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Project Title/Work Order SAMPLER BIAS - PHASE I		EDT No. 611608
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2	1	Cog.Eng. J. L. SMALLEY	<i>J. L. Smalley</i>	3/7/95	R1-17	DW Hamilton	<i>DW Hamilton</i>	3/7/95	S7-15	2	1
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7. Abstract <p>This documents Phase I determinations on sampler induced bias for four sampler types used in tank characterization. Each sampler i.e., grab sampler or "bottle-on-a-string", auger sampler, sludge sampler and universal sampler is briefly discussed and their physical limits noted.</p> <p>Phase II of this document will define additional testing and analysis to further define "Sampler Bias".</p>		
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SAMPLER BIAS - PHASE I

Supporting Document
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SAMPLER BIAS - PHASE I

This documents Phase I determinations on sampler induced bias for four sampler types used in tank characterization. Each sampler i.e., grab sampler or "bottle-on-a-string", auger sampler, sludge sampler and universal sampler is briefly discussed and their physical limits noted.

Phase II of this document will define additional testing and analysis to further define "Sampler Bias".

Currently, there are four basic samplers (excluding the vapor samples) used to retrieve samples from the waste tanks at Hanford. The types of samplers are described below.

Grab Sampler or "Bottle-on-a-String": The grab sampler is the easiest method of obtaining samples from the tanks. The system is comprised of a bottle, stopper, weight and wire rope. There are two types of bottles used; a wide mouth (125ml) bottle for sampling low viscosity sludges and a narrow mouth (120ml) bottle for liquids. The bottle is lowered into the waste media where the sample is taken. This sampling method can obtain samples within 5 inches (sometimes lower if the bottle is laid on it's side) of the bottom of the tank, however, it is limited to liquid and low viscosity sludges. Recovery percentages in liquids and low viscosity sludges is 100%. Additional bias considerations are; it is important to understand that material collected from a single elevation (Plane) is not representative or to be considered a profile. Material collected in the bottle may be contaminated by material from adjacent elevations due to the movement of the sampler when the stopper or cork is removed. The material collected in the sample bottle may be contaminated by material from higher elevations as the sampler is raised (without the stopper) to the surface. Samples collected are not currently temperature controlled (except for freeze protection) after removal from the tank. Sample content may be mixed or agitated during transit to the laboratory for analysis. The sample bottle will be contaminated by air from the bottle and the vapor in the tank as the sampler is moved through the space on the way out of the tank. Gases generated by or associated with the waste are free to escape from the sample before the sample is capped (after removal from the tank). Solids/liquids mixtures may not be accurately represented as material with less viscosity will more easily enter and fill the bottle. Typical costs for grab sampling is \$40K.

Auger Sampler: The auger sampler is a manually operated system that is used to obtain solid waste samples from the tanks. It was originally designed specifically to take a 10 gram (minimum) sample from the top surface of the waste; however, it has been used successfully to obtain deeper samples from the tanks. There are currently two different sizes of auger sampler, 10 inches and 20 inches. The effective waste profile in which the auger sampler can be used is limited by the longer sampler, approximately 20 inches. The maximum capacity for either auger is approximately 30 cc/in of depth with expected recovery of a maximum of 20 cc/in.

This recovery is based on how the lab manually scrapes the samplers off in the hot cell which leaves a portion of the sample on the auger bit as well as inside the auger sheath. Due to the inherent design and operation of the auger sampler, low viscosity materials can not be recovered; therefore, this sampler is only used to obtain salt cake and dense sludge samples.

Other limitations include the potential to alter the sample's physical characteristics and moisture content. The sampler is designed to penetrate hard materials by cutting and grinding as it is lowered into the waste material. This makes it impossible to recover a physically undisturbed sample with the auger sampler. The sampler is also not sealed until it is raised out of the tank and transferred into the shipping cask. Not only does this take up to an hour, but the sample to void volume ratio in the cask may be greater than ten; both may adversely effect the moisture content of the sample. Typical costs for auger sampling is \$75K.

Reference: Work Plan for Surface Sampler, WHC-SD-WM-WP-076, and Plant Operator Procedure T0-080-008.

Sludge Sampler: This sampler is a modified universal sampler that is used in push mode core sampling. The sampler is loaded into the drill string and the drill string pushed into the waste using a Longyear drill rig. For this type of sampling a complete profile of the tank waste is taken in 19 inch segments. The maximum volume of this sampler is 300 ml in a 19 inch segment and is limited to liquid and sludge samples. This sampling method can obtain samples within 1.5 inches of the bottom of the tank. Sampled media are limited to materials that can be pushed through with recovery percentages usually in excess of 90%. Typical costs for a complete push mode core is \$220K.

Reference: Functional Requirements for High Level Waste Sampler Positive Closure and Sample Actuator System, RHO-CP-1412.

Universal Sampler: The universal sampler was designed to obtain salt cake, sludge and liquid samples from the waste tanks. It is used in both push and rotary mode core sampling. The sampler is loaded into the drill string and the drill string is either pushed or rotated through the waste using a Longyear drill rig. For this type of sampling a complete profile of tank waste is taken in 19 inch segments. The maximum volume for this sampler is 300 ml for liquids and sludges or 245 ml for salt cake samples. This sampling method can obtain samples within 3 inches of the bottom of the tank. Testing has shown recovery percentages in excess of 90% for liquids, sludges, and hard salt cake simulants. Typical cost for a complete rotary mode core is \$380K.

Reference: Rotary Mode Core Sampling Development Test Report, WHC-SD-WM-TRP-076.

Acceptance Test Report for Rotary Mode Core Sample Truck, WHC-SD-WM-ATR-048.

Other Bias/Errors Pertaining to the "Sludge" and "Universal" Samplers are;

Smearing

Due to the nature of the sampler designs, the material at the top of the sample travels up through the bottom of the sampler and can possibly smear on the bottom of the sample tube and then attach itself to the lower portion of the sample.

Head Fluid

The head fluid used to keep the waste out of the bit and drill string when the sampler is removed can change the waste properties at the top of each segment. Both nitrogen gas and water are used as head fluids. Nitrogen gas can dry out the sample and water can dilute the sample.

A chemical tracer, LiBr, is used to determine the amount of sample dilution when water is used as a head fluid, allowing bias to be quantified.

Hard Material over Soft Material

The rotary bit in push mode moves the material in contact with the bit face to the sides and allows the material in the bit opening to enter the sampler. When the material below is softer than the material above, the material can be pushed down, taking the potential sample with it. This has been demonstrated in testing. This situation does not appear to be a problem with the 60 degree push mode bit because it effectively pushes material in a lateral direction rather than downward.

The rotary bit in rotary mode (without purge) mechanically moves the material in contact with the bit face out of the way (to the sides) and allows the material in the bit opening to enter the sampler. During transition from the hard layer to a much softer layer, a piece of hard material can break off and block the drill bit opening. This results in poor recovery during the portion of the segment when blockage occurs.

Also during rotary mode, nitrogen purge gas is released through holes in the drill bit to provide drill bit cooling. When a liquid sample is being taken in rotary mode (as would be the case during a hard to soft transition), the sample can be contaminated by the capture of purge gas.

Gap Between Valve and End of Sampler

After the valve has been closed on the sampler, the bit is raised about an inch and a half. The material below the valve is supposed to stay in place (relative to waste) so it will not be sticking up when the next sampler is inserted. If it stays with the sampler, the next sample could come up short and if it falls out or remains in place relative to the bit, it will be squeezed flat when the next sampler is inserted or may prevent the sampler from being fully lowered into the bit.

Handling and Sampling Containers

These are factors which could impact sample representation for all types of samples:

- Sample container material
- Environmental conditions (temperature, pressure, humidity)
- Sample Preservation (when possible)
- Etc.

Field/Trip blanks allows bias to be determined.