INNOVATIVE TECHNOLOGY
Summary Report

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Fluidic Sampler

Tanks Focus Area

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INNOVATIVE TECHNOLOGY
Summary Report

Fluidic Sampler

OST Reference #2007

Tanks Focus Area

Deployed at
Savannah River Site
Aiken, South Carolina

INNOVATIVE TECHNOLOGY
Summary Report

Purpose of this document

Innovative Technology Summary Reports are designed to provide potential users with the information they need to quickly determine if a technology would apply to a particular environmental management problem. They are also designed for readers who may recommend that a technology be considered by prospective users.

Each report describes a technology, system, or process that has been developed and tested with funding from DOE's Office of Science and Technology (OST). A report presents the full range of problems that a technology, system, or process will address and its advantages to the DOE cleanup in terms of system performance, cost, and cleanup effectiveness. Most reports include comparisons to baseline technologies as well as other competing technologies. Information about commercial availability and technology readiness for implementation is also included. Innovative Technology Summary Reports are intended to provide summary information. References for more detailed information are provided in an appendix.

Efforts have been made to provide key data describing the performance, cost, and regulatory acceptance of the technology. If this information was not available at the time of publication, the omission is noted.

All published Innovative Technology Summary Reports are available on the OST Web site at http://OST.em.doe.gov under "Publications."

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SECTION 1
SUMMARY

Technology Summary

Problem Definition
Millions of gallons of radioactive and hazardous wastes are stored in underground tanks across the U.S. Department of Energy (DOE) complex. To manage this waste, tank operators need safe, cost-effective methods for mixing tank material, transferring tank waste between tanks, and collecting samples. Samples must be collected at different depths within storage tanks containing various kinds of waste including salt, sludge, and supernatant (AEAT 1996).

With current or baseline methods, a grab sampler or a core sampler is inserted into the tank, waste is maneuvered into the sample chamber, and the sample is withdrawn from the tank. The mixing pumps in the tank, which are required to keep the contents homogeneous, must be shut down before and during sampling to prevent airborne releases. These methods are expensive, require substantial hands-on labor, increase the risk of worker exposure to radiation, and often produce nonrepresentative and unreproducible samples (SRS 1997a).

How It Works
The Fluidic Sampler manufactured by AEA Technology Engineering Services, Inc., enables tank sampling to be done remotely with the mixing pumps in operation. Remote operation minimizes the risk of exposure to personnel and the possibility of spills, reducing associated costs. Sampling while the tank contents are being agitated yields consistently homogeneous, representative samples and facilitates more efficient feed preparation and evaluation of the tank contents. Figure 1 shows the above-tank portion of the Fluidic Sampler. Figure 2 shows the replacement plug and pipework that insert through the tank top.

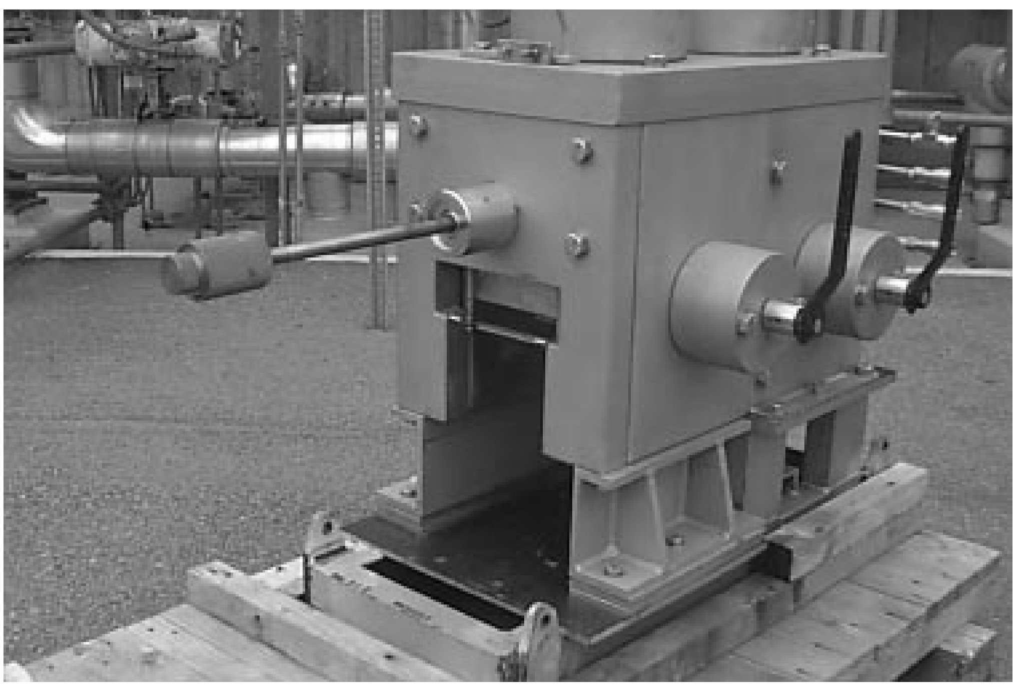

Figure 1. Fluidic Sampler bottle-handling apparatus sitting atop riser.

Advantages over Baseline
Fluidic Samplers are an innovative technology that offers an alternative to baseline samplers. Baseline samplers require the tank mixers to be shut off, yielding a sample mixture that is different from when the mixers are operating. The tank mixers operate without interruption for samples taken with the Fluidic Sampler. Personnel also have a greater exposure to radiation using the baseline approach, whereas the only exposure from fluidic sampling is from transporting the clean sample bottle from the sampler to a

cask. Using the Fluidic Sampler also reduces secondary waste, as there is nothing to disposition after a sample is taken.

Figure 2. Replacement plug and in-tank sampler pipework.

Potential Markets

Waste tanks located across the DOE complex can be sampled using the Fluidic Sampler. The Office of Science and Technology (OST) has supported two full-scale demonstrations of three fluidic devices—a sampler, a reverse-flow diverter (RFD) pump, and a fluidic diode pump—at AEA Technology's facilities in North Carolina and the United Kingdom. The successful demonstrations have resulted in two additional contracts to deploy these technologies at Savannah River Site (SRS) and Hanford. Based on the final test results, additional Fluidic Samplers will be installed at other tanks across the DOE complex (Power fluidic devices, *Initiatives* 1997).

Demonstration and Deployment Summary

A Fluidic Sampler procured for use in the In-Tank Precipitation process was installed September 21, 1998, in SRS Tank 48. The objective of In-Tank Precipitation is to precipitate potassium/cesium tetraphenyl borate salt, which is removed from the salt solution by filtration. The sampler is used to verify the composition of the decontaminated salt solution. Although In-Tank Precipitation is not currently operating, on July 22, 1999, the new Fluidic Sampler technology was used for the first time to sample the contents of Tank 48.

Participants

This project is a collaborative effort involving AEA Technology; SRS; Pacific Northwest National Laboratory; DOE Environmental Management (EM); Tanks Focus Area (TFA); the Characterization, Monitoring and Sensor Technology and Robotics Technology Development Crosscutting Programs; and International Programs.

Commercial Availability

Fluidic Samplers have been extensively tested and used in nuclear installations in the United Kingdom for the past 20 years, and more than 400 systems have been installed with no failures to date (Power fluidic devices, *Initiatives* 1997). Information on the Fluidic Sampler is available from AEA Technology Engineering Services, Huntersville, North Carolina.

Future Plans

Several deployments of the Fluidic Sampler are planned:

- Fabrication of a Fluidic Sampler for SRS Tank 40 has been completed, the last pieces of hardware were delivered in February 1999, and deployment is planned in 1999. Tank 40 is a sludge feed tank containing high-level waste (HLW) being transferred to the Defense Waste Processing Facility.

- The Hanford Site is adapting the Fluidic Sampler system to collect samples at multiple tank depths. These samples are needed to ensure the waste meets vitrification specifications. Idaho National Engineering and Environmental Laboratory is joining the Project Hanford Management Council (PHMC) and AEA Technology team to assess the Fluidic Sampler for potential application in HLW tanks at the Idaho Nuclear Technology and Engineering Center (TFA 1999).

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Other
All published Innovative Technology Summary Reports are available on the OST Web site at http://ost.em.doe.gov under “Publications.” The Technology Management System (TMS), also available through the OST Web site, provides information about OST programs, technologies, and problems. The OST/TMS ID for the Fluidic Sampler is 2007.

SECTION 2
TECHNOLOGY DESCRIPTION

Overall Process Definition

The Fluidic Sampler consists of an RFD pump with a specially designed sampling tee installed in the discharge pipework, which delivers a sample of the liquid through a sample needle to a sample bottle. Figure 3 shows a typical arrangement and mode of operation. The RFD pump draws liquid from the tank and sends it through the sample tee. As liquid passes the end of the sampling needle and returns to the tank, a venturi effect draws air out of the sampling bottle, creating a partial vacuum in the bottle. When the delivery pulse from the pump ends, the liquid velocity past the sample needle decreases. After a brief period, the vacuum exceeds the venturi effect, the flow of liquid is reversed, and liquid is drawn up into the sample bottle. Eventually the flow ceases, the vacuum breaks, and the system is ready for another cycle (AEAT 1996).

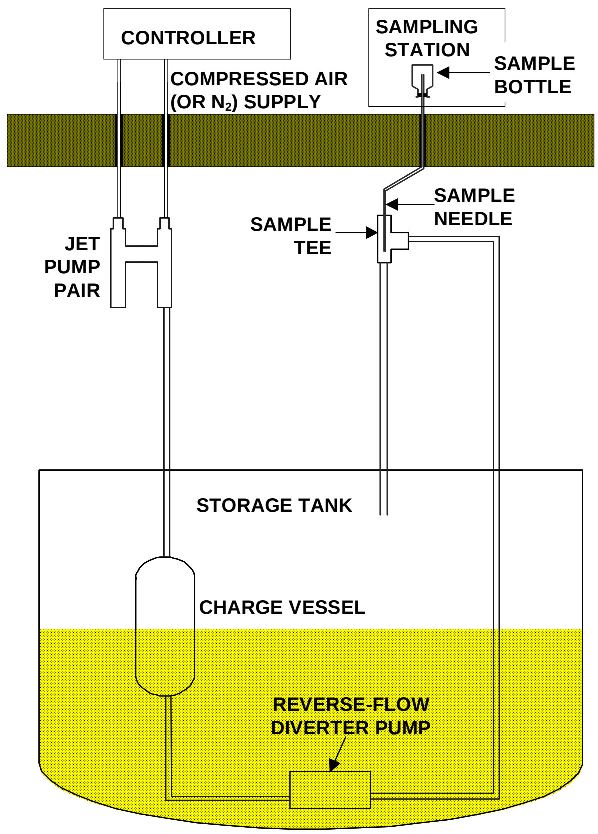

Figure 3. Schematic of Fluidic Sampler technology.

Figure 4 is a detailed view of a typical sample bottle and needle. A sample is collected over several pump cycles. The sample tee design ensures that, when no sample bottle is on the needle, no liquid passes up through the needle. If the pump is run without a bottle, for example to purge the sample lines, the flow draws a small amount of air down through the needle into the tank. However, without a bottle to hold the vacuum, there is no driving force for fluid flow into the needle and thus no means for fluid to escape through the needle. A shielded containment with simple manipulator arms is used to place and remove the bottle on the sample needle as well as to deposit it in a shielded cask for transport.

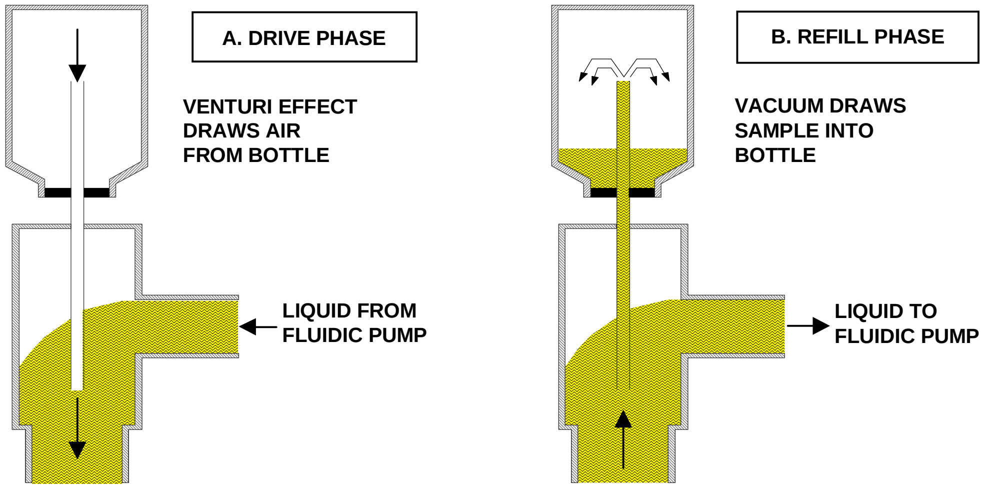

Figure 4. Sample bottle and needle detail.

Deployment Goals and Objectives

Table 1 describes the major elements of the Fluidic Sampler equipment at SRS and the associated performance goals and objectives. During FY99–FY01, TFA will continue development and improvements of the Fluidic Samplers to further demonstrate the capabilities at SRS, Hanford, and other potential sites across the DOE complex.

Table 1. Fluidic Sampler deployments at Savannah River Site

Location	Timeline	Equipment	DOE Application
Tank 48	Installed September 1998 Prestart testing and commissioning completed July 1999	• Small reverse-flow diverter (RFD) pump removes precipitous slurry from waste tank via needle to 70-mL shielded sample bottle. • Controller uses compressed N_2 gas to operate system. • Configured to fit through 6-inch riser. • Charge vessel for sample pump is 4-inch diameter; piping to and from sample tee is 1-inch diameter (much smaller than that required for transfer pumps, permitting sampler to fit through smaller riser). • Support pipe for assembly is 5-inch diameter and contains all sampler piping and fittings within tank down to the charge vessel, including nitrogen supply pipes, jet pump, sample tee, drain line, and upper portion of delivery pipe from RFD.	• Tank is 85 ft in diameter by 30 ft deep with concrete-covered top. • Tank is a salt-processing tank for In-Tank Precipitation, which was suspended on January 23,1998. • Future of salt pretreatment is uncertain in terms of the process to be used, cost, and schedule.
Tank 40	December 1999	• Essentially same as in Tank 48 except compressed air is used and there are changes in the plug dimensions due to variations in riser geometry.	• Tank is a feed tank for the Defense Waste Processing Facility, used for washing sludge to remove unwanted components. • Extended Sludge Processing Tanks are sampled 20 times per year.

The Fluidic Sampler design is currently being modified to obtain representative samples from multiple depths. The variable-depth Fluidic Sampler is needed to support private-sector treatment of tank waste at Hanford. The capacity for at-tank analysis will be added to the sampling system to provide additional support for privatized waste treatment. Representative samples and rapid analysis ensure that waste meets the feed specifications for the waste vitrification process.

System Operation

The Fluidic Sampler offers many operational benefits. Table 2 summarizes the system operation requirements for Fluidic Samplers.

Table 2. Fluidic Sampler system operation requirements

Special operational parameters	• Entire fixed-depth sampler can be installed through 6-inch penetration in riser plug, providing continuous containment of sample bottles and shielding for operators. • No connections with existing piping are needed; sampler can be located in convenient riser 6 or more inches in diameter. After sampler is installed, only two air (or nitrogen) supply pipes and sample needle enter riser. • Air (or nitrogen) supply control equipment including pressure reducer, solenoid valves, and pressure transducers are weatherproof designs located on tank top. PRESCON controller is located nearby in weather-protected enclosure. Service air (or nitrogen) connections are provided along with 115-VAC power supply for PRESCON controller. Compressed air (or nitrogen) usage averages 6 standard cubic feet per minute.
Materials, energy, other expendable items	• Power fluidics components: reverse-flow diverter, jet pump pair, sampler tee, needle assembly with replacement needles, sample bottles, support piping, PRESCON controller, lead shielding, piping components, and N_2 or compressed air to drive unit. Minimal electricity requirements for controller.
Personnel	• Operation is possible with one person but more convenient with two.
Secondary waste stream	• Fully contained system generates no “job waste.”
Potential operational concerns and risks	• Risk is very minimal as system is fully contained. Power fluidics hardware and piping are installed from the sampling station through riser. Samples are deposited in the vial inside sampling station and transferred to shielded cask remotely, thereby protecting operators. Small needles (1/8–3/16-inch interior diameter) are located within large shielded unit.

SECTION 3
PERFORMANCE

Demonstration Plan

A Fluidic Sampler was installed and operated in FY96 at the Fluidic Pump and Sampler Facility in Charlotte, N.C. Sampler demonstrations in September and October 1996 involved a “cold” verification test of the sampling equipment, including the following:

- A full-height test assembly.
- A preliminary test with water.
- Use of a simulant slurry representing the composition of the actual in-tank material: a combination of china clay and water mixed to achieve at least 32 wt % solids and specific gravity of 1.2. The clay/water mixture was specifically selected to produce viscosity reflecting that indicated by site rheological data.
- Tests conducted with a sample bottle in place to verify that simulant material could be drawn up the full height of the assembly and into the bottle. It was also verified that at least 2 mL of material per cycle could be pulled into the bottle.
- Tests with the bottle removed to verify that no simulant material escaped through the needle during cycling.

The sampler pump delivered 20 mL of sample in approximately 2 min., with no sign of fluid leaking or spurting from the needle. The demonstration proved the value of the Fluidic Sampler and helped DOE identify field applications for deployment.

SRS deployed the Fluidic Sampler for In-Tank Precipitation and Extended Sludge Processing. The In-Tank Precipitation process requires frequent sampling of Tank 48 to characterize the tank contents. Originally, two Fluidic Samplers where to be deployed, but it was determined that a single Sampler in Tank 48 would be adequate. For Extended Sludge Processing Tanks, the original plan was to deploy this Sampler in Tank 42 or Tank 51, but a decision was made that Tank 40 would present a better opportunity.

The plan for the SRS deployments is summarized in Table 3. A key success factor is to verify that the sampler eliminates manual sampling requirements. If so, risers no longer need to be removed or opened to obtain a sample, dramatically reducing the potential for inadvertently spreading contamination and for personnel radiation exposure.

Results

The Fluidic Sampler was installed in Tank 48 at SRS during September 1998. Full functional testing carried out on the equipment prior to shipment showed that the Fluidic Sampler could operate to the standards requested by SRS (Danfelt 1997). The equipment’s inherently safe design and commissioning testing made installation and operational risks small. During the week of July 19, 1999, the Fluidic Sampler technology was used for the first time to sample the contents of Tank 48 during pre-start testing. Several minor adjustments were made to tailor the Sampler to the application. Performance data from testing is currently being compiled.

The Fluidic Sampler has been designed to meet specific requirements, fabricated, tested, and delivered to SRS for installation in Tank 40. The shielding in the Sampler station is designed to withstand radiation levels from the sludge. The controls function exactly as in the Tank 48 sampler.

Table 3. Savannah River Site demonstration goals and objectives

Location	Specific Operation Evaluated	Status	Goals and Objectives
Tank 48	• Required frequent and accurate sampling to characterize contents during In-Tank Precipitation. • Due to suspension of In-Tank Precipitation, Tank 48 will no longer generate precipitate slurry; however, sampling will still be necessary to characterize its contents for eventual remediation.	• Sampler unit installed week of September 21, 1998. • In-tank power fluidics hardware and piping were installed through riser in tank top. Shielded sampling station sits atop and seals tank riser. • Sample collected in 70cc stainless steel bottle positioned inside sampling station and then transferred to shielded cask remotely, thereby protecting operators. Baseline for Tank 48 sampler unit was cable and winch–type variable-depth sampler, which was removed in June 1998 in anticipation of deployment of Fluidic Sampler.	• Uniform sample collected 12–18 inches off tank bottom. • Sample collected while all four slurry pumps are operating. • Sample is well-mixed and representative. • As-low-as-reasonably-achievable (ALARA) performance improved by eliminating manual sampling practices.
Tank 40	• Will be used to characterize Defense Waste Processing Facility sludge feed material consisting of inorganic, insoluble feed material.	• Sampler has been fabricated, and equipment has been delivered to site.	• Same as above.

SECTION 4
TECHNOLOGY APPLICABILITY AND ALTERNATIVES

Competing Technologies

The current baseline consists of manual sampling through tank access points (risers). In this procedure, the plug is removed from the riser, and a container is manually lowered into the sludge, filled, and removed. The mixing pumps in the tank, which are required to keep the contents homogeneous, must be shut down during sampling activities. The contents of the tank quickly settle and stratify, resulting in less representative individual samples and requiring that more samples be taken to provide an average estimate.

Individuals who sample SRS Tank 48 using the baseline manual method are exposed to a dose of approximately 16 mrem per sample. Because Extended Sludge Processing Tanks must be sampled 20 times a year, total annual exposure equates to a dose of 320 mrem. The current dip sampling method also increases the risk of environmental contamination because of job waste originating from sampling equipment (SRS 1997a).

Benefits of the Fluidic Sampler technology over baseline include the following:

- Improved safety (reduced radiation exposure to personnel and environment)
  - Keeps the sample in a shielded and sealed containment at all times
  - Includes leaded glass viewing windows and light bulbs so that sample bottle may be viewed and if a plastic bottle is used, the filling process can be verified remotely
  - Eliminates the need to remove or open a riser to obtain a sample

- Reduced cost
  - Eliminates replacement costs of worn-out components
  - Increases plant productivity by reducing maintenance and allowing plant processes to continue during sampling (i.e., no lost processing time while tank agitators are stopped and restarted)

- Increased reliability/maintainability
  - Allows samples to be taken from homogeneous mixture
  - Enables sampling from locations other than the liquid surface
  - Eliminates maintenance because there are no moving parts
  - Facilitates flushing and decontamination because the system has no crevices to trap contaminants

Technology Applicability

Fluidic Samplers provide cost savings and improved safety compared to manual sampling. Fluidic Samplers are most applicable for tanks that require repeated sampling to verify that waste meets specifications for transfer and subsequent processing. It helps prevent transfer line plugging and the delivery of out-of-specification feeds.

Hanford requires sampling and rapid analysis of samples from multiple depths. To meet these requirements, a Multiple-Depth Sampler and an At-Tank Analysis System are being developed. A promising application for Fluidic Samplers is sampling feed staging tanks prior to transfer to processing facilities operated by private vendors.

Patents/Commercialization/Sponsor

AEA Technology designed the Fluidic Sampler and holds all patent and licensing rights. Two Fluidic Samplers will be deployed at SRS as part of the EM-50 Accelerated Site Technology Deployment (formerly Technology Deployment Initiative) Program. This project is a collaborative effort involving AEA

Technology; SRS; Pacific Northwest National Laboratory; DOE-EM; TFA; the Characterization, Monitoring, and Sensor Technology and Robotics Technology Development crosscutting programs; and International Programs.

SECTION 5
COST

Methodology

A cost comparison between baseline and fluidic sampling was developed for the Extended Sludge Processing Tank application. Samples are needed to determine whether tank contents are suitable for vitrification and to provide for producing test glass samples made in a laboratory. Estimates are in 1998 dollars. Assumptions for the comparison are as follows:

Baseline

- To collect a sample requires approximately 9 man-hours at a cost of $540 per sample. This estimate includes drafting the job control plans, donning protective clothing, deploying radiation-control personnel, and supervising all personnel and operations.
- Tanks are sampled an average of 20 times per year. Frequent sampling is required because the baseline process does not allow for a homogeneous sample. When the mixing pumps are shut down, tank contents quickly settle and stratify, resulting in less accurate individual samples and requiring more samples to be taken to provide an average estimate.
- Another $21,000 of analytical control support is needed to analyze the composition of the sample material (organic, inorganic, and radionuclide makeup).
- Additionally, a very complicated apparatus is required to obtain a large sample from the mid-depth portion of the tanks.

Fluidic Samplers

- Fluidic Sampler equipment costs include sampler design, fabrication, qualification tests, delivery, and commissioning.
- Extended Sludge Processing Tanks currently require minimum worker radiation protection on top of the tank slab. Riser plug removal and sampler installation are done in a contamination-control enclosure with workers in air-supplied plastic suits.
- Operations personnel supply flush water via water hose when required. No provision for flush water is included in this estimate.
- Plant air service is provided in this estimate.

Cost Analysis

Table 3 compares costs for the baseline to those for the Fluidic Sampler at SRS Tank 48 in 1998 dollars.

Table 3. Cost comparison for the baseline and the Fluidic Sampler in SRS Tank 48

Description	No.	Units	Hours	Rate	Total	Remarks
Baseline						
Remove samples from tank	20	Each	9	$60	$10,800	100-mL sample
Analyze samples	20	Each		$21,000	$420,000	
Remove special sample	1	Each	240	$60	$14,400	3-L sample
Analyze sample	1	Each		$21,000	$21,000	
Total estimated annual direct costs					$466,200	
Site general and administrative costs					$148,718	
Total estimated annual costs					$614,918	
Total estimated baseline life-cycle costs (FY98–FY06 @ $615K)					$5,535,000	
Fluidic Sampler						
FY98 costs						
Purchase and install Fluidic Sampler					$750,000	
Remove samples from tank	10	Each	6	$60	$3,600	100-mL sample
Analyze samples	10	Each		$21,000	$210,000	
Remove special sample	1	Each	240	$60	$14,400	3-L sample
Analyze sample	1	Each		$21,000	$21,000	
Total estimated FY98 direct costs					$999,000	
Site general and administrative costs					$317,086	
Total estimated FY98 costs					$1,316,086	
Out-year costs						
Remove samples from tank	10	Each	6	$60	$3,600	100-mL sample
Analyze samples	10	Each		$21,000	$210,000	
Remove special samples	1	Each	240	$60	$14,400	3-L sample
Analyze samples	1	Each		$21,000	$21,000	
Total estimated annual direct costs					$249,000	
Site general and administrative costs					$79,431	
Total estimated annual out-year costs					$328,431	
Total estimated Fluidic Sampler life-cycle costs (FY98 @ $1,316K + FY99–FY06 @ $329K)					$3,948,000	

Capital Costs

Capital costs for the first Fluidic Sampler for SRS are approximately $750,000. Table 4 shows an approximate breakdown of costs (AEAT 1996). Costs for subsequent samplers were $500,000 to $600,000.

Table 4. Capital costs for first Fluidic Sampler, in 1998 $ thousands

Component	Cost
Design	200
Fabrication	170
Containment design	120
Containment fabrication	140
Procedures	30
Testing	70
Installation support	20
Total	750

Operating Costs

Operating and maintenance costs for the Fluidic Sampler are minimal. Costs include labor to supervise the system operation, compressed air or nitrogen, and flush water.

Cost Benefit
Substantial cost benefits result from the following:

- needing fewer samples because they are taken from a homogeneous mixture,
- eliminating the cost of replacing worn-out components,
- eliminating much routine maintenance,
- reducing secondary waste in the form of worn-out components, and
- reducing radiation exposure, contamination risk, and safety work associated with maintenance and operation.

Cost Conclusions

Table 5 shows the life-cycle cost savings from a single Fluidic Sampler deployment. Using the Fluidic Sampler will not produce net cost savings until the fourth year. However, during years 5 through 9, cost savings accrue to $1.5 million.

Table 5. Cost savings from the life cycle of one Fluidic Sampler, in $ thousands

Component	Year									Total
	1	2	3	4	5	6	7	8	9	
Baseline	615	615	615	615	615	615	615	615	615	5,535
Fluidic Sampler	1,316	329	329	329	329	329	329	329	329	3,948
Savings	(701)	286	286	286	286	286	286	286	286	1,587

SECTION 6
REGULATORY AND POLICY ISSUES

Regulatory Considerations

Regulatory/Permitting Issues

There are no additional state or regional regulatory permits or requirements for deployment of this technology. DOE site plans will be in effect; key safety and baseline operational change documents will be produced as necessary. The only regulatory concern was trying to meet SRS's Lead Program requirement, which controls the amount of lead introduced to the site. The lead was used in shielding to protect personnel from excessive radiation exposure.

Aspects of Fluidic Sampler design that deal with entry or installation into a radiological controlled area (RCA) are coordinated with Health Physics Technology and the Radiological Controls and Health Physics Department to minimize the time spent in the RCA. The most efficient means of installation in an RCA is used to keep radiation exposure and contamination risks as low as reasonably achievable (ALARA). Modular components are used to the maximum extent possible to facilitate installation, operation, and maintenance. All lead shielding will be fully sealed in stainless steel, and the design will consider Resource Conservation and Recovery Act (RCRA) nonhazardous shielding materials, such as tungsten composites, where practical (AEAT 1996).

Secondary Waste Streams

The Fluidic Sampler is a fully contained system; no "job waste" is generated during the sampling process.

CERCLA/RCRA Considerations

DOE site plans encompass Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and RCRA considerations. The following sections summarize how the Fluidic Sampler addresses the nine CERCLA evaluation criteria.

Human Health and Environment	The Fluidic Sampler is fully contained within the tank, so it does not endanger human health or the environment. While some hypothetical incidents could cause the loss of component function, none result in contaminated materials getting out of the tank inadvertently. In addition to the design features, fluidic pumps and samplers have an excellent track record in nuclear applications.
Compliance with ARARs	The Fluidic Sampler meets applicable or relevant and appropriate requirements (ARARs). To support needs at Hanford and INEEL, options are being tested for filling the sample bottle to gather tank wastes that potentially contain volatile organic constituents.
Reduction of Toxicity, Mobility and Volume through Treatment	The Fluidic Sampler does not increase the volume of waste and reduces the risk of spills on the top of the tank.
Long-Term Effectiveness and Permanence	Fluidic Sampler operation supports permanent treatment and disposal of radioactive waste stored in tanks.
Short-Term Effectiveness	Fluidic Sampler design includes many fail-safe features. While some hypothetical incidents could cause the loss of component function, none result in contaminated materials inadvertently escaping the tank.
Implementability	Fluidic Samplers have no moving mechanical parts within the tank, offering lower maintenance, longer lifetimes, and higher availability than comparable systems using conventional valves and pumps.

Costs	Costs to build and operate Fluidic Samplers are lower than for the baseline technology.
State Acceptance	SRS is currently demonstrating the Fluidic Sampler technology. The South Carolina Department of Health and Environmental Control supported the idea and approach of using the Fluidic Sampler.
Community Acceptance	The SRS Citizen's Advisory Board strongly supported the Fluidic Sampler technology.

Safety, Risks, Benefits, and Community Reaction

Worker Safety
Employing the Fluidic Sampler will give substantial and long-term reduction in personnel exposure by replacing manual sampling techniques. The Fluidic Sampler does not directly expose workers to hazardous or radioactive materials. The only contact a worker has is with a clean, filled sample bottle with mechanically placed lid.

Risks
Fluidic Samplers have an excellent track record in nuclear applications. Fluidic sampling pumps are installed in many nuclear plants as stand-alone pumps with the sole duty of collecting representative samples of tanks content. About 40 systems have been installed in operating plants, and 22 will come on line in the next 12–18 months. No samplers have failed to date.

Benefits, and Community Reaction
When specifically compared with the sampler used previously in SRS Tank 48, a Fluidic Sampler offers the following benefits:

- greater ease of operation,
- faster sampling,
- elimination or minimization of flushing water additions and the potential for flushing water to dilute the sample,
- visual confirmation of sample bottle filling (when using a plastic sample bottle),
- easier maintenance,
- no requirement for cables or winches, and
- requires raising only the sample, not a sample retriever, above the tank top.

Community Reaction
There is no history of accidents with this technology. Future full-scale processes would be required to comply with DOE safety policies and guidelines. It is expected that these processes would need to be covered by an amendment to an existing Safety Assessment Report.

This technology causes no routine release of contaminants, and no potential impacts from transportation of equipment, samples, waste, or other materials are associated with this technology.

SECTION 7
LESSONS LEARNED

Implementation Considerations

The Fluidic Sampler can be designed to facilitate a wide variety of uses. Sampling can be conducted from a number of discrete depths (depending on riser size and the pumping application) and for a large range of viscosities. This technology causes no routine release of contaminants, and no potential impacts from transportation of equipment, samples, waste, or other materials are associated with this technology.

Having no moving parts and possessing maintenance-free features within the radioactive environment, power fluidic devices are inherently designed to ALARA conditions. The design uses existing tank risers and piping runs that minimize radiation exposure during installation and prevent the inadvertent release of tank contents. Engineering analyses indicate that Fluidic Samplers can safely be placed on tanks.

Technology Limitations

A potential limitation of the Fluidic Sampler is that it must be used with a sludge type in the design range. The solution is to establish during the design stage ranges for viscosity, density, and other pertinent properties that might be encountered for that application.

Installation of the sampler can be challenging, since it involves lifting the equipment over the top of the tank. A plug must be opened to deploy the sampler into the tank. The plug area must have a special tent built around it with a special air system to ensure that airborne releases are controlled. Lifting the sampler over the tank involves using a crane. Working with cranes is logistically demanding and requires advance planning.

Sampling waste that contains volatile organics requires an alternate approach to filling the sample bottle. Modifications are needed to ensure that the filled bottle contains representative quantities of volatile organic constituents.

Technology Selection Considerations

The Fluidic Sampler manufactured by AEA Technology allows tank sampling to be done remotely, with the mixing pumps in operation. Remote operation minimizes the risk of exposure to personnel and the possibility of spills, reducing associated costs. Sampling while the tank contents are being agitated yields consistently homogeneous, representative samples, facilitating more effective evaluation of tank contents.

The Fluidic Sampler can be designed for a range of viscosities. SRS provided AEA Technology with a broad range of viscosities expected in the tanks where the Fluidic Samplers would be installed, and AEAT designed Fluidic Samplers to operate in that range. Fluidic Samplers can reportedly be designed to sample extremely viscous sludge. However, it is important that the potential viscosity range of the wastes be considered in the design and selection of the Fluidic Sampler.

Fluidic Samplers have been demonstrated at both fixed and variable depths. Multiple-depth samplers, however, are more complex in design and require further development for application in HLW tanks. If rapid sampling and analysis are required, an on-line analytical technique—Laser Ablation/Mass Spectrometry—can be included with the Fluidic Sampler. In the spring of 1999, AEA Technology worked with Hanford to test full-height equipment suitable for multiple–depth sampling.

APPENDIX A
REFERENCES

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APPENDIX B
ACRONYMS

ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE	U.S. Department of Energy
EM	Office of Environmental Management
FY	fiscal year
HLW	high-level waste
OST	Office of Science and Technology
PHMC	Project Hanford Management Contract
RCA	radiological controlled area
RCRA	Resource Conservation and Recovery Act
RFD	reverse-flow diverter
SRS	Savannah River Site
TFA	Tanks Focus Area