This document was prepared in conjunction with work accomplished under
Contract No. DE-AC09-96SR18500 with the U.S. Department of Energy.

# SALT CORE SAMPLING EVOLUTION AT THE SAVANNAH RIVER SITE

Tom Nance
Dan Krementz
William Cheng

*Savannah River National Laboratory*
*Savannah River Site*
*Building 723-A*
*Aiken SC, 29808*
*thomas.nance@srnl.doe.gov*

*The Savannah River Site (SRS), a Department of Energy (DOE) facility, has over 30 million gallons of legacy waste from its many years of processing nuclear materials. The majority of waste is stored in 49 buried tanks. Available underground piping is the primary and desired pathway to transfer waste from one tank to another until the waste is delivered to the glass plant, DWPF, or the grout plant, Saltstone. Prior to moving the material, the tank contents need to be evaluated to ensure the correct destination for the waste is chosen. Access ports are available in each tank top in a number of locations and sizes to be used to obtain samples of the waste for analysis. Material consistencies vary for each tank with the majority of waste to be processed being radioactive salts and sludge. The following paper describes the progression of equipment and techniques developed to obtain core samples of salt and solid sludge at SRS.*

## I. INTRODUCTION
## II. SHORT CORE SAMPLING “THE FIRST STAB”

The Short Core Sampler was developed for use in the top layer of salt. This surface sample was originally obtained by use of a core cup mounted to a pipe mast with retention of the sample through compression. The compression cup (see Fig. 1), was split down the sides and during sampling, material was pushed into the sample cup pushing the two split halves apart. The sample cup was driven down into the salt by impacting the sample mast manually with a hammer. The size of the sample cup was determined by the minimum quantity needed for analysis and the dimensions of the transport package void. The transport packages vary in void size but are approximately 4” high by 2-3/4” diameter. This compression cup design was modified with a number of changes including the incorporation of a quick disconnect pin for faster release of the cup for packaging.


Fig. 1. Compression Sample Cup

This sampler was successful with solidified materials but loose materials required a better retention technique. Removal of the material from the sample cup was also quite difficult remotely by manipulator arms within the laboratory hot cells since the sample had to be dug out of the compression sample cup. Plastic basket sample retainers with split fingers to allow material to enter but not to exit were attempted with positive results. The first model of this basket retainer required unthreading of set screws in the lab cells to disassemble and remove the sample (see Fig. 2). The design was later improved to ease sample removal using manipulator arms. The new design disassembled with rotation of the outer cutting mouth releasing the basket retainer (see Fig. 3). The design was further enhanced with a piston and two indicator pins to indicate sample quantity. Upon detaching the sample cup from the sample mast, the two quantity indicator cup pins are visible and their relative extension indicates the quantity obtained. The sample piston inside of the sample cup also provided a simple means to empty the sample cup. After removing the cutting mouth and basket, the quantity indicator pins could be pushed down to the top of the sample cup pushing the piston downward and extruding the sample out of the sample cup.

Fig. 2. Short Core Sampler with Basket Retainer

Due to the need to provide a full sample, the quantity indicating pins of the described Short Core Sampler had to be removed prior to packaging the sample in the transport package due to space constraints. If the sample quantity indicated was insufficient and required reinsertion into the tank, the contaminated sampler and lower mast had to be handled by operators to reassemble. A separate section to indicate quantity was then added to eliminate the pins from the sampler and eliminate the pre-removal step in packaging the sample. The quantity indicator (see Fig. 3) allows the operator to observe the quantity of the sample obtained without physically contacting the sampler cup. The mast is lifted and the operator observes the quantity indicator section for the sample amount obtained without mast disassembly and the associated radiation exposure. A remote camera could also be used within the tank to observe the quantity indicator remotely and thus retrieve the mast only with a full sampler. Weep holes were designed in the quantity indicator to allow for drainage in case of submerging the indicator in supernate, liquid waste.

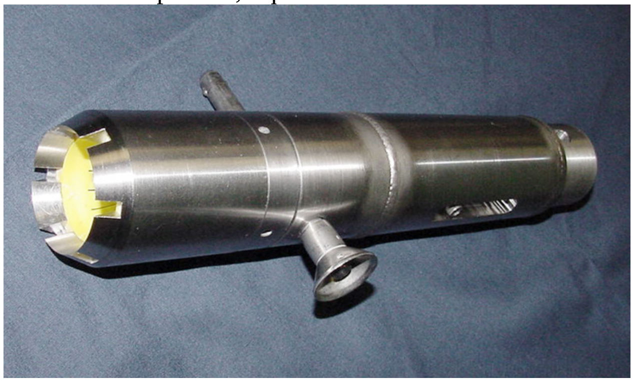

Fig. 3. Short Core with Quantity Indicator

## III. LONG CORE SAMPLING: "THE TALE GROWS LONGER"

The use of the larger 9968 transport package allowed for evolution of the sample cup design into the long core sampler. The long core sampler was greater in length than the short core's 4" and ranged in length up to 12" (see Fig. 4). This sample cup provided two to three times the sample quantity but didn't provide a positive sample that could be examined easily for strata. A new version was later developed with the sample cup separating into two halves to allow observation of the visible layers within the sample (see Fig. 5).

Fig. 4. Long Core Sampler

Fig. 5. Long Split Core Sampler

Extensive sample testing was conducted with a number of materials used for waste simulants. Different consistencies of the waste were simulated from soft material to hardened materials. A kaolin clay/water mixture with viscous Bingham plastic properties was the primary material used and was found to move out of the path of the sample cup. Another long core sampler was designed and tested with a widened cutting edge to obtain soft materials (see Fig. 6).

Fig. 6. Wide-Mouth Long Core Sampler

The inability of the long core sampler to obtain soft waste material led to development of the Parallel Vial Snapper Sampler (see Fig. 8). This mast-deployed pneumatic actuated sampler was used to push the two long jaws into the waste separately and actuate the jaws together.

Fig. 7. Parallel Vial Snapper Sampler

## IV. DISSOLUTION SAMPLING: "THE SAMPLING SOLUTION IS DISSOLUTION"

The advent of the development of the short and long core samplers provided information on the surface and upper layer of the waste in tanks. Many tanks, however, contain deep amounts of salt and salt column information is needed to enable large layers of salt to be washed down and removed from the tank. Transfer of salt layers from the tanks potentially causes accumulations of radioactive constituents and requires evaluation prior to transfer. A technique was proposed to drive a tube into the salt to the depth of the transfer, dissolve the salt within the well or caisson, and obtain a sample of all the heavy constituents within the bottom of the caisson. The amount of radioactive constituents found in the dissolved salt in the caisson can be used to estimate the amount of radioactive elements within the tank and the criticality potential of washing down the salt layer. This technique was first performed using cam-lock caisson connections and deployment of the caisson by manual impacting. This technique provided approximately 9 feet of progress driving into the saltcake (see Fig. 8).

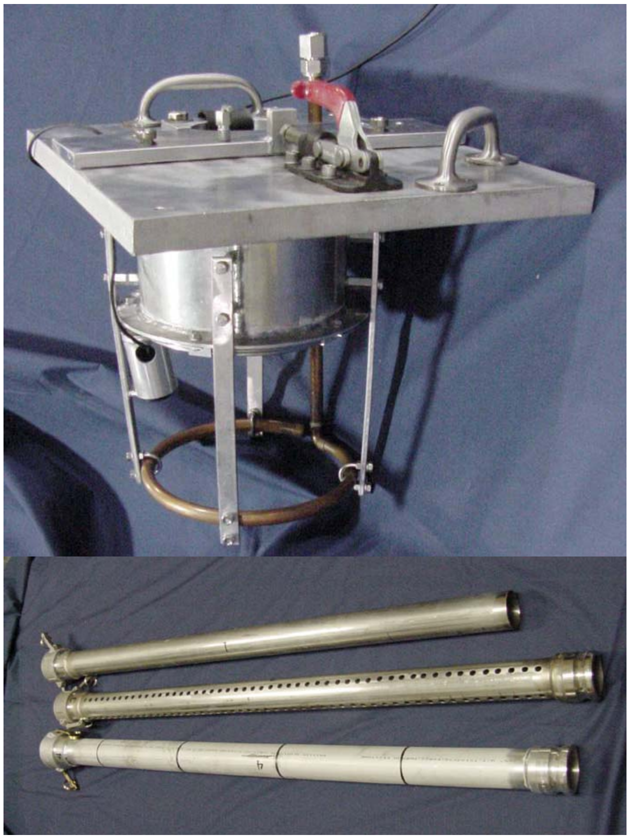

Fig. 8. Dissolution Sampler with Camlock Caisson

The dissolution technique was taken a step further by eliminating the caisson and performing dissolution by using a water sparger. The sparger was used to dissolve the salt as it simultaneously burrowed a hole in the salt (see Fig. 9). This technique proved difficult to regulate the depth of the dissolution. This technique also provided results that were based on assumptions of hole size and hole integrity that can not be easily confirmed, leading to higher uncertainty in the sample results.

Fig. 9. Dissolution Sampler without Caisson

The dissolution technique was later used with an improved caisson design and an improved installation technique. Improvements were made to the caisson couplings to streamline them for deployment through the salt and design them for impact and seal retention. Installation was improved through use of a commercial air-powered impact driver to drive the caisson into salt. The driver eliminated the use of operators manually hammering and the potential for injury during the hammering process. The two improvements resulted in a 14 foot installation into the saltcake in the tank with a large reduction in the installation time.

## V. DEEP SAMPLING: "GETTING TO THE BOTTOM OF THINGS"

Long core sampling provided the needed sample from the top surface of salt for small waste transfers but analysis of deeper surface samples was desired. Multiple long sample corers inserted into the salt in succession could provide the deep core sample needed. A guide pipe was lowered to the salt surface and a rod mast with a sample tube was lowered through the guide pipe (see Fig. 10). The rod mast was then impacted with a hammer and later a pneumatic actuated hammer to drive the cup into the salt. After retrieval of the sample cup, a second cup was inserted down the guide pipe and the cup pushed down into the hole left by the first cup. Following impacting and retrieval of the second cup, a third cup was used to obtain a total of three feet of core sample. This sampling technique proved to be the most successful in obtaining undisturbed salt samples to three foot in depth. Questions of the integrity of the salt hole and whether it caves in following the first sample are still unanswered with this technique. The second and third samples could therefore be at least partially composed of material from the upper layer of salt since the hole was not lined. Failure of commercially available sample tubes led to the development of hardened 440C stainless steel tubes especially designed for impact.

Fig. 10. Three Foot Core Sampling

The next challenge was soon raised with the call to perform sampling of an entire core of the salt within a tank. A commercial push sampler was selected for its ability to obtain long core samples without a drill string, guide pipe, mast retrieval between samples. The hydraulic actuated push sampler was modified with a frame that secured the device to the tank top. A wireline sampling system was then procured to be used in the push sampler. The wireline sampler is composed of a sample tube, a locking section and a retrieval cable. The sample tube and locking section are lowered by the retrieval cable within the drill string. Upon reaching the bottom, the locking section locks the sample tube at the bottom of the drill string. After pushing the guide string and sample core cup into the salt and obtaining a sample, the sample cup is then retrieved by pulling on the retrieval cable.

The push core sample device was limited in its success due to hardened salt and push limits not allowing the full capacity of the device to be used. The push sampler was capable of pushes up to 40,000 lbs. but was limited to 11,000 lbs due to tank top loading concerns. The push sampler did not have a drill attachment and evaluations of purchasing a drill attachment for the push sampler or purchasing a proven commercial core drill sampler were conducted. The evaluation resulted in a decision to purchase a new drill system. The new drill system consisted of a Longyear LM-75 that was modified with a frame to attach it to the tank top. The system had been used successfully with numerous samples obtained in radioactive salt at DOE's Hanford facility. A different wireline system with a remotely actuated ball valve to retain the sample within the sample tube had been used at Hanford as well. This sample tube, deployment and retrieval system were also selected for use at SRS.

## VI. CONCLUSIONS

Sampling of tanks is an important step in the processing of the legacy waste at SRS. Core sampling has been taken from short core sampling with manual deployment, progressed to long core sampling, dissolution sampling, impact sampling, and finally push and drill sampling. Further progress will be needed to gain the samples needed but the development of a universal tank salt core sampler is not far away.