Tank Waste Sampler Selection Criteria and Hierarchy

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Abstract: This document describes solid and liquid waste samplers that have been developed or are under development to retrieve waste from Hanford Site tanks. It also discusses sampler capabilities, limitations, and constraints.

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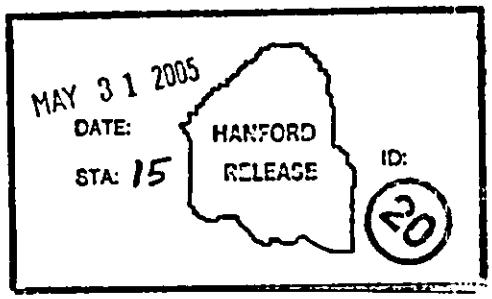

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LIST OF TERMS

Abbreviations and Acronyms

AMS	Articulated Mast System
DQO	data quality objective
MRS	Mobile Retrieval System
TSAP	Tank Sampling and Analysis Plan

Units

ft	foot
in.	inch
mL	milliliter

1.0 INTRODUCTION

The Tank Closure Project has several tank waste samplers that are available for deployment, or are under development. The finger trap and clamshell samplers are available for solid sample collection. Under development are the modified clamshell and off-riser samplers, which are primarily intended for solid sample collection. Liquid sample collection is essentially limited to the well-established bottle-on-a-string sampler, although the off-riser sampler could be used when conditions would preclude successful bottle-on-a-string sampler deployment.

For solid sample collection the hierarchy of deployment is as follows:

- Finger trap sampler
- Clamshell sampler
- Modified clamshell sampler
- Off-riser sampler.

This hierarchy is based on deployment cost, operational complexity, and waste generation. Selection of a sampler proceeds to the next lower tier in the hierarchy if that sampler provides the required capability not available from a sampler higher in the hierarchy.

2.0 GENERAL SAMPLER DESCRIPTION

General tank waste sampling requirements for closure characterization are specified in the *Single-Shell Tank Component Closure Data Quality Objective* (RPP-23403). The data quality objective (DQO) requirements encompass various sampling topics including:

- Quantity of material that must be collected
- Number of locations that must be sampled
- Need for duplicate samples collection.

The sampling process presented in the DQO must be re-evaluated and updated accordingly before any new sampler can be deployed for closure characterization. Additional requirements are specified in a Tank Sampling Analysis Plan (TSAP) that is developed specifically for each sampling event.

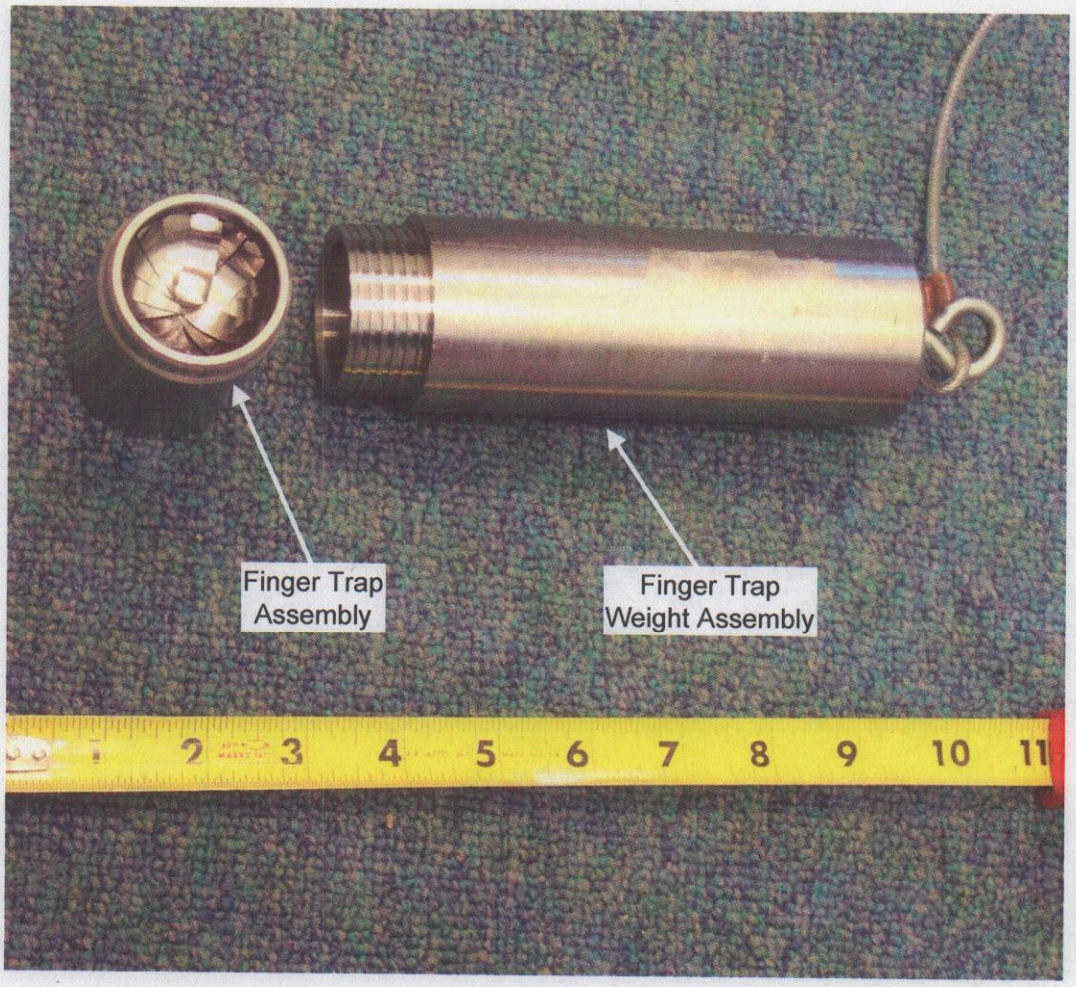
2.1 FINGER TRAP SAMPLER

The baseline for solid sampling is the finger trap sampler (Figure 1). The finger trap sampler consists of the finger trap assembly and finger trap weight assembly. A cable attached to the standard bottle hoist is used to lower and retrieve the finger trap sampler.

The finger trap sampler is contained within a glove bag, which is placed on a table positioned above the tank access riser. A 4-in. diameter section of pipe, referred to as the top hat, is used to make a sealed connection between the riser and the glove bag. The top hat's flanged end is

bolted to the riser and the open end penetrates through the glove bag's bottom. Sleeving is used to seal the top hat to the glove bag. After the sampling event is completed the glove bag, top hat, hoist, and finger trap weight assembly are discarded as waste.

Figure 1. Finger Trap Sampler.



The finger trap sampler is lowered into a riser and allowed to pierce the soft solids layer using gravity as the motive force. Travel through the solids layer forces the fingers to open, which allows material to flow into the finger trap assembly cavity. Once travel stops, the fingers return to their closed position trapping material within the cavity.

After the finger trap is reeled into the glove bag, the finger trap assembly is removed from the weight assembly. The finger trap assembly is placed inside a plastic bag, the bag is sealed, and the sealed bag is placed inside a 500-mL sample bottle or a Teflon[1] jar. The bottle or jar is then placed in the SAFESEND[2] or Steel Pig before being placed into the shipping pig for transport to the laboratory. A new finger trap assembly is screwed onto the finger trap weight assembly and

[1] Teflon is a registered trademark of Dupont E I De Nemours and Company, Wilmington, Delaware.
[2] SAFESEND is a registered trademark of 3M Corporation, St. Paul, Minnesota.

the process is repeated until a sufficient quantity of material is retrieved in accordance with the TSAP.

Advantages of the finger trap sampler are its relative low deployment cost (requiring approximately $25K of consumables per tank sampling event), simple operation, and extensive operational history. However, the finger trap sampler is limited in the applications under which it can be deployed. A sample can only be collected from material that resides directly below a riser. The solid material must be a reasonably soft sludge. Hardpan and fine sand-like materials are difficult or impossible to sample. Also, the solids layer depth must be at least 1 ¼ in. for the fingers to open and allow waste into the finger trap cavity. Ideally, about 3 in. of solids depth is needed to fill the finger trap assembly.

The finger trap sampler is not practical for liquid sample collection. The fingers are not watertight. Some interstitial liquid will be contained within the solid, but an unreasonable number of finger traps would be needed to collect the 2,800 mL of liquid required for analysis.

A 10 ft by 10 ft space allocation free of interferences (i.e., installed surface equipment) around the access riser is needed to setup the sample table and allow operator access. The space envelope increases to 14 ft by 14 ft if operators must be on supplied air. If interferences exist, the sample table can be placed on a lightweight scaffold that creates a platform above the interferences for the sampler system and operators.

2.2 CLAMSHELL SAMPLER

The clamshell sampler consists of the clamshell and clamshell actuator (Figure 2). A pneumatic umbilical cord provides a connection between the actuator and an air compressor. A cable attached to a winch is used to lower and raise the clamshell sampler.

The clamshell sampler is contained within a glove box, which is placed above the tank access riser. A top hat provides a sealed connection between the riser and the glove box. After the sampling event is completed the clamshell is placed in a sample bottle and shipped to the laboratory where it is discarded as waste. The clamshell actuator, glove box, and other ancillary equipment can be reused in future deployments.

The clamshell sampler is lowered down a riser. As it is lowered, the clamshell is pneumatically actuated to the open position and allowed to pierce the solids layer using gravity as the motive force. After the clamshell is submerged within the solids layer it is pneumatically actuated into the closed position, trapping material within the clamshell.

Once the clamshell sampler is reeled into the glove box one of two alternate actions are performed. The first mode entails removing the clamshell from the actuator, placing a retaining clip onto the clamshell, and placing the clamshell in a Teflon jar. A new clamshell is attached to the actuator and the sampling process is repeated until a sufficient quantity of material is retrieved in accordance with the TSAP. The jars are placed in a plastic bag, the bag is sealed, and the sealed bag is placed inside the SAFESEND before being placed into the shipping pig for transport to the laboratory.

Figure 2. Clamshell Sampler.

Under the second mode, the actuator is used to open the clamshell and the collected material is manually scraped into a pre-marked sample bottle. The sampling process is repeated until a sufficient quantity of material is retrieved (i.e., collected material is at the same level as the pre-marked level on the sample bottle). Sample bottles are then placed in a plastic bag, the bag is sealed, and the sealed bag is placed inside the Steel Pig before being placed into the shipping pig for transport to the laboratory.

The clamshell sampler deployment is relatively inexpensive. Depending on the number of clamshells used, the cost of consumables for each deployment range from approximately $4,700 to $47,000. However, the number of times the clamshell sampler can be deployed is limited. Eventually the glove box interior becomes contaminated to a level where it must be

discarded and replaced with a new system. The clamshell sampler replacement cost (including glove box and ancillary equipment) is estimated at about $330K.

Like the finger trap sampler, the clamshell sampler is limited in the applications to which it can be deployed. A sample can only be collected from material that resides directly below a riser and the solids layer must be relatively soft. However, the clamshell sampler can collect material from a solids layer that is at least ¼ in. deep. Ideally, about ¾ to 1 in. of solids depth is needed to fill the clamshell.

While the clamshell sampler could be used to collect a liquid sample, such an application is not practical. The clamshell holds 67 mL of material. To collect the 2,800 mL of liquid needed for analysis, the clamshell sampler would have to be lowered into the tank at least 42 times. If the liquid contains suspended solids and the solid material is very gritty, the clamshell may have difficulty maintaining its seal to hold liquids.

An 18 ft by 18 ft space allocation free of interferences (i.e., installed surface equipment) around the riser is needed to setup the glove box and allow operator access. If interferences exist, the glove box can be placed on a medium-duty scaffold that creates a platform above the interferences for the glove box and operators.

2.3 MODIFIED CLAMSHELL SAMPLER

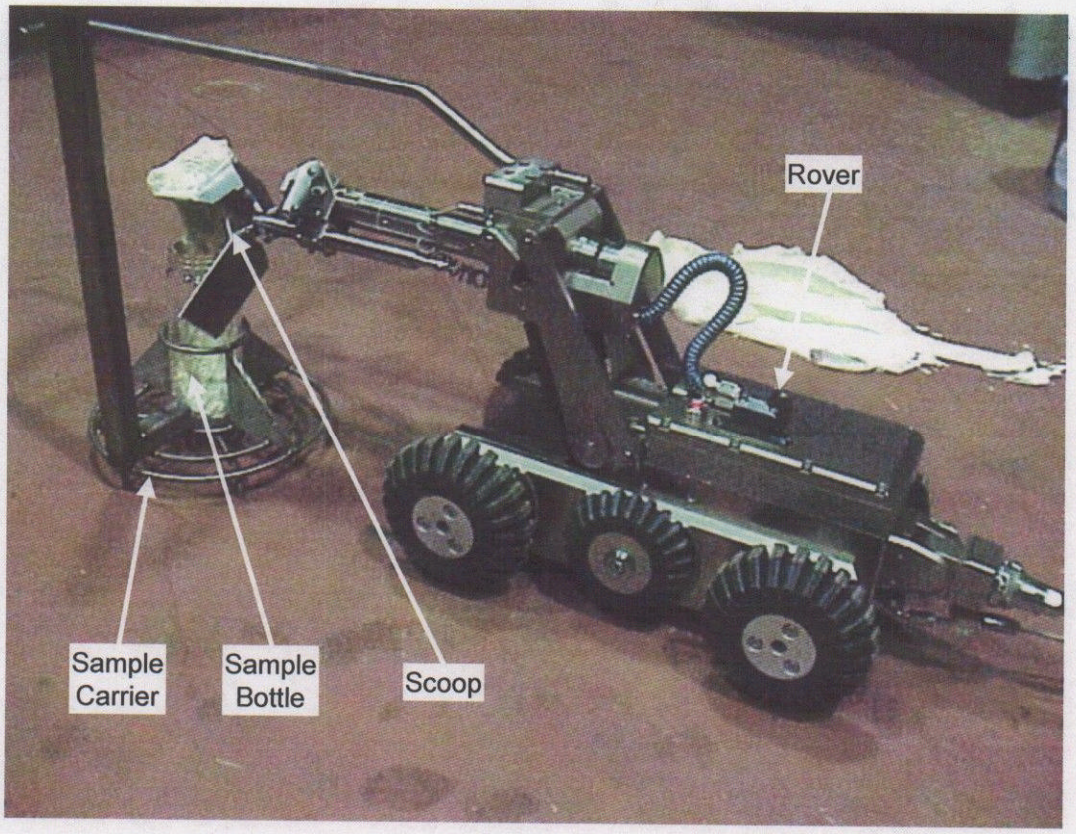
The modified clamshell sampler is identical to the clamshell sampler except the equipment is contained in a glove bag, rather than a glove box. Because the modified clamshell sampler is based on a glove bag concept, its initial procurement cost is considerably lower than the clamshell sampler ($115K versus $330K). There is no need to periodically replace the entire system because the contaminated equipment is discarded after each deployment. However, the glove bag approach precludes reuse of a larger fraction of the equipment (e.g., clamshell actuator and pulley assembly) relative to the clamshell sampler with its glove box. Therefore, a large amount of consumables are used during deployment and their estimated cost ranges from $54.2K to $96.5K, depending on the number of clamshells used.

2.4 OFF-RISER SAMPLER

The off-riser sampler is depicted in Figure 3. The off-riser sampler consists of an electrically-powered rover, fitted with a sample scoop, and sample carrier, which holds a sample bottle. An electric umbilical cord provides a connection between the rover and an external power source. A cable is attached to a winch to lower /raise the rover, and a separate cable is attached to a reel to lower/raise the carrier.

Setup for deployment involves bolting a 12-in. diameter top hat to the access riser. Given its weight and size, the rover is contained within the top hat while the top hat is affixed to the access riser. A knife valve on the bottom of the top hat prevents the rover from falling out until the umbilical cord and winch cable are attached after the glove bag is erected. Opening the knife valve allows the rover to be lowered to the tank floor once the rover is secured to the cord and cable.

Figure 3. Off-Riser Sampler.



The top hat penetrates a glove bag, which is placed on a table located above the tank access riser. Setting on top of the glove bag is the sample carrier reel, which is used to lower/raise the sample carrier. Separate from the glove bag is a containment box that houses the cable reel and winch. After the sampling event is completed, the top hat, glove bag, rover, sample carrier reel, and sample carrier are discarded as waste. The containment box and its equipment contents are potentially reusable.

The rover is lowered down through the riser to the tank floor followed by the sample carrier. Once lowered to the tank floor the rover can travel to virtually any location to collect a sample from the tank floor. After the rover travels to the desired location and collects material in its sample scoop it returns to the carrier and deposits the collected material in the sample bottle.

When sufficient material has been placed in the sample bottle the sample carrier is reeled up into the glove bag. The sample bottle is removed from the carrier, placed inside a sealed plastic bag, the sealed bag is placed inside the Steel Pig, and the Steel Pig is placed in a shipping pig for transport to the laboratory. A new sample bottle is placed in the sample carrier and the operation is repeated as necessary to collect the desired quantity of material in accordance with the TSAP.

The off-riser sampler is relatively expensive (requiring approximately $70K to $113.4K of consumables per sampling event, depending on the degree to which equipment can be reused). However, unlike the finger trap or clamshell-based samplers, the off-riser sampler is not limited to collection of material directly beneath a riser. The only substantial limitations are that a 12-in.

riser is required for tank access and solids layer depth must be at least 1 ¼ in. to allow waste into the sample scoop.

The off-riser sampler is somewhat more practical for liquid sample collection than are the clamshell-based samplers. The sample scoop holds 135 mL of material and the carrier is designed to hold a 500-mL bottle. To collect the 2,800 mL of liquid required for analysis the rover would have to make at least 21 round trips between a liquid pool and carrier. In addition, the carrier would have to be lowered and raised at least six times.

An 18 ft by 18 ft space allocation free of interferences around the riser is needed to setup the glove bag and containment box, and allow operator access. If interferences exist, the glove bag and containment box can be placed on a light-duty scaffold that creates a platform above the interferences for the sampler system and operators.

2.5 BOTTLE-ON-A-STRING SAMPLER

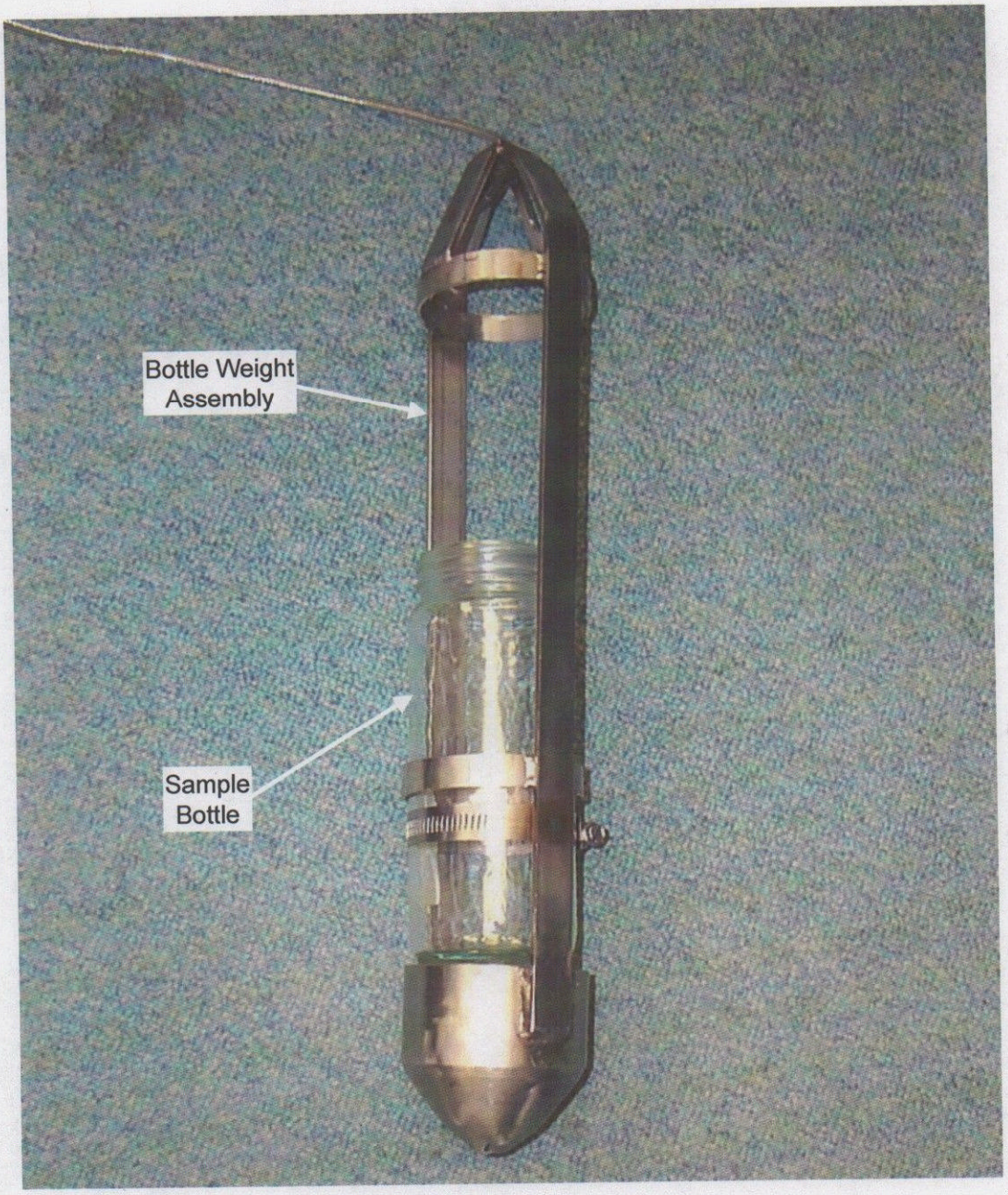
The bottle-on-a-string sampler is depicted in Figure 4. As the name implies, this sampler is a sample bottle affixed to a cable. The bottle is housed in a bottle weight assembly so that the bottle will not float on the liquid. The cable is attached to the standard bottle hoist, which is used to lower/raise the finger trap sampler.

The bottle-on-a-string sampler is contained within a glove bag, which is placed on a table located above the tank access riser. A top hat provides a sealed connection between the riser and the glove bag. After the sampling event is completed the glove bag, weight assembly, and hoist are discarded as waste. The sampler is relatively inexpensive (requiring approximately $2,500 of consumables per sampling event).

The bottle is lowered through a riser into a liquid pool located directly below the access riser. If the liquid pool does not extend out to the riser, and provided the geometry is favorable, operational experience demonstrates that sliding the bottle down a tank's dished floor may be possible.

Given that the bottle lip is 11 in. above the bottle weight assemble bottom, a 12-in. liquid depth is required to fill the bottle in the upright position. A minimum 2-in. liquid depth can be sampled by laying the bottle weight assembly on its side, allowing the bottle to be partially filled. Therefore, additional grabs are needed to collect the required 2,800 mL needed for analysis.

Figure 4. Bottle-On-A-String Sampler.



3.0 DETAILED LISTING OF SAMPLER CAPABILITIES AND LIMITATIONS

This section provides a detailed description of the capabilities and limitations associated with each sampler. The Tank Closure Project's deployment hierarchy for solid sample collection is the finger trap sampler, clamshell sampler, modified clamshell sampler, and off-riser sampler. This hierarchy is based on deployment cost, operational complexity, and waste generation. Selection progresses to the next lower sampler in the hierarchy only if that sampler provides a

required capability not available from a sampler higher in the hierarchy. Liquid sample collection is limited to the well-established bottle-on-a-string sampler, but the off-riser sampler's capabilities could be necessary in some situations.

3.1 FINGER TRAP SAMPLER

The finger trap sampler is the Tank Closure Project's baseline system for solid sampling and is the first sampler evaluated for deployment. Other samplers lower in the hierarchy are only evaluated for deployment if this sampler is deemed unacceptable for the application under consideration.

3.1.1 Capabilities

The finger trap sampler is suitable for solids sampling where the material is located directly below a riser, available for tank access, and the solids layer depth is greater than 1 ¼ in. In cases where tank retrieval is based on the articulated mast system (AMS) and the AMS can make contact with the sample cable, testing has demonstrated that the AMS can position the finger trap sampler over material located away from the riser. Use of the AMS to position the finger trap sampler will be verified during post-retrieval sampling of single-shell tank (SST) C-203. Although not demonstrated, use of the mobile retrieval system (MRS) to position material below a riser for sampling should be possible.

3.1.2 Limitations and Constraints

Operational limitations and constraints are as follows:

- Waste must be directly below the access riser or some other means (e.g., AMS) must be available to convey the sampler to an off-riser location.
- Waste depth must be greater than 1 ¼ in. before the fingers will open and allow material into the sampler. At least 3 in. of waste is required to completely fill the sample cavity.
- Waste must be soft enough to allow a 10-lb weight to penetrate it.
- Waste cannot be predominately fine particles similar to sand.
- Waste must have a low dose rate.
- Liquid samples cannot be collected.
- Minimum riser diameter is 4 in.
- In-tank camera is recommended to ensure that a sample is obtained, but a sample can be collected without a camera.
- Procedure has the finger trap sampler restricted to use in only a glove bag.

- 10-ft by 10-ft (without supplied air) or 14-ft by 14-ft (with supplied air) unobstructed space envelope is required over the riser.
- Type of scaffolding is not restricted (light- or medium-weight scaffold is acceptable).
- Sampling equipment can be manually lifted into position above the riser (a crane is not required).
- Weight associated with this sampling activity is below the 5,000-lb limit, there are no dome-load issues, and dome load tracking is not required when using the finger trap sampler.
- Finger trap assemblies can be either placed inside a glass bottle or Teflon jar, placed in either a Steel Pig (for maximum shielding) or SAFESEND (for minimum shielding), and Shipping Pig containers for shipment to the laboratory.
- Removal of finger trap assembly from the weight assembly results in the maximum extremity dose to the hands.
- Weight of sample sent to laboratory must rely on an imprecise visual estimate of the quantity of material in the sample bottle during its removal from the weight assembly.
- Sampler procurement involves shop fabrication, which results in an extended delivery period and updates to H-2 drawings due to welding issues.
- Parts can be ordered to include finger trap and weight assemblies, or just the finger trap assembly.
- Finger trap sampler requires the standard bottle hoist assembly. The cylinder and handle are shop fabrication items, and the remaining parts are off-the-shelf items. Off-the-shelf items are ordered using the Bill of Material. Millwrights are required for installation.
- The bottle hoist assembly is identical to that used for liquid sampling with the bottle-on-a-string sampler. Control of spare hoist is limited and inventory of this item must be tracked very closely.
- Spare glove bags are maintained by the Field Sampling group.

3.2 CLAMSHELL SAMPLER

The clamshell sampler is the next solids sampler evaluated for deployment.

3.2.1 Capabilities

The primary competitive advantage the clamshell sampler has over the finger trap sampler is that it can collect a sample from a solids layer that is at least ¼ in. deep. However, like the finger trap sampler this sampler is generally limited to solids sampling where the material is located

directly below a riser available for tank access. In the special case where tank retrieval is based on the AMS, it may be possible for the AMS to position the clamshell sampler over material located away from the riser. However, this use of the AMS has not been demonstrated. In addition, the MRS should be able to position material below a riser for sampling, but this capability has yet to be demonstrated.

3.2.2 Limitations and Constraints

The following identifies operational limitations and constraints.

- Waste must be located directly below the access riser or some other means (e.g., AMS) must be available to convey the sampler to an off-riser location.
- Waste depth must be greater than ¼ in. before sufficient material will be captured inside the clamshell.
- Waste must have low dose rate, but exposure can be controlled better than when a finger trap sampler is used.
- Liquid sample collection is possible provided a tight seal can be obtained when the clamshell closes. This will be strongly influenced by the physical properties of the material being sampled.
- If waste contains particle similar to gravel, the sampler may not fully close and this would create potential contamination concerns.
- Minimum riser diameter is 4 in.
- The tank cannot be accessed through a sludge measurement port cap (3-in. internal diameter pipe section). The sludge measurement port cap section must be removed from the riser flange.
- Use of an in-tank camera is recommended to ensure that a sample is obtained, but a sample can be collected without a camera.
- Procedure has the clamshell sampler restricted to use in only the glove box.
- An approximate 16-ft by 16-ft (without supplied air) or 20-ft by 20-ft (with supplied air) unobstructed space envelope is required over the riser.
- Given that the glove box weight is about 4000 lb, a medium-weight scaffold is required if a raised sampling platform must be created above obstructions.
- Crane, forklift, or both may be required to position the glove box into sampling position over riser.

- Dome-load issues may be encountered given the sampling equipment's (e.g., glove box) weight and potentially the weight of a scaffold. Dome load tracking may be required in the work package.
- If samples are shipped in clamshells, sample quantity and physical properties (color, type, etc.) are unknown.
- If samples are transferred from the clamshell to a sample bottle, visual estimates of the sample quantity collected and its physical properties are possible. Visual estimate of the sample quantity can be enhanced by using a glass bottle with a mark made to the bottle's exterior that corresponds to amount (grams) of required material.
- If clamshells are shipped, use of a Teflon jar in SAFESEND and Shipping Pig provides limited shielding capabilities. Maximize shielding during shipment is provided by using a 485-mL jar the Steel Pig and Shipping Pig.
- If samples are transferred from clamshells into a sample bottle, use of glass bottle in Steel Pig and Shipping Pig maximizes shielding during shipment.
- Clamshell order includes one funnel and scrapper per clamshell.
- All sampler equipment is commercially available (ordered by part number) and shop fabrication is not required.
- The hoist system is not designed to be repaired in place. If any facet of the hoist system requires repairs or the umbilical cord must be replaced, the entire hoist system must be replaced. Hoist system repairs will, therefore, be labor intense.

3.3 MODIFIED CLAMSHELL SAMPLER

Once the modified clamshell sampler is ready for deployment, it will be the next solid sampler evaluated for use.

3.3.1 Capabilities

The modified clamshell sampler has no intrinsic sampling capabilities beyond those intrinsic to the clamshell sampler. However, the lower sampler weight may yield operational benefits relative to ease and speed of setup.

3.3.2 Limitations and Constraints

The following identifies tentative operational limitations and constraints. This information will be confirmed and finalized after the modified clamshell sampler is fully developed.

- Waste must be located directly below the access riser or some other means (e.g., AMS) must be available to convey the sampler to an off-riser location.

- Waste depth must be greater than ¼ in. before sufficient material will be captured inside the clamshell.
- Waste must have low dose rate, but exposure can be controlled better than when a finger trap sampler is used.
- Liquid sample collection is possible provided a tight seal can be obtained when the clamshell closes. This will be strongly influenced by the physical properties of the material being sampled.
- If waste contains particles similar to gravel, the sampler may not fully close and this would create potential contamination concerns.
- Minimum riser diameter is 4 in.
- The tank cannot be accessed through a sludge measurement port cap (3-in. internal diameter pipe section). The sludge measurement port cap section must be removed from the riser flange.
- Use of an in-tank camera is recommended to ensure that a sample is obtained, but a sample can be collected without a camera.
- An approximate 10-ft by 10-ft (without supplied air) or 14-ft by 14-ft (with supplied air) unobstructed space envelope is required over the riser.
- Sampler is not restricted on type of scaffolding that can be use (light- or medium-weight scaffold is acceptable).
- All sampling equipment can be manually lifted into position above the riser (a crane is not required).
- The equipment weight is below the 5,000-lb limit. Therefore, there are no dome load issues to address and dome load tracking is not required when using the modified clamshell sampler.
- If samples are shipped in clamshells, sample quantity and physical properties (color, type, etc.) are unknown.
- If samples are transferred from the clamshell to a sample bottle, visual estimates of the sample quantity collected and its physical properties are possible. Visual estimate of the sample quantity can be enhanced by using a glass bottle with a mark made to the bottle's exterior that corresponds to amount (grams) of required material.
- If clamshells are shipped, use of a Teflon jar in SAFESEND and Shipping Pig provides limited shielding capabilities. Maximize shielding during shipment is provided by using a 485-mL jar the Steel Pig and Shipping Pig.

- If samples are transferred from clamshells into a sample bottle, use of glass bottle in Steel Pig and Shipping Pig maximizes shielding during shipment.
- Clamshell order includes one funnel and scrapper per clamshell.
- All sampler equipment is commercially available (ordered by part number) and shop fabrication is not required.
- Spare glove bags are maintained by the Field Sampling group.

3.4 OFF-RISER SAMPLER

Once the off-riser sampler is ready for deployment, it will be the last solids sampler evaluated for use given its high deployment cost. Also, this sampler could be used to collect a liquid sample, although it would only be selected if there were no possibility of reaching the liquid pool with the bottle-on-a-string sampler.

3.4.1 Capabilities

The off-riser sampler has the ability to travel to virtually any unobstructed location inside the tank and collect a sample off the tank floor.

3.4.2 Limitations and Constraints

The following identifies tentative operational limitations and constraints. This information will be confirmed and finalized after the off-riser sampler is fully developed.

- Waste depth must be ¼ in. before material will be captured inside the sample scoop.
- This sampler cannot be used to collect a hardpan material (i.e., salt lick).
- Waste must have low dose rate, but exposure can be controlled better than when a finger trap sampler is used.
- Liquid sample collection is possible provided the rover can be position near a suitable liquid pool.
- Minimum riser diameter is 12 in. However, sampler set-up requires only one riser to satisfy the DQO requirements because samples can be collected from multiple locations within the tank.
- Use of an in-tank camera is required to position the rover, ensure that a sample is obtained, and guide the transfer of material from the sample scoop to the sample bottle located in the carrier.

- An 18-ft by 18-ft (without supplied air) or 20-ft by 20-ft (with supplied air) unobstructed space envelope is required over the riser.
- Sampler is not restricted on type of scaffolding that can be use (light- or medium-weight scaffold is acceptable).
- Crane, forklift, or both may be required to position sampling equipment over the access riser.
- There are no dome-load issues in using the off-riser sampler.
- Visual estimates of the sample quantity collected and its physical properties are possible. Visual estimate of the sample quantity can be enhanced by using a glass bottle with a mark made to the bottle's exterior that corresponds to amount (grams) of required material.
- Use of glass bottle in Steel Pig and Shipping Pig containers maximizes shielding during shipment.
- All sampler equipment is commercially available (ordered by part number) and shop fabrication is not required.
- Spare glove bags are maintained by the Field Sampling group.

3.5 BOTTLE-ON-A-STRING SAMPLER

The bottle-on-a-string sampler is the Tank Closure Project's baseline system for liquid sampling and is the first sampler evaluated for deployment. Solids samplers are only evaluated for liquid sampling deployment if this sampler is deemed unacceptable for the application under consideration.

3.5.1 Capabilities

The bottle-on-a-string sampler is suitable for liquid sampling where the material is located directly below a riser available for tank access and is at least 2 in. deep. Under some circumstances the bottle can be caused to slide down a tank's dished bottom into a liquid pool away from the riser.

3.5.2 Limitations and Constraints

The following identifies operational limitations and constraints.

- Generally, waste must be directly below riser.

- Waste depth must be greater than 2 in. before liquid will flow into the bottle in a horizontal position (bottle will not be full). A liquid depth of over 12 in. is required to fully fill the bottle in the upright position.
- Solid samples cannot be obtained, but collection of suspended solids is possible.
- Minimum riser diameter is 3 in. In some instances sampling can be accomplished through a 2 ½-in diameter riser.
- Use of an in-tank camera is recommended to ensure that a sample is obtained, but a sample can be collected without a camera.
- Procedure has bottle-on-a-string sampler restricted to use in only the glove bag.
- A 10-ft by 10-ft (without supplied air) or 14-ft by 14-ft (with supplied air) unobstructed space envelope is required over the riser.
- Sampler is not restricted on type of scaffolding that can be use (light- or medium-weight scaffold is acceptable).
- All sampling equipment can be manually lifted into position above the riser (a crane is not required).
- The equipment weight is below the 5,000-lb limit. There are no dome-load issues and dome tracking is not required when using the bottle-on-a-string sampler.
- Bottle-on-a-string sampler requires the standard hoist assembly. The cylinder and handle are shop fabrication items and the remaining parts are off-the-shelf items. Off-the-shelf items are ordered using the Bill of Material. Millwrights are required for installation.
- Control of spare hoist is limited and inventory of this item must be tracked very closely.
- Spare glove bags are maintained by the Field Sampling group.

4.0 ACCESS RISER SELECTION

The riser available for tank access is a key factor that drives sampler selection. The most preferred access riser is one that is free of installed equipment, and is located directly above a 3-in. deep solid layer for solids sampling or 12-in. deep liquid pool for liquid sampling. However, this ideal situation will be a rare condition for post-retrieval closure sampling.

If an equipment-free riser is not located directly above a sufficient quantity of material, riser equipment removal is required or the off-riser sampler must be deployed. In most instances access riser selection will be based a cost and operational-complexity trade off between that associated with a given sampler's deployment and that associated with clearing a riser of

installed equipment for access. The following identifies the preferred hierarchy for riser equipment removal.

- In-tank video camera
- ENRAF[3] or manual tape level indicator
- Vapor tube
- Remote water distribution device
- Liquid observation well
- Stilling well
- Pump.

5.0 SUMMARY

The Table 1 summarizes the main characteristics of each sampler. For solid sample collection the hierarchy of deployment is finger trap sampler, clamshell sampler, modified clamshell sampler, and off-riser sampler. This hierarchy is based on deployment cost, operational complexity, and waste generation. Selection of a sampler proceeds to the next lower in the hierarchy only if that sampler provides a required capability not available from a sampler higher in the hierarchy. Liquid sample collection is primarily limited to the well established bottle-on-a-string sampler, although the off-riser sampler could be selected if necessary.

Table 1. Sampler Characteristics and Deployment Hierarchy. (2 sheets)

Sampler	Key Attributes	Key Limitations
Solids Sampling		
Finger trap	• Low deployment cost (~ $25K in consumables) • Extensive deployment history • Relatively simple setup and operation • Potentially can be deployed to an off-riser location in tanks outfitted with an Articulated Mast System (AMS)	• Requires a greater than 1 ¼ in. deep solids layer located directly beneath an available access riser • Minimum 4 in. diameter riser required
Clamshell	• Low to moderate deployment cost (~ $5K to $50K in consumables) • Entire system requires periodic replacement at an estimated cost of $330K • Moderate deployment history • Potentially can be deployed to an off-riser location in tanks outfitted with an AMS	• Requires a greater than ¼ in. deep solids layer located directly beneath an available access riser • Minimum 4-in. diameter riser required • Size and weight factors complicate setup

[3] ENRAF is a registered trademark of Enraf-Nonius, N.V. Verenigde Instrumentenfabrieken, Enraf-Nonius Corporation Netherlands, Rontegenweg 1, Delft, Netherlands.

Table 1. Sampler Characteristics and Deployment Hierarchy. (2 sheets)

Sampler	Key Attributes	Key Limitations
Modified clamshell	• Moderate deployment cost (~ $55K in consumables) • Relatively simple setup and operation • Potentially can be deployed to an off-riser location in tanks outfitted with an AMS	• Requires a greater than ¼ in. deep solids layer located directly beneath an available access riser • Minimum 4-in. diameter riser required
Off-riser	• High deployment cost ($70K to $115K in consumables) • Can collect solids sample from virtually any location on the tank floor	• Greater than 1 ¼ in. deep solids layer required • Minimum 12-in. diameter riser required
Liquid Sampling		
Bottle-on-a-string	• Low deployment cost (~ $2K in consumables) • Relatively simple setup and operation • with favorable tank geometry can potentially be deployed to an off-riser location	• Requires a greater than 2-in. deep liquid pool located directly beneath an available access riser • Minimum 3-in. diameter riser required
Clamshell	• Low deployment cost (~ $5K in consumables) • Entire system requires periodic replacement at an estimated cost of $330K	• Requires a greater than ¼ in. deep liquid pool located directly beneath an available access riser • Depending on the amount and properties of suspended solids, the clamshell may not be able to maintain a liquid seal • A large number of grabs may be necessary to obtain a sufficient quantity of material • Minimum 4-in. diameter riser required • Size and weight factors complicate setup
Modified clamshell	• Moderate deployment cost (~ $55K in consumables) • Relatively simple setup and operation	• Requires a greater than ¼ in. deep liquid pool located directly beneath an available access riser • Depending on the amount and properties of suspended solids, the clamshell may not be able to maintain a liquid seal • A large number of grabs may be necessary to a sufficient quantity of material • Minimum 4-in. diameter riser required
Off-riser	• High deployment cost ($70K to $115K in consumables) • Can collect liquid sample from virtually any location on the tank floor where a sufficient pool of material resides	• Greater than 1 ¼ in. deep liquid pool is required • Minimum 12-in. diameter riser required

6.0 REFERENCE

RPP-23404, *Single-Shell Tank Component Closure Data Quality Objective*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.