimum time the drums should be staged after venting to abate the hydrogen concentration in the headspace from an initial quantity to a final hydrogen quantity before moving the drums to another location. Important parameters include the 15 percent Technical Safety Requirement and 5 percent shipping limits (transfer of waste containers with greater than 5 percent H_2 to other facilities is allowed under certain conditions, but the 5 percent limit remains a best management practice).

To provide a conservative estimate, staging times for the different filters with different hydrogen concentrations are rounded to the next larger whole day. In addition, one full day has been added to the estimate to accommodate venting that may have occurred late into the day when multi-shift venting activities have been performed. The following situations are analyzed:

- Single filter in a 55-gallon drum
- Various overpacked drum situations including a triple-contained drum
- Kerr-McGee Corporation drums that contain an inner liner
- FL-10, L-10, or 10L 110-gal drums
- Multiple filters in a drum.

After startup of the retrieval and venting operations, FH initiated a technical exchange whereby one of NucFil's retrieval and drum venting subject matter experts from Savannah River visited the Hanford retrieval operations. The NucFil subject matter expert made recommendations to FH management that, when implemented resulted in reducing the drum vent cycle time by 6 minutes. These recommendations included: 1) Eliminate the Lower Explosive Limit test sequence, as it proved to have no additional value over the GC testing; 2) Move the manifold seal test (proof that the system is leak-tight) from before every drum to once per day, and; 3) Various human factors changes to the operator interface software.

Key Managerial Tools to Foster a Win-Win Program

Overall, the success of the accelerated design and fabrication of the mDVS was based upon creating a win-win situation between FH and NucFil. Throughout the design, test and implementation stage, both companies worked together to meet project objectives. Fluor Hanford's contract management was excellent and is credited as a key factor in keeping the procurement on track. Further, it is recommended that in similar design/build contracts that buyer personnel are on-site at the contractor's location during critical periods such as design reviews, factory acceptance testing, and final engineering document review and acceptance. Regular contractor visits imposed by FH facilitated communication and a mutual understanding of critical attributes. Timely review of contractor submittals is essential for fast-tracked projects. An additional excellent practice employed by FH was to require weekly status meetings via teleconference. These teleconferences were designed to discuss issues as they arose. The weekly teleconferences are credited by both FH and NucFil as facilitating open communications during design, fabrication, and system implementation. Communication channels remain strong and intact today.

Approach to Documentation

The mDVS operating and maintenance manuals were prepared with input from the lead operators who would be responsible for the day-to-day operations of the mDVS. This turned out to be an excellent practice. Prior to and during the Factory Acceptance Test at NucFil's facility in Golden, Colorado, FH had two of the lead operators for the mDVS participate in the preparation of the operation manual, maintenance manual, and even began developing site specific operation procedures. The result of this approach was user friendly and comprehensive documents.

CONCLUSION

The FH LLBG site continues to meet the rigorous challenges of removing, radio assaying, venting, and shipping drums containing suspect TRU waste to WRAP. To date over 7,600 drums have been removed from the LLBG, and of those, over 2,200 drums have been successfully vented. FH and NucFil continue to work together to find ways to enhance the operation, safety, and performance of the mDVS.