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SRR-CES-2012-00031, Rev. 0

April 13, 2012

TO: P. E. Carroll, 704-71F

FROM: R. O. Voegtlen, 704-71F

Title: Summary Report of the Equipment Grout Mock Up Test

Summary:
This report documents the results of the equipment grout mock up test conducted per requirements of M-TPL-F-00013 "Equipment Grout Mock-Up Test Plan" (See reference [1]). The test confirmed field manufactured equipment fill grout met required properties and successfully filled a mock-up model with grout.

Background:
The F-Tank Farm (FTF) Tanks 18 and 19 are ready to be permanently closed. These tanks will be filled with grout for the purpose of chemically stabilizing residual material, filling the tank void space, and discouraging future intrusion. Equipment such as the Advanced Design Mixer Pump (ADMP), transfer pumps/jet, standard slurry pumps, equipment-support masts, sampling masts, dip tube assemblies, and robotic crawlers remains in the tanks. The expectation is that grouting the equipment in place will result in less worker exposure and expense than removing the equipment for disposal. The Tank 18 and 19 closure strategy is to grout the equipment in place and eliminate vertical pathways by filling the voids in the equipment to the maximum extent practical.

To accomplish the grouting of equipment to the maximum extent practical, Savannah River National Laboratory (SRNL) performed a study (See reference [2]) which identified the ADMP as the most limiting equipment configuration, identified qualifying grout properties for minimizing voids and vertical fast paths, and performed an ADMP mock-up fill test. Because the test was performed in the SRNL lab the size of the mock-up was limited. As a result, a scale-up of this test was recommended which would utilize the field produced grout filling a mock-up model of the most limiting equipment configuration – the ADMP.

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Objectives:

The test had two objectives, first to verify field formulated grout properties and second to field demonstrate equipment grout fill of a limited mock-up model representing the Advanced Design Mixer Pump (ADMP). Two independent tests (Part A and Part B) have been performed to meet the two test objectives stated above.

Test Setup:

Part A – Grout Property Test

Part A was designated as the Grout Property Test. This test included manufacturing the equipment fill grout using grout formula T1a-62.5FA as shown below in Table 1 (reference [2]). The purpose of this test was to determine the flow characteristics of the manufactured grout over time.

Table 1 – T1a-62.5FA Grout Formula

Ingredient	Weight Percent
Masterflow® 816	24.35
Blast Furnace Slag, Grade 100	6.50
Fly Ash, Class F, ASTM C618	40.59
Domestic Water	28.58

The primary Test Equipment included the following (see Figures 1 and 2);

- ChemGrout® mixer
- high shear colloidal pump
- transfer hose
- grout holding tank
- holding tank agitator
- feed hopper
- grout pump
- recirculation line

The general procedural steps followed during the testing are summarized below;

1. Add water to mixer and holding tank and then pump through all associated lines and equipment to wet equipment surfaces. Shutdown and drain water from all lines and equipment.
2. Add grout mix components to mixer in the following order; water, fly ash, slag, and Masterflow grout. Add enough components to make eight (8) cubic feet of grout (minimum).
3. Mix for a minimum of 5 minutes and then start colloidal pump. After 30 seconds to 2 minutes, transfer to holding tank. Upon completion of transfer, shutdown colloidal pump and clean mixer and associated equipment.
4. Start holding tank agitator and operate for a minimum of 5 minutes.

5. Open valve to feed hopper, start grout pump and pump through recirculation line back to holding tank.
6. Pull a sample every 15 minutes and perform a Flow Cone Test per ASTM C939 and document results. Acceptance criteria for test is < 16 seconds.
7. Continue recirculation and sampling for 3 hours.
8. After 3 hours, shutdown grout pump and clean holding tank, grout pump, and all associated equipment.

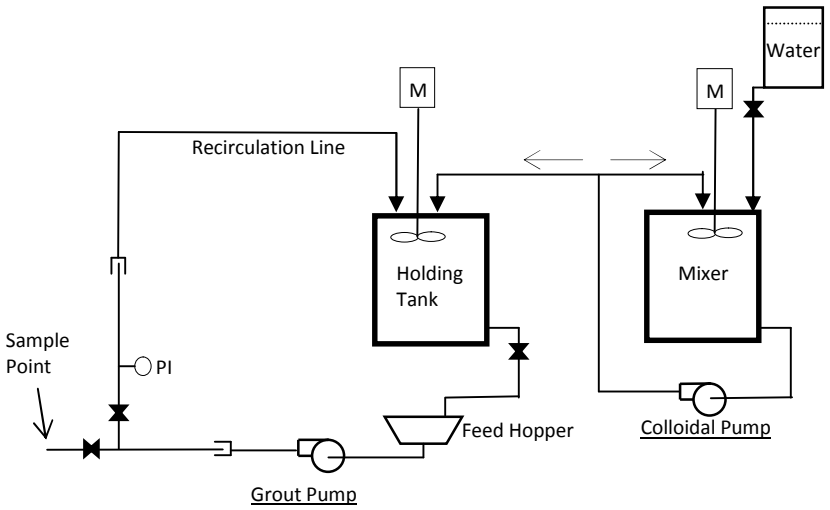

Figure 1 – Test Configuration For Grout Property Test

Figure 2 – Test Equipment For Grout Property Test

Part B – Mock-up Model Fill Test

Part B was designated as the Mock-Up Model Fill Test. This test consisted of filling a mock-up model of an ADMP with equipment fill grout. This test is scaled up compared to the mock-up tests performed by SRNL (reference [2]) as the equipment grout batch size has been increased from 0.25 cubic feet of grout to 6.3 cubic feet of grout. The purpose of this test was to;

1) Demonstrate the feasibility of performing a continuous fill of the mock-up model using gravity fill; and
2) Determine an acceptable fill rate that results in complete filling of the mock-up model.

The general equipment configuration for the test is shown in Figure 3. The mock-up model of the ADMP included eight (8) sections of pipe separated by baffles with a 1-inch diameter flow path provided in each baffle (see Figure 4). Actual test equipment is shown in Figures 5 through Figure 8.

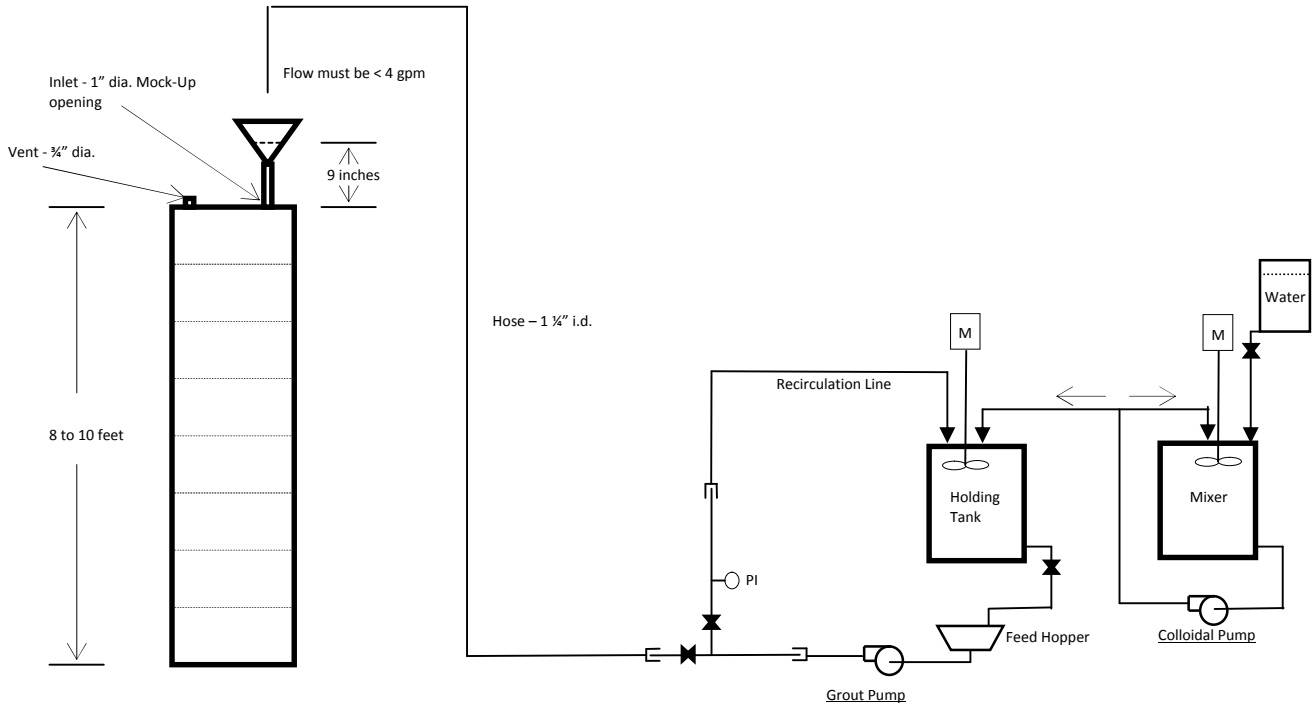

Figure 3 – Test Configuration for Mock-Up Model Fill Test

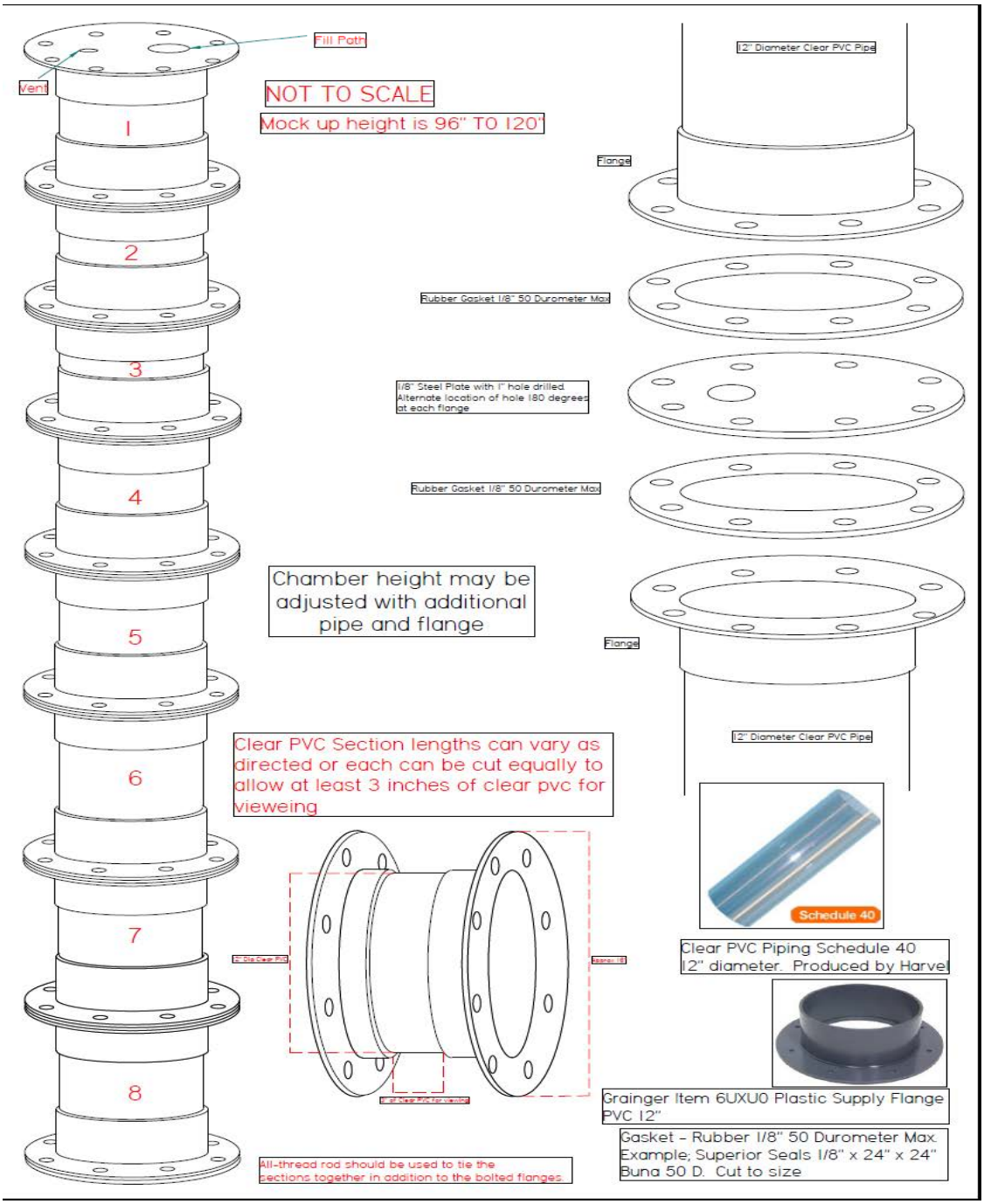

Figure 4 – Mock-up Model

Figure 5 – Top of Mock-up Model and Grout Addition Funnel

Figure 6 –Grout Addition Funnel

Figure 7 – Middle of Mock-Up Model

Figure 8 – Bottom of Mock-Up Model

The general procedural steps followed during the testing are summarized below;

1. Add water to mixer and holding tank and then pump through all associated lines and equipment to wet equipment surfaces. Shutdown and drain water from all lines and equipment.
2. Add grout mix components to mixer in the following order; water, fly ash, slag, and Masterflow grout. Add enough components to make enough grout to fill the mock-up model (approximately 8 cubic feet of grout).
3. Mix for a minimum of 5 minutes and then start colloidal pump. After 30 seconds to 2 minutes, transfer to holding tank. Upon completion of transfer, shutdown colloidal pump and clean mixer and associated equipment.
4. Start holding tank agitator and operate for a minimum of 5 minutes.
5. Start grout pump and transfer grout to the mock-up model at a rate not to exceed 4 gallons per minute.
6. Maintain the level of grout in the addition funnel at approximately 9 inches above the top of the mock-up model.
7. Observe the filling of the mock-up model with grout, document the evolution via video surveillance, and document observations made during the filling. Adjust feed rate as necessary to optimize filling. Clean all test equipment once the test is complete.

Test Results and Discussion:

Part A – Grout Property Test

Flow cone test results from the Grout Property Test are provided in Attachment 1. Two flow cone tests were taken at each time period and an average time was calculated. Review of the data indicates that the grout did not initially meet acceptance criteria for flowability. Test results exceeded the 16 second acceptance criteria at the beginning of the test and at 15 minutes. At 30 minutes into the test, the grout flow was meeting the 16 second acceptance criteria and this continued until the test reached the 2 hour time period. The initial out of range flowability results were attributed to an insufficient mix time.

At 2 hours into the test, cone test flow time began increasing until flow stopped at 2 hours and 45 minutes into the test. Heat from the grout pump and the recirculation of the grout resulted in a slow and steady increase in the grout temperature during the course of the test. It is postulated that this increase in temperature led to an increase in viscosity of the grout which affected flowability after two hours.

Part B – Mock-up Model Fill Test

Observations from the mock-up model fill test include the following;

- The first two test sections filled completely in the first 10 minutes of the test.
- After the first two sections filled, the fill rate had to be reduced to allow adequate venting in order to continue filling the lower sections of the mock-up model.
- Once the fill rate was reduced, the filling continued successfully until the mock-up model was 100% filled.
- Total time required to fill the mock-up model was 45 minutes.

Conclusion:

The Grout Property Test showed that the grout maintains flowability for at least two hours. This is more time than is expected to be needed to fill any of the abandoned equipment in Tanks 18 and 19. Additionally, grout temperature may affect flowability over time, so steps should be taken to ensure that ambient temperatures during the grouting evolution do not result in significant increases in grout temperature.

The Mock-up Model Fill Test demonstrated that the equipment in the tank should be able to be filled with the equipment fill grout specified by SRNL. The test showed that the grout was self-venting (i.e., could fill and vent through the same 1-inch diameter opening). The test also showed that the fill rate was a critical factor to obtain complete filling of the equipment.

References:

[1] M-TPL-F-00013, Revision 0, "*Equipment Grout Mock Up Test Plan*"

[2] SRNL-STI-2011-00564, Revision 0, "*Tank 18 and 19-F Tier 1A Equipment Fill Mock Up Test Summary*"

Attachments:

Attachment 1 – Summary Report Data (2 pages)

Attachment 1 - Summary Report Data (Page 1 of 2)

ASR 18-203 (11/07)

Washington Group
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Summary Report of Testing Activities

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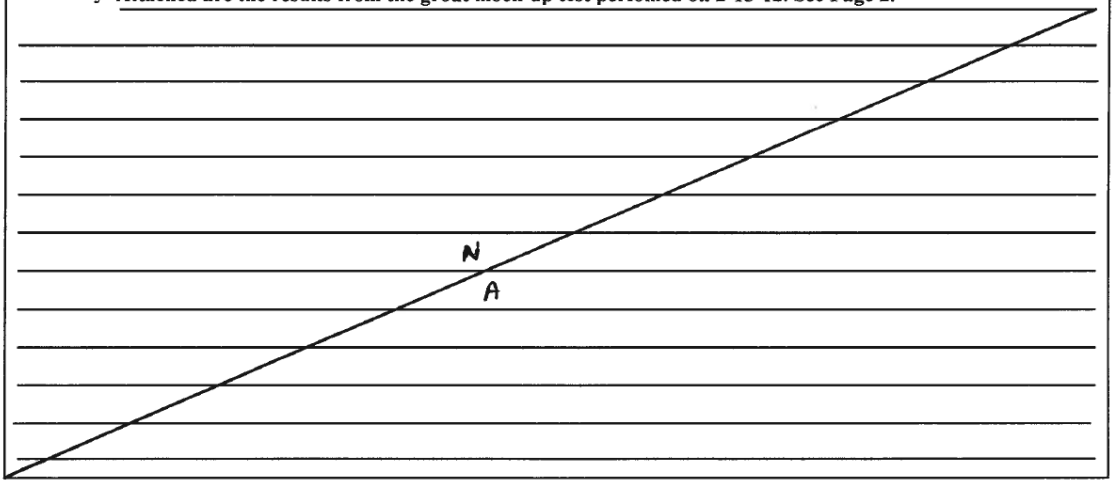
[X] Report [ ] Cover Sheet

Approvals (If required)	Work Package No.: M-TPL-F-00013
Civil Materials Testing Supervisor: W. L. Mhyre	QCIR No.: N/A
	Project No.: N/A
Quality Programs & Civil Materials Testing Manager: W. Pope Jr.	Design Category: GS
	Report No.: 2012-M-TPL-F-00013-0001 Date: 2-15-12
Lab No.: N/A	Test Method: ASTM C 939 JTW 2-16-12
Discipline: Civil	Description: Grout Testing Results
Location: F-Tank Farm: Equipment Grout Mock-Up	Reported to: M. Pallon, 2-4823

Summary: Attached are the results from the grout mock-up test perfomed on 2-15-12. See Page 2.



M&TE: FC-1, FC-3, & TG-415	Cal. Due Date: 6-6-12, 1-18-13, & 3-14-12	Procedure: C-QCP-020
NCR No.: N/A		Rev: 0
Test Results: [ ] Conforming [ ] Nonconforming [*X] N/A		PCNs: 1, 2, & 3
Remarks: *For Engineering Evaluation		Specs: M-TPL-F-00013
		Rev: 0
		DCFs: N/A
		N/A

Inspector (Print/Sign): Justin T. Waymer / Justin Waymer Level: II Date: 2-16-12

Reviewer (Print/Sign): W.L. Mhyre / W.L. Mhyre Level: III Date: 2-16-12

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Attachment 1 - Summary Report Data (Page 2 of 2)

ASR 18-250 (11/07)

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Summary Report of Testing Activities (Continuation Sheet)

Report Title: F-Tank Farm: Equipment Grout Mock-Up **Report No.:** 2012-M-TPL-F-00013-0001

Item #	Summary

Sample Time (hrs:min)	Flow Cone Times (s)	Avg. TIme (s)	Temperature (°F)
0:00	20.8 / 20.0	20.4	71
0:15	16.8 / 18.0	17.4	Not Measured
0:30	15.5 / 16.3	15.9	Not Measured
0:45	15.6 / 15.2	15.4	Not Measured
1:00	15.0 / 15.4	15.2	90
1:15	15.0 / 15.0	15.0	95
1:30	15.0 / 15.0	15.0	105
1:45	15.2 / 15.8	15.5	106
2:00	16.0 / 16.8	16.4	Not Measured
2:15	18.2 / 20.0	19.1	115
2:30	24.0 / 25.0	24.5	113
2:45	Did Not Flow	N/A	118
3:00	Not Measured	N/A	Not Measured

At the 2 hr 45 min test, the grout was too thick to flow through the flow cone. The mock-up test was stopped before the 3 hr test could be run.

N A

N A

Comments:

N A

WP 2-23-12

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