OIG-SR-17-01, OIG Special Report Department of Energy's Actions to Address Worker Concerns Regarding Vapor Exposures at the Hanford Tank Farms

November 2016

The Department of Energy Office of Inspector General (OIG) conducted a special review from May through November 2016 that looked at chemical vapor exposure concerns at Hanford's tank farms. The OIG team assessed the status of actions to address the 47 TVAT recommendations, reviewed key policies and procedures, and interviewed 52 tank farm workers.

The OIG review "did not reveal significant issues with regard to the Department's and WRPS' strategy and ongoing actions to address vapor risks." The review team also noted that "Department and WRPS leadership have taken action to improve communication with the workforce on issues pertaining to vapors." There were three recommendations stemming from the OIG review, and WRPS is committed to their implementation. WRPS is:

- Taking steps to strengthen the tracking and closure of vapor issues using the Problem Evaluation Request (PER) system.
- Working to summarize prior and ongoing engineering control evaluation reports and to share these with the workforce and the public.
- Continuing to develop and sustain a strong safety culture by using the Chemical Vapors Solutions Team and other ways for employees to raise safety concerns.

The OIG will continue to monitor the evolving situation pertaining to vapors, actions taken to address vapor risks, and any concerns that are expressed regarding retaliation.

The attachment below summarizes engineering control technologies that have been or are being evaluated for reducing or eliminating tank farm vapors.

Proposals to Address Tank Farm Vapor Hazards

Many technologies have been or are being evaluated for reducing or eliminating tank farm vapors. Studies have examined combinations of adsorbents (e.g., activated carbon), absorption (e.g., water scrubbing), oxidation (e.g., thermal or catalytic), biofiltration, and dilution/dispersion (e.g., increased active ventilation and taller stacks). Proposed technologies are reviewed in RPP-RPT-23101 and SRNL-STI-2016-00484. Testing of some technologies began in the late 1980s and has continued intermittently through today. Efforts range from simple activities such as closing shut-off (isolation) valves in tank risers, to complex multistage treatment of ventilation exhaust. Technologies deployed thus far have had some success, while others were problematic (RPP-22171). WRPS has an ongoing program to evaluate engineering controls that will be integrating results as we get final data from the vapor monitoring and detection system (VMDS) and as the Industrial Hygiene Technical Basis is updated. In addition, WRPS Engineering has provided briefings on engineered controls.

Engineering Controls considered and being implemented:

Upgraded DST Active Ventilation

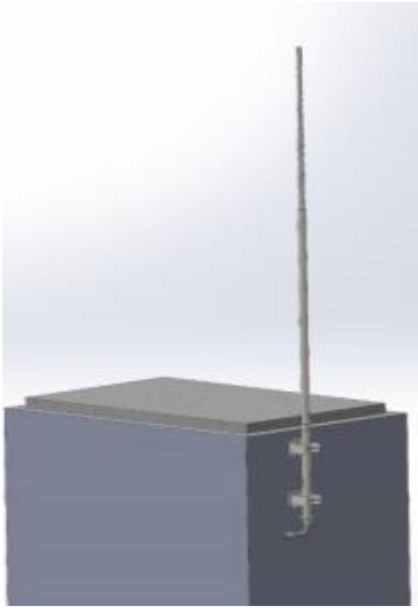
Active ventilation systems in AN Farm (left photo) and AP Farm (right photo) have been upgraded which has increased dilution and dispersion of tank farm vapors. Flow through the stacks was about doubled, and stack height in AP Farm was increased from 13 ft. to 40 ft. Vapor measurements in the stacks show concentrations are about half what they were before the upgrades. Ventilation upgrades are also planned for SY tank farm.

Control of Vapors Grand Challenge Winner

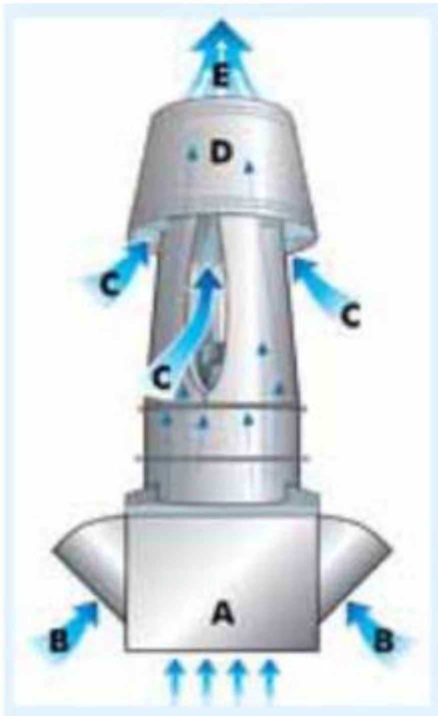
Multiple technologies would be needed to remove the different tank farm gases and vapors and the recent DOE Grand Challenge Winner proposed such a solution. A combination of thermal oxidation (destroys VOCs), adsorption (removes mercury and other chemicals), and catalytic conversion of the combustion products will be used to treat vapors. The proposal is to complete pilot scale testing and to conduct a site trial by late 2017.

Increasing Stack Height

Stack extensions move exhaust discharge farther away from worker breathing zones and enhance vapor dispersion and dilution. The 242-A Evaporator stack is being extended from 65 ft. above ground level (photo below) to 111 ft. above ground level (drawing right) and is scheduled to be completed during April 2017.



Exhaust Booster



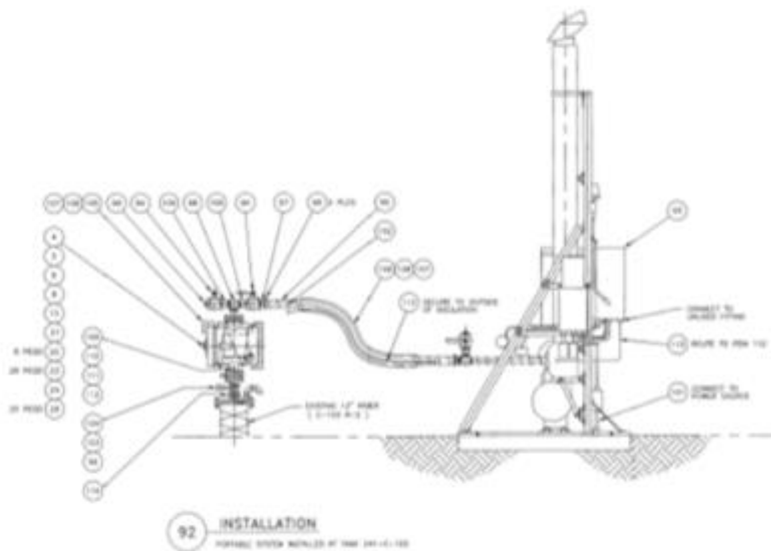
An exhaust booster mixes tank ventilation gases and vapors with outside air. Vapors are immediately diluted and exit the stack at much higher speeds. This sends the exhaust air jet plume up higher. Exhaust boosters are used across many industries and have been shown to be effective, and this technology received the highest ranking in a recent study that evaluated proposed Hanford Tank Farm Vapors abatement technologies (SRNL-STI-2016-00484). Exhaust boosters will be the next technology deployed in tank farms with work beginning in 2017 and field deployment demonstration in 2018.

A. Exhaust enters booster
B. Air is introduced through the wind-band
C. More air is mixed into exhaust plume as it moves through the booster
D. Exhaust air accelerates to higher speeds
E. Exhaust air jet plume travels vertically up to 120 ft. above nozzle

Engineering Controls Considered, implemented, and lessons learned:

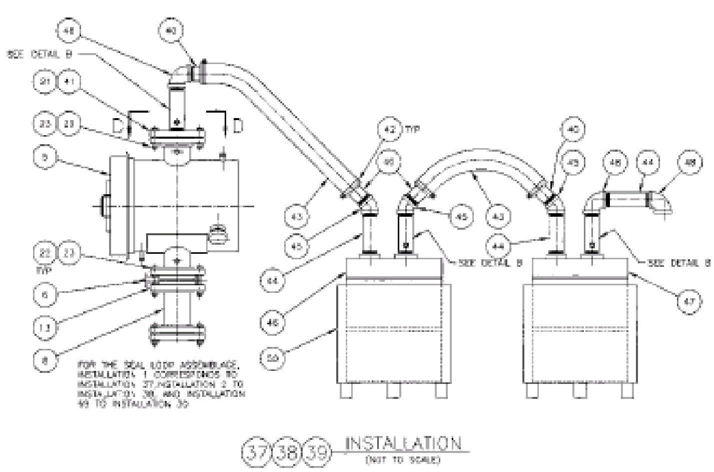
Vapor mixing system

The vapor mixing system (VMS) installed on tank C-103 was an early attempt at diluting tank farm vapors by mixing with outside air. Tank C-103 was a passively ventilated SST before the VMS was installed, and the system was designed pull tank vapors through a 2-inch flexible hose and then mix with 800 cfm of outside air up and out of a stack. The system was installed in 1995, and attempts were made to operate it until it was disconnected in 2000. The primary reason the VMS did not work as intended was because water condensation stopped flow in the 2–inch line from the tank even after heat tracing was added. Lessons learned from VMS operations are documented in RPP-22171.



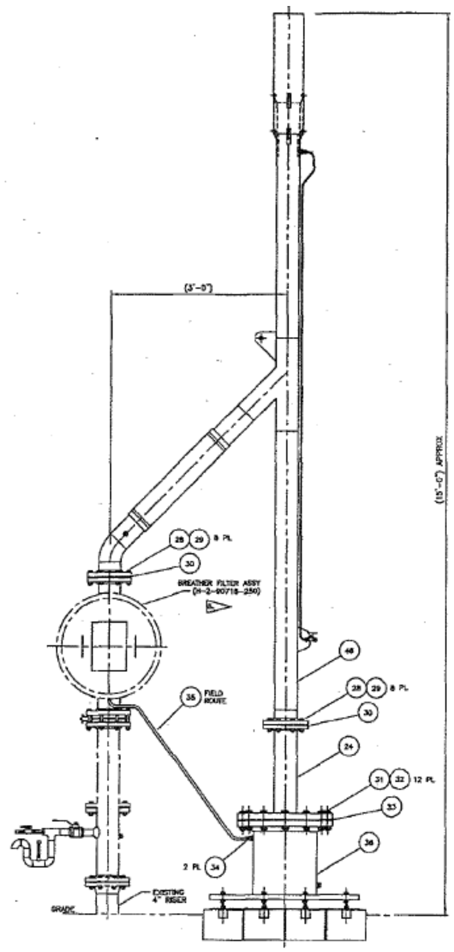
Activated Carbon Filters

Activated carbon filters were connected to SST C-103 in the early 1990s. The system was designed with two stages to remove organics, ammonia, and NO_x (nitrogen oxide). No fans or blowers were added so it relied on passive ventilation. The carbon filters were sized so that they would only need replacing every six months. The system provided no measureable improvement in vapor or odor control because water condensed and flooded the activated carbon filters. Lessons learned from operating the system are documented in RPP-22171.



Raising Breather Filter Height

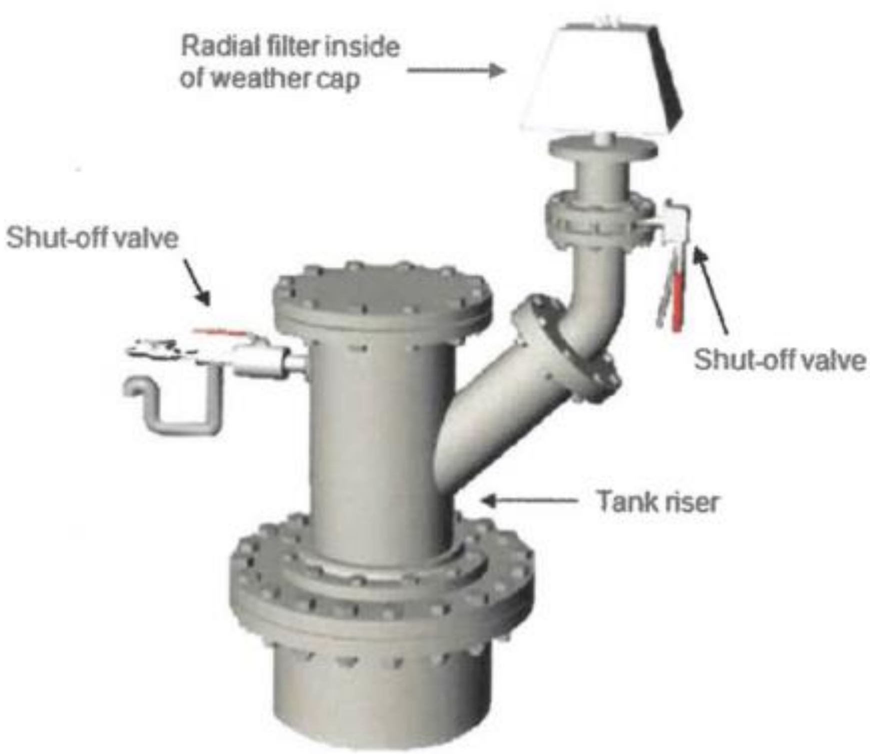
Many of the SST breather filters are 3 to 5 ft. above ground level, which would be near a worker's breathing zone if they were standing next to it. Starting in 2004, breather filter stack extensions were added to some tanks (left photo) to extend the height to about 15 ft. above ground level (right drawing). Although some improvement is gained from elevating breather filters, passive ventilation and vapor dispersion is dependent on weather. The decision has been made to add active ventilation to A Farm and AX Farm, the next SSTs that are planned for retrieval.



Closing Isolation Valves to Reduce Vapors

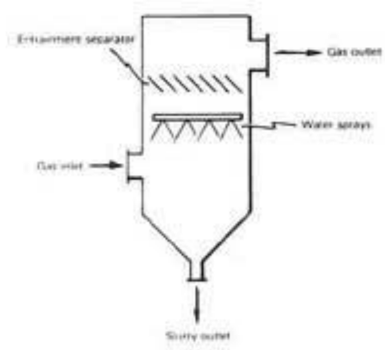
The SSTs are passively ventilated through a riser that has a high efficiency particulate air (HEPA) filter attached and there is a shut-off (isolation) valve before the filter that can be closed during HEPA filter change out. Closing breather filter valves in BY Farm in an attempt to reduce tank vapor emissions had unintended consequences that resulted in an increase in reported odors. In the evening of November 10, 2003 all but one of the BY Farm breather filter isolation valves were shut to see if that would reduce vapor releases. On November 13, 2003 an operator taking morning rounds in BY Farm experienced a strong ammonia odor in an area not usually associated with vapors.

The reason this did not work is because there are many risers and pipes that extend into the tank headspaces and it is not possible to seal the tanks airtight by closing the breather filter isolation valves. Air pressure within the tank headspaces is constantly equalizing with outside air pressure. When breather filter isolation valves are open, most flow goes through this route. However, when the valves were closed, flow was forced through small pinhole gaps. Vapor emissions from known locations (breather filters) were swapped with releases from many unfiltered small openings that were up to 100 feet away from the tank headspace. More incidents occurred because vapors were being released from locations not normally associated with vapors. A lessons learned from this experience was published in IB-04-13.



Wet Scrubbing

Wet scrubbing of tank farm gases and vapors has been evaluated. This technology works by transferring soluble gases and vapors from the exhaust to a liquid. This could be effective for removing ammonia and soluble organics, but would need to be combined with more technologies to remove other potentially harmful vapors. Wet scrubbing also produces a secondary liquid waste stream that would need disposal. An evaluation of wet scrubbing is documented in SRNL-STI-2016-00484.



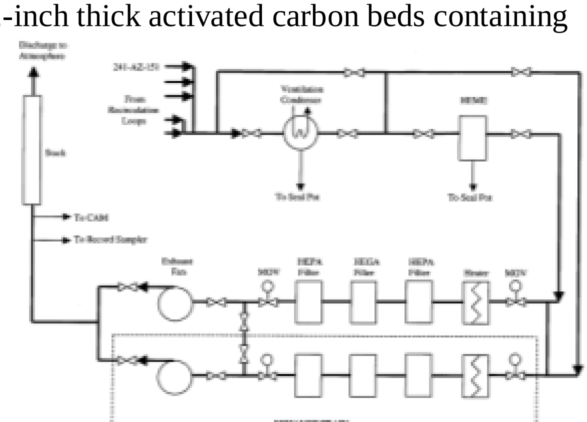
Wet Scrubber

Thermal Oxidation

Organic compounds in tank farm vapors can be destroyed through combustion (thermal oxidation). A fuel gas would be added to tank farm exhaust and the mixture heated to a temperature ranging from 640 to 2,700 °F. Thermal oxidizers are widely used and the technology is mature. Combustion can create other harmful gases including NO_x, acids, dioxin, and furans, so an additional technology would needed to treat these potential combustion products. An evaluation of thermal oxidation is documented in SRNL-STI-2016-00484.

High Efficiency Gas Adsorption (HEGA)

A high efficiency gas adsorption (HEGA) system was installed in the 702-AZ ventilation system in the late 1990s. This ventilation system handles the exhaust from four Hanford Site DSTs, AY-101, AY-102, AZ-101, and AZ-102. The HEGA modules have 2-inch thick activated carbon beds containing about 86 pound of activated carbon. The 702-AZ HEGA system had only limited success and regularly failed its performance testing. An evaluation of 702-AZ HEGA system is documented in RPP-22171.



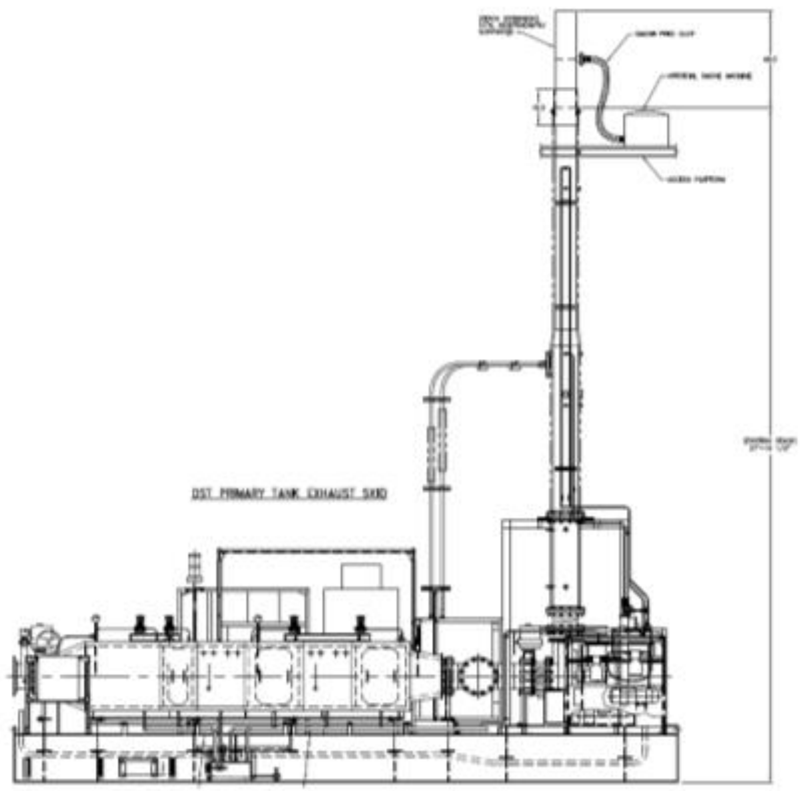
Engineering Controls considered but not implemented:

Solar Powered Ventilator

Solar powered ventilators like the one pictured here have been considered as additions to the passively ventilated SSTs. The ventilators would introduce about 25 cfm of air flow through the tanks which would help dilute headspace vapors.

Addition of Artificial Smoke to Exhaust

Vapors and gases from Hanford tanks are not visible and the addition of a non-toxic artificial smoke to the exhaust is being considered. If exhaust was visible, workers could see where the vapors were and then could move to avoid the plume.

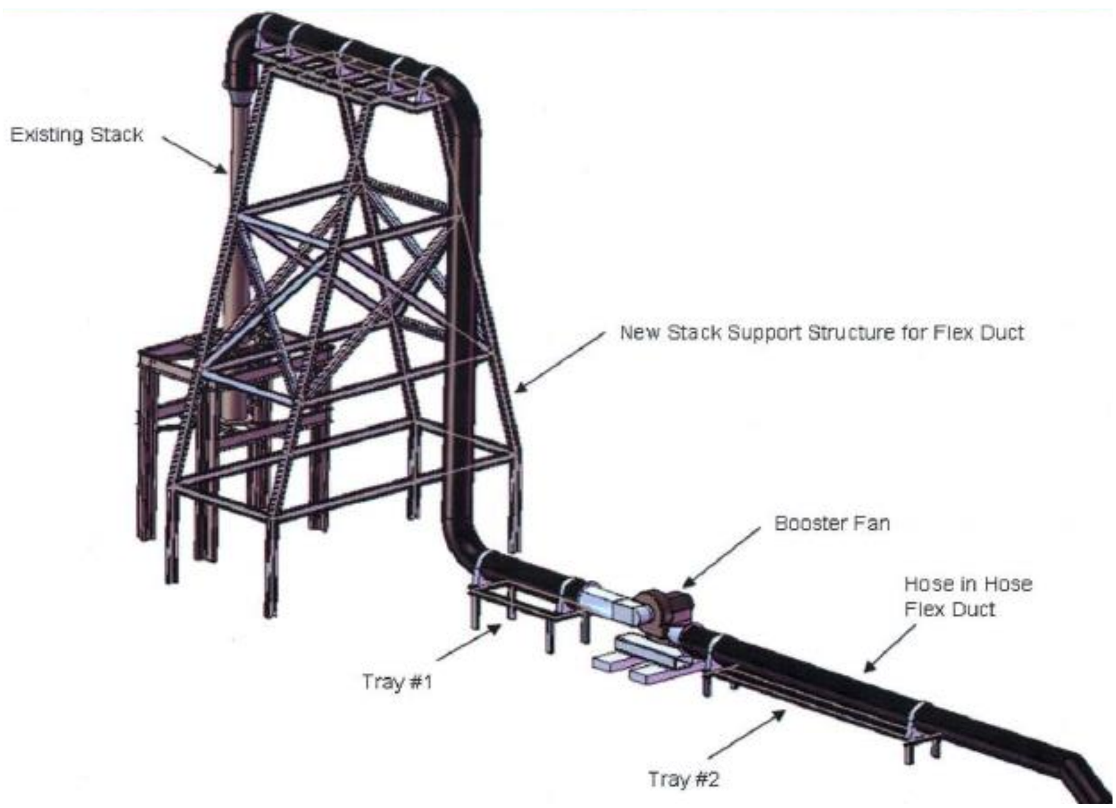


Fume Extractor

Portable fume extractors have been used elsewhere to capture vapors created during light-duty welding or where paints and solvents are used.   Fume extractors could be placed in and around work areas to help mitigate vapors. If such equipment were used they would likely contain both particulate and activated carbon filters.

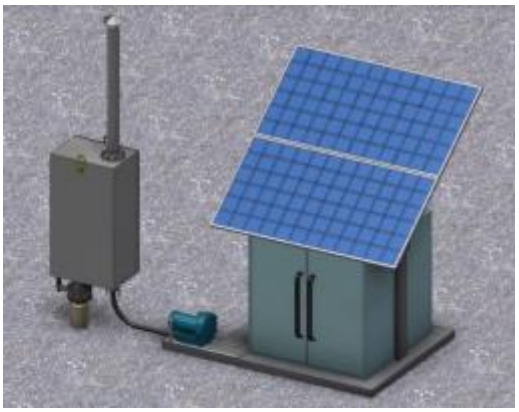
Rerouting Active Ventilation Stack Discharge

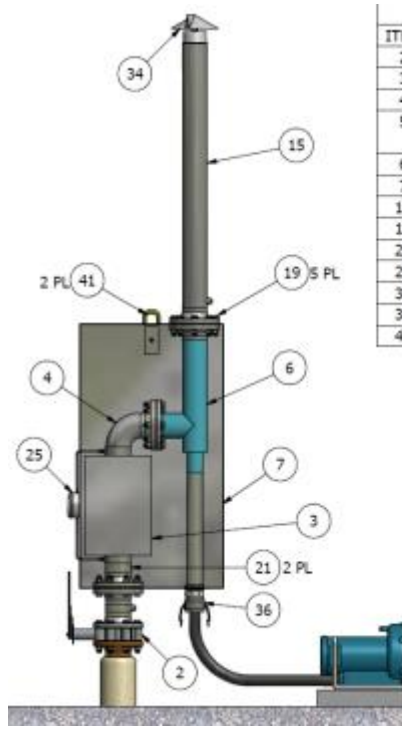
An option that was first evaluated in 2004 was to reroute exhaust coming from active ventilation systems. As shown in the illustration, the ventilation stack would be capped and the exhaust would be routed through flexible duct with booster fans placed where needed. The exhaust point could in theory be moved 1000s of feet away from where workers are located; however, a considerable amount of equipment and infrastructure would be needed to implement this solution.



Solar Powered Ventilation

Adding small solar powered active ventilation units to the SSTs was considered. A small electric motor would provide constant air flow through a small stack connected to a tank riser. Flow through the stack creates a Venturi effect that draws out and dilutes tank vapors.



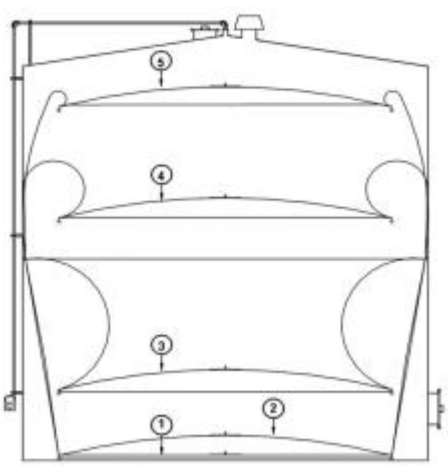


PARTS

ITEM	QTY	PART NUMBER
2	1	Butterfly Valve
3	1	HEPA filter
4	1	4" 90 Elbow
5	5	4" Butt Flange
6	1	Venturi Assembly
7	1	Cover Box (1/8" Wall)
15	2	4" 10S Pipe - 36" Length
19	32	5/8"-11 bolt 3 1/2" Length
21	2	4" 40S Pipe - 2" Length
25	1	Magne Helic DP Gauge
34	1	Wind Direction Cap
36	1	Cam Lock
41	2	Hoist Ring - Side Mount

Vapor Holding Tanks

Installation of vapor holding tanks has been proposed. The system has a volume of about 12,000 ft^3 and would collect vapors over about a 16 hour period. The holding tank would then be vented during off hours when fewer workers are around. This solution might not be practical because each of the 149 SSTs would likely require a holding tank.



1. EMPTY CONDITION
2. MINIMUM FILL-BLOWER OFF
3. 35% VOLUME FILL
4. 70% VOLUME FILL
5. 90% VOLUME FILL

Biofiltering Tank Farm Vapors

Biofiltering uses microorganisms to decompose volatile organic compounds and has been proposed to treat tank farm vapors. Some industries have used this technology successfully, but some of the tank farm vapors are not biodegradable and this technology was judged to have a low chance for success. An evaluation of biofilter technology is documented in SRNL-STI-2016-00484.