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7. Abstract

This document describes the Test Procedure for studying the feasibility of the prototype core sampler.

8.

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Table of Contents

1.0	INTRODUCTION / PURPOSE	2
2.0	GENERAL TEST INFORMATION AND REQUIREMENTS	2
2.1	Concord Sampler Description	2
2.2	Test Facility	2
2.3	Simulant	2
2.4	Measurement and Test Equipment	3
3.0	TEST DESCRIPTION	3
3.1	Required Test Data	3
4.0	RESULTS	4
	APPENDIX A	5

TEST PROCEDURE PROTOTYPE CORE SAMPLER

1.0 INTRODUCTION / PURPOSE

The purpose of this test is to attempt to determine the adequacy of the prototype Sampler, provided to us by DOE-RL. The sampler was fabricated for DOE-RL by the CONCORD Company by request of DOE-RL. Recovery tests will be performed with this sampler in three different consistencies of kaolin sludge simulants. A minimum of six tests will be done in each of the simulants.

2.0 GENERAL TEST INFORMATION AND REQUIREMENTS

2.1 Concord Sampler Description

The sampler is a hollow steel sampling tube with a tapered nose and a retractable point. The point is sealed against the inside wall of the sampler by two O-rings, which keep the waste material from entering the sampler prematurely. When the point is retracted, the biggest O-ring assists in collecting the sample by producing a slight negative pressure within the sampler tube. The sampler can be operated by hand. The concept is similar to, but simpler than, the present WHC rotary valve sampler in that a solid core is recovered and an O-ring piston is used to provide a negative internal pressure to assist sample recovery.

2.2 Test Facility

The test facility will be located in the Chemical Engineering Laboratory, 2703-E Building/200 East. The test will be performed in three 55-gallon drums each filled with a kaolin sludge of a different consistency. The drums will contain an approximate depth of 33 inches of sludge. The prototype Concord sampler will attempt to collect 19-inch samples at two distinct depths. No waste tank simulation with full length or any length of the auger shroud equipment will be attempted in this test. A simple locating and clamping tool will be made to facilitate the sampling.

2.3 Simulant

Three kaolin-based simulants with moisture contents of approximately 33%, 35% and 45%, representing a range of the anticipated waste sludge will be used. Appendix A presents the reasoning behind these simulant mixtures. The simulants will be packaged in 55 gallon sealed drums with a simulant depth of 33 inches. At approximately every 9 to 10 inches the simulant will have a colored layer of approximately 1 to 2 inches. This is done to qualitatively evaluate the sampler's ability to collect a discrete sample at a specified depth and to visually identify if any smearing occurs during sampling and extrusion.

The simulant is comprised of non-hazardous materials that are physically, but not chemically or radiologically, representative of the expected tank waste sludge. After testing is complete, all used and unused simulant will be disposed of in accordance with state and federal regulations.

2.4 Measurement and Test Equipment

The following equipment is anticipated for use during this testing:

- Prototype core sampler;
- Three drums of kaolin simulant;
- Accessory equipment to hold sampler into position above and in waste;
- Calibrated weight scale - minimum range 0 to 1200 grams, ± 1 gram;
- Standard graduated measuring glass with a volume of 1000 cubic centimeters (cc), and a minimum graduation of 10 cc;
- Measuring tape;
- Extrusion tray.

3.0 TEST DESCRIPTION

The prototype core sampler will be used. The stroke of the sampler is approximately 19 inches. The maximum volume of the sampler measured by filling the sampler with water is 230 cc. However, a solid core 19 inches long with a diameter equal to that of the sampler's cutting shoe opening is only 165 cc. Three samples from each simulant will be taken from the top of the sludge, and another three samples will start about 10 inches from the top of the sludge (see Figure 1 and Figure 2). After retrieval of the sampler, the recovered sludge will be extruded into a tray and the length of the sample measured and recorded. The position and appearance of the colored rings will also be documented. The weight of the tray should be pre-recorded and with each sample the tray and sample together will be weighed and combined weight recorded. After this step the sample will be put in a 1000 cc measuring glass filled with approximately 500 to 700 cc of water, and the increased volume will be recorded. The net volume will be the volume of the extracted waste simulant. The test will be done by hand, assisted by a stand to help stabilize and set the sampler during testing (see Figure 3).

All test data and variations or modifications to this test will be recorded on the attached data sheets.

3.1 Required Test Data

- Verify and record calibration of the weight scale;
- Record the simulant depth in the 55 gallon drum and the approximate depths of the colored bands;
- Record the starting point of sampling operation and record the length of the stroke;
- Record the length of the sample and the location of the colored simulant rings;
- Record weight of the empty tray and the weight of the tray with the sample;
- Record the amount of water in the 1000 cc measuring glass and the total volume after the sample is put into the measuring glass;
- At the time of the test, collect a sample of the simulant of approximately 500 cc from each of the 55-gallon drums for analysis of specific weight, moisture content and shear strength of the simulant.
- Record any observations during testing (ie: gaps in sample upon extrusion, point at which the collected sample broke off from the waste below, etc.).

4.0 RESULTS

Results of this testing will be documented in written form, including all results (with completed data sheets) and conclusions as to the viability of the prototype core sampler.

APPENDIX A

Simulant Selection for Testing Prototype Core Sampler

Selection of simulant for testing the prototype core sampler should evaluate the following parameters:

1. Shear strength - a measure of the ability of the simulant to be "cut" by the leading edge of the sampler (the cutting shoe). The lower the shear strength, the easier it is to push the sampler into the simulant. This impacts the sampler's ability to collect a sample without bridging the cutting shoe.
2. Tensile strength - a measure closely related to the cohesiveness of the simulant. The lower the tensile strength, the more likely the sample will slide out the bottom when removed from the waste. For the purposes of sample recovery, vertical extrusion tensile strength directly correlates with the sampler's ability to retain a collected sample.

Shear strength appears to be simulated quite readily by either kaolin or bentonite clay and water mixes. Simulants with shear strengths between 2 and 80 kilodynes per square centimeter (kdyne/cm^2) are achievable using 55% and 69% kaolin (by weight) and water mixtures, respectively. These shear strengths represent the fluid and plastic limits of a kaolin/water mixture. The fluid and plastic limits of a bentonite/water mixture are at 16% and 32% bentonite by weight, and correspond with shear strengths of 2 and 65 kdynes/cm^2 , respectively (Daymo, et al, 1994). PNL estimates (M. Powell, personal communication) of shear strengths of sludges recovered from prior sampling of the tanks themselves range from 2 to 50 kdynes/cm^2 . Therefore, either clay could likely be used to simulate the shear strength of the waste in the Hanford tanks.

Unfortunately, very little work has been done to evaluate simulants for tensile strength of the waste tank sludges. However, it has been theorized (Powell, 1994) that for cohesive materials, such as the sludges from the Hanford waste tanks, there is a single linear relationship between shear strength and vertical extrusion tensile strength, despite differences in composition of the simulant. Therefore, when shear strengths are low, tensile strengths will also be low. This may also be true of actual tank sludges, but has not been tested. The relationship identified in the Powell study was 1.7/1 vertical extrusion tensile strength/shear strength. Given the clay mixtures described above, sludges with tensile strengths as low as 3.4 kdynes/cm^2 should therefore be simulated by the above mixtures. This should enable testing of the prototype core sampler in simulants with very low tensile strengths, where recovery can be lost. Sludges with high vertical extrusion tensile strengths may also present a problem for recovery. Sludge from within the sampler may be "pulled out" upon removal of the sampler from the waste, if the break between the collected sample and the media directly below it does not occur at the level even with the cutting shoe of the sampler. Powell's work theorizes that the 1.7/1 ratio of vertical extrusion tensile

strength/shear strength relationship should hold true for tank sludges as well as simulants. While this has not been tested, it is likely that both clay simulants will provide a reasonable approximation of tank sludge vertical extrusion tensile strength.

The choice of simulants to be used therefore is not effected by shear or tensile strength. While kaolin can provide a stiffer simulant, both kaolin and bentonite appear to have a broader range of shear strengths than those observed in the tank sludges. As discussed above, tensile strength is assumed to be approximated by both simulants equally well. It therefore should not matter greatly which simulant is used for this study.

Since shear and tensile strengths are equally simulated by the two clays, the decision to use one over the other is based on a comparability of results to other sampler studies. Previous Westinghouse studies have used kaolin-based simulants to evaluate the effectiveness of various push mode bits. Kaolin clays will therefore be used to remain consistent with these previous studies.

The kaolin mixes proposed are 55% by weight, 65% by weight, and 67% by weight kaolin with water. These correspond with anticipated shear strengths of 2, 23, and 50 kdynes/cm², respectively (the shear strength of kaolin clay increases exponentially as moisture content decreases, accounting for the large increase in shear strength between the 65% and 67% kaolin clays). This should roughly correlate with the range of shear strengths of the tank sludges themselves.

SKETCH PROTOTYPE

FULL TOP STROKE

Figure 1

FULL MID STROKE

Figure 2

TEST STAND
Figure 3

DATA SHEET #1

DATE:	WEIGHT TRAY+SAMPLE	WEIGHT TRAY	NET WEIGHT SLUDGE	LENGTH SAMPLE	DISTANCE BETWEEN BANDS	VOLUME WATER+SLUDGE
10-26-94	in GRAMS	in GRAMS	in GRAMS	in cm	in cm	in cc
DRUM #1						
SAMPLE #1					#1	
Start at 0					#2	
in. insert.					#3	
					#4	
SAMPLE #2					#1	
At 0 in.					#2	
insertion					#3	
					#4	
SAMPLE #3					#1	
At 0 in.					#2	
insertion					#3	
					#4	
DRUM #1						
SAMPLE #1					#1	
At 10 in.					#2	
insertion					#3	
					#4	
SAMPLE #2					#1	
At 10 in.					#2	
insertion					#3	
					#4	
SAMPLE #3					#1	
At 10 in.					#2	
insertion					#3	
					#4	
DRUM #2						
SAMPLE #1					#1	
At 0 in.					#2	
insertion					#3	
					#4	
SAMPLE #2					#1	
At 0 in.					#2	
insertion					#3	
					#4	
SAMPLE #3					#1	
At 0 in.					#2	
insertion					#3	
					#4	

[illegible]

DATA SHEET #2

DATE:	WEIGHT TRAY+SAMPLE in GRAMS	WEIGHT TRAY in GRAMS	NET WEIGHT SLUDGE in GRAMS	LENGTH SAMPLE in cm	DISTANCE BETWEEN BANDS in cm	VOLUME WATER+SLUDGE in cc	VOL WA in
10-26-94							
DRUM #2					#1		
SAMPLE #1					#2		
Start at 10					#3		
in. insert.					#4		
SAMPLE #2					#1		
At 10 in.					#2		
insertion					#3		
					#4		
SAMPLE #3					#1		
At 10 in.					#2		
insertion					#3		
					#4		
DRUM #3					#1		
SAMPLE #1					#2		
At 0 in.					#3		
insertion					#4		
SAMPLE #2					#1		
At 0 in.					#2		
insertion					#3		
					#4		
SAMPLE #3					#1		
At 0 in.					#2		
insertion					#3		
					#4		
DRUM #3					#1		
SAMPLE #1					#2		
At 10 in.					#3		
insertion					#4		
SAMPLE #2					#1		
At 10 in.					#2		
insertion					#3		
					#4		
SAMPLE #3					#1		
At 10 in.					#2		
insertion					#3		
					#4		

Range: A1:V61

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