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**MELTER FEED TANK OPERATING MAP
FROM THE FA-10.02 TEST DATA (U)**

by
T. L. Spatz

Thomas L. Spatz
Author

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SRTC SAVANNAH RIVER TECHNOLOGY CENTER, AIKEN, SC 29808
Westinghouse Savannah River Company
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APPROVALS

8/17/94
D.R. MUHLBAIER, GROUP MANAGER DATE

8/17/94
M.R. BUCKNER, ATS LEVEL 3 MANAGER DATE

8/16/94
J.L. STEINKE, TECHNICAL REVIEWER DATE

8/15/94
T.L. SPATZ, AUTHOR DATE

9/2/94
C.T. RANDALL, CUSTOMER, DWPT DATE

10/1/94
J.T. CARTER, MANAGER, PROCESS COGNIZANT ENGINEERING DATE

10/3/94
R.E. EDWARDS, MANAGER, CHEMICAL AND SALT
PROCESSING CELLS DATE

10/5/94
J.E. OWEN, MANAGER, MELTER AND OFF-GAS PROCESSING DATE

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1. Summary

This report presents data from the DWPF-FA-10.02 test of the Melter Feed Tank (MFT). The data are presented in the form of operating maps, Figs. 1 through 4, which are plots of the liquid level versus the wt% total solids (and yield stress) for two agitator speeds. The maps are divided into regions of acceptable feed loop operation and unacceptable feed loop operation. This report does not consider how closely the compositions of the MFT, the melter feed lines, and the Hydragard samples agree.

The significant observations in this report are as follows:

- Both feed loops satisfy the operability criteria down to a liquid level below the upper impeller blade at low speed agitation (65 rpm).
- Under high speed agitation (130 rpm), feed loop #2 operates much more poorly than feed loop #1.
- The uncertainty associated with the wt% total solids of a slurry sample is larger than the current design basis range for total solids.
- The dilution of slurry due to pump priming is shown graphically in the chronological presentation of wt% total solids.

Recommendations for future tests are as follows:

- Additional data should be acquired to develop a complete operability map for the feed loops. (Data are needed at low liquid levels (below 3000 gal) to determine where the feed pumps lose prime under low speed agitation (65 rpm).)
- Provide additional data for 100 rpm agitator speed, and any other speed anticipated during normal operation, to map the operability of the feed systems at those agitator speeds.
- Electronic recording of the dates and times at which samples are pulled is needed for future tests.

The data used to produce the operating maps are given in two parts. The first part is the results of the sampling analysis and is given in the Tables section. The second is the liquid level, agitator power, and the feed flow signal which is given in the Appendix. The liquid level, agitator power, and feed flow signal are obtained from data in the DWPF Process Information Management System (PIMS) computer software.

The sample analysis was performed by DWPT under controls described in SRL-PMC-91-0075, Rev. 4, "The DWPT-TNX QA Program Description (U)"; and WSRC-RP-94-558, Rev. 0, "Baseline Task Technical Plan to Develop Technical Bases For Rheology Control of DWPF Melter Feed Preparation Processes (U)" [1]. Also presented in this report is the methodology used to label and track samples for the FA-10.02 test (and WP-19.01 test). The instruments used to record the data at DWPF, into the PIMS system, are governed by 1Q, procedures QAP 12-1, "Control of Measuring and Test Equipment (U)", and QAP 12-2, "Control of Installed Process Instruments (U)".

The controls stated above are sufficient for baseline applications and the data presented in this baseline technical report do not require the qualification of any existing data; however because of the limited data available and the nature of the process it is suspected that the operability maps should still only be used as guidelines for plant operation.

2. Introduction

The operability of the Melter Feed Tank (MFT) feed loops has been tested during the DWPF-FA-10.02 test. The ability to feed the melter at three distinct melter feed rates (0.20, 0.45, & 0.90 gpm), two distinct agitator speeds (65 & 130 rpm), varying liquid levels, and varying slurry rheologies was tested. This report correlates the operability of the feed loops with the above mentioned variables.

The definition of feed loop operability will be discussed first. A schematic diagram of the MFT and the feed loops to the melter is given in Fig. 5 [2]. There are two melter feed pumps that circulate slurry through a 2 inch recirculation loop. At the top of each recirculation loop is a strainer that slurry is fed through, entering 3/8" Sch. 80 piping leading from the strainer to the melter. The feed loops are designed to operate without any valves in the flow loop. Theoretically, the pump speed is increased to increase the pressure at the strainer and the flow rate to the melter. The feed loops are controlled by the flow rate reading in the 3/8" line going to the melter. When the flow rate to the melter starts to deviate from the set point, the pump speed is adjusted to bring the feed flow rate back to the set point. The indicated feed flow rate fluctuates due to pressure fluctuations. Acceptance criteria have been established for these fluctuations at various melter feed set points. The acceptance criteria for the three set points used in the DWPF-FA-10.02 test are stated below [3].

SET POINT	ACCEPTANCE RANGE
0.20 gpm	0.15 - 0.40 gpm
0.45 gpm	0.35 - 0.70 gpm
0.90 gpm	0.80 - 1.15 gpm

Figure 6 shows a typical feed flow signal for both flow loops at all three set points while the MFT was under low agitation (65 rpm). Charts of this type are generated from the DWPF Process Information Management System (PIMS). A solid line is drawn through the set point, and hatch marks drawn to illustrate the upper and lower acceptance criteria. When a melter feed signal is outside of the acceptable range, for that set point, the feed loop generating that signal is considered inoperable. Generally when a feed loop generates a feed rate signal outside of the acceptance criteria, a pump trip due to loss of suction is imminent.

The objective of this report is to correlate the above mentioned operability of the feed loops with the conditions within the tank (agitator speed, liquid level, and rheology or percent solids). The agitator speed and liquid level are obtained from PIMS charts similar to Fig. 6. Obtaining the rheological properties of the slurry in the MFT at particular times will be discussed in the next two sections of this report.

During the course of the DWPF-FA-10.02 testing many unacceptable feed rate signals were detected and several pump trips occurred due to loss of prime. All of these incidents occurred under high speed agitation. Some of these unacceptable signals were produced when the liquid level in the MFT was well above the upper impeller blade. This behavior was not expected and is not clearly understood. Several hypothesis have been generated to explain the unacceptable fluctuations in the feed flow signal. The goal of this report is not to explain this phenomenon, but to present the

data of the DWPF-FA-10.02 test in such a way that an unacceptable signal could be avoided. To do this, this report will present the tank levels, agitator speed, and either wt% total solids or yield stress for periods when the feed loops were operated during the DWPF-FA-10.02 test.

3. Sample Tracking

The data collected for this report came from primarily two sources. The first source is the feed loop signal information which came from the PIMS charts. The second source of information was the analysis of the slurry in the tank. In order to link the two pieces of information the feed loop signal date and time was mated to the slurry properties at the same date and time. The PIMS charts state the date and time when the data were acquired at the top of each chart. Obtaining the date and time for samples pulled for analysis and the results of the analysis was somewhat more difficult. The difficulty was because the concept of combining this information did not get proposed until after the DWPF-FA-10.02 test was finished. This section will discuss how acquisition of samples was planned and tracked for the DWPF-FA-10.02 test.

There were five locations where samples were acquired from the Melter Feed Tank. They are; 1) the high grab sampler, 2) the low grab sampler, 3) loop #1 outlet at the melter, 4) loop #2 outlet at the melter, 5) and the Hydragard sample pump. These samples were collected in small vials ('peanut' vials) of about 15 mL in volume. These vials are labeled by etching the glass of the vial with an alphanumeric code that indicated which sample location the sample originated from and what type of analysis was to be performed on that sample (elemental or total solids).

A flow chart of the sample tracking of etched vials is given in Fig. 7. A brief discussion of this flow chart follows [4]. The first step was that the test objectives were stated by the Defense Waste Processing Technology (DWPT) department. The Applied Statistics Group reviewed the test objectives and suggested the number of vials to collect and the location at which they should be collected. This information was given to the DWPF Startup group where the sampling information, including vial numbers, was written into the test procedure. The DWPF laboratory etched the vials for the test and gave them to the Melter Feed Tank Test Engineer. The DWPF-FA-10.02 test was run according to procedure and the labeled vials were filled when the procedure called for that vial number to be filled. The operating personnel at that time recorded the time and date (for DWPF-WP-19.01 and DWPF-FA-10.02 Appendix XXI) or just the date (for DWPF-FA-10.02 Appendix XVII) depending on what the procedure dictated. That was the **only record of date and time** corresponding to a vial number. The etched filled vials were sent to TNX for analysis. The results of the analysis were entered into the TNX Laboratory Information Management System (LIMS), along with the date that the sample was analyzed; not the date it was pulled from the tank. The results were given to the Applied Statistics Group, who designed the sampling scheme, and a report was generated. The report was reviewed by DWPF/T to determine if the test objectives were met and then the report was released for distribution.

The only record of the date and time a particular etched vial was filled is in the actual DWPF-FA-10.02 procedure. There was no electronic recording of the date and time of when a sample was acquired. The tracking of the tank slurry properties over time could

have been simplified if the date and time corresponding to the sample being pulled had been recorded into the TNX LIMS system.

There were also samples pulled from the Melter Feed Tank during this test that were placed in un-etched containers. This report refers to these samples as 'informal' samples [4]. Samples may be collected at any time and placed in un-etched containers. This was done for large volume samples (250 mL) to perform foaming tests at TNX. Also, routine samples were pulled from the Hydragard system for total solids analysis at the DWPF Laboratory. The only reference for the dates and times when these samples were pulled is in the Test Log for that date. The DWPF laboratory data are traceable through the DWPF LIMS system and through the rigorous searching through the Test Log for the corresponding date and time. Very few of these samples were used in this report. They can be identified in the data tables (Table 1 to 5) as the samples with 'NA' as the vial identification number.

4. History of Wt% Total Solids

The slurry samples were evaluated for total solids, insoluble solids, elemental analysis, and rheological properties depending upon the reasoning behind the acquisition of the individual sample. The Sample Tracking section describes how samples of the slurry are obtained for analysis and how the dates and times associated with samples are recorded. Samples were acquired for two different analysis; total solids (and rheology) analysis or elemental analysis. The only characteristics of the bulk slurry that were traceable over the duration of the DWPF-FA-10.02 test were the weight percent of total solids in the slurry and the elemental solids percents. Insoluble solids analysis and rheological analysis were derived from larger volume samples (typically 500 mL) acquired at selected times. Correlations have been derived for yield stress and consistency as a function of insoluble solids, for the slurry used in the DWPF-FA-10.02 test, by J.C. Marek [5]. Reference [5] also correlates wt% insoluble solids to wt% total solids. These correlations are given below, as used in this report.

$$(\text{WT\% Insoluble Solids}) = 0.165 + 0.77 * (\text{WT\% Total Solids})$$

$$\text{Yield Stress (Dynes/cm}^2\text{)} = -548.2 + 16.2 * (\text{WT\% Insoluble Solids})$$

The wt% total solids, and the related rheological properties, changed with time in the Melter Feed Tank. The most common cause of this change was the lowering of the wt% total solids by adding water to the tank in order to prime a pump (sample or feed pumps). Another change in the wt% total solids in the tank occurred when a new batch is transferred from the Slurry Mix Evaporator (SME). During the DWPF-FA-10.02 tests the same batch of slurry was reconstituted in the SME and pumped back into the MFT several times. Each reconstitution changed the wt% total solids and the rheology of the slurry. The first step in correlating the rheological properties to the operability of the feed loops was to determine what the wt% total solids was in the MFT over the duration of the DWPF-FA-10.02 test. Knowing the wt% total solids at any instant during the test, one could determine the rheological properties using the correlations in Ref. [5].

There were five locations where samples were acquired from the Melter Feed Tank. They are; 1) the high grab sampler, 2) the low grab sampler, 3) loop #1 outlet at the melter, 4) loop #2 outlet at the melter, 5) and the Hydragard sample pump. Figure 8

illustrates the history of wt% total solids in the MFT over the entire time frame of the DWPF-FA-10.02 test. The January and February of 1994 data are from Appendices of DWPF-FA-10.02, when pump operability problems led to greater scrutiny of the rheology of the slurry in the MFT. The January data is reproduced in Fig. 9 and represents samples acquired during DWPF-FA-10.02 Appendix XVII. The February data is reproduced in Fig. 10 and represents samples acquired during DWPF-FA-10.02 Appendix XXI. Both Figs. 9 and 10 show a chronological decrease in the wt% total solids during testing that is attributed to the addition of water to prime pumps. A reduction (or thinning) in wt% solids causes a reduction in yield stress and consistency. The data are also given in tabular format in Tables 1, 2, 3, 4, and 5.

A brief discussion of the uncertainty associated with the wt% total solids will be given next. A statistical analysis was performed on the DWPF-FA-10.02 Extended testing data by T.B. Edwards [6]. The results of the analysis for wt% total solids state that the percent relative standard deviation for each sampler system for each test phase ranged from 1.5% to 6.9%. Of significance in this results statement is the phrase 'for each sampler system'. Reference [6] shows a statistically significant difference between the wt% total solids sample acquired from the Hydragard and the wt% total solids sample acquired from loop #2 for the same test phase. This wt% total solids deviation due to sampling location should be added to the relative standard deviation reported in Ref. [6] to determine the overall uncertainty related to the samples in Figs. 8 to 10. The uncertainty related to each individual sampling system has not been determined at the time this report was written. Using the relative standard deviation of 6.9%, and multiplying by 2 for a 95% confidence interval, the relative uncertainty of the wt% total solids in Figs. 8 to 10 is about 14%. Then, for example, for a 50 wt% total solids data point the uncertainty is ± 7 wt% (similarly: 40 ± 5.6 wt%).

There is a significant problem associated with this reported statistical uncertainty from the experimental data. The current design bases for the feed pumps is for a slurry with a yield stress of 25 - 150 dynes/cm² and a consistency of 10 - 40 cPoise [7]. Reference [7] states:

The current process operating constraint to control the rheological properties within these limits is to maintain the total solids concentration in the range of 40 - 50 wt% total solids.

If a sample was analyzed as 45 wt% total solids, with the confidence intervals of ± 6.3 wt%, one could say with 95% confidence that the contents of the tank are between 38.7 wt% and 51.3 wt%. The confidence intervals for the mean design bases sample are larger than the entire design bases. Therefore, with the present uncertainty in wt% total solids, one can not say with 95% confidence that, for any given sample, the slurry in the MFT is within the current design bases. This 38.7 to 51.3 wt% total solids confidence interval, when converted to yield stress, is within the upper design bases limit but outside the lower design bases limit for yield stress. The 38.7 and 51.3 wt% total solids correspond to approximately 14 and 94.4 dynes/cm² yield stress, respectively. This confidence interval stretches just below the current design bases for yield stress of 25 to 150 dynes/cm².

5. Operability Maps

The operating maps are graphical presentations of the acceptance of the feed flow signal (loop #1 and loop #2) during the DWPF-FA-10.02 test. The data used to produce

the operating maps are given in two parts. The first part is the results of the sampling analysis and that is given in the Tables section. The second is the liquid level, agitator power, and the feed flow signal which is given in the Appendix. The liquid level, agitator power, and feed flow signal is from the information in the appendix and was obtained from DWPF PIMS. These data were not independently verified. Data are plotted relating the liquid level (in gallons) to either the wt% total solids or yield stress. The plot symbol will be changed, in these plots, to illustrate the acceptability of the feed flow signal. Refer to Figs. 8 - 10 to get wt% total solids. Interpolation was used to obtain wt% total solids for times when no samples were taken. For runs after 1/24/94, no change in concentration was assumed until the MFT was filled again on 2/16/94.

Figure 11 illustrates the low-agitation (65 rpm) data set. Each symbol on Fig. 11 represents a point in time when a feed loop was operating. The triangular symbols represent feed loop #1 and the circles feed loop #2. At 65 rpm the feed signal was well within the acceptable tolerance range at all tank levels. Of special interest are the lowest liquid level points on the graph. Recall that a feed loop signal becoming unacceptable is a predecessor to the feed pump losing prime and shutting down. Feed loop #1 operated acceptably down to 2400 gallons at approximately 44 wt% total solids. This is approximately 1600 gallons below the top of the upper impeller blade. Feed loop #2 operated acceptably down to 3200 gallons at approximately 44 wt% total solids. This is approximately 800 gallons below the top of the upper impeller of the Melter Feed Tank. In both cases the upper impeller was totally exposed. The lowest recorded liquid level, for total solids less than 40 wt%, at which a feed pump was running was approximately 4000 gallons. The window of operation for 65 rpm agitation will be any liquid level above those three bottom points on Fig. 11, where the feed pumps are known to have operated acceptably.

There are two instances in the 65 rpm data where feed loop #2 appeared to plug (refer to Fig. 11). The evidence supporting a plugged feed line is a gradual decrease in the feed flow corresponding to a gradual increase in the recirculation flow. Recall that the feed flow rate is what regulates the feed pump speed. When the feed line starts to plug and the flow rate decreases, a signal is sent to the feed pump to increase rpm and bring the feed flow back up to the set point. The increased recirculation flow corresponds to the increased pump speed. In the case of the plug occurring on 2/26/94 at 3070 gallons tank level the feed loop was restarted within 2 hours and ran acceptably for at least 4 hours after restarting. For this reason the plugging instances are not labeled as unacceptable operation. There was insufficient data to substantiate a trend for plugging between liquid level and wt% total solids.

The high speed agitation (130 rpm) data set is given in Fig. 12. At high-speed agitation there were many instances of unacceptable feed loop signals. The unacceptable feed loop signals are illustrated by the filled triangles and circles for feed loop #1 and feed loop #2, respectively. There are two noteworthy features in Fig. 12. The first is that both feed loops do not operate acceptably at 130 rpm agitation below the top of the upper impeller blade (below 4300 gallons). Because of this it is recommended to never operate the feed loops at 130 rpm agitation when the liquid level is at or below 4300 gallons for all wt% total solids. The second noteworthy feature in Fig. 12 is the fact that feed loop #2 signal becomes unacceptable at a higher liquid level than feed loop #1, for the same wt% total solids. Another way to restate this phenomenon is that feed loop #1 can operate with a much more dilute slurry than feed loop #2 at the same liquid level.

The best operation of both feed loops occurs when the slurry is at or above 50 wt% total solids.

It is difficult to visualize the operating map from the presentation of the individual data points represented in Figs. 11 & 12. The operating maps for feed loops #1 and #2 are presented in Figs. 1 & 2, respectively. The shaded areas in Figs. 1 & 2, for high-speed agitation, represent unacceptable feed loop signals. The shaded areas in Figs. 1 & 2, for low speed agitation, represent unproven operating conditions. Operation of each feed loop should be confined to the liquid level and wt% total solids above the shaded area representing a particular feed loop and agitator speed if the feed loops are expected to operate acceptably. Uncertainty bounds are drawn on the maps to indicate how the uncertainty related to the wt% total solids (discussed in Section 4: History of Wt% Total Solids) affects the operating maps. Uncertainty bounds are also drawn to indicate the uncertainty related to the liquid level measurement. The uncertainty related to the liquid level is due to the signal noise and a bias associated with the Holledge gages. A 1" bias (~70 gal.) has been stated for the Holledge gages by D. Postles [8]. The signal noise was determined from the liquid level data retrieved from the DWPF PIMS. Figure 13 illustrates the liquid level signal for both high (130 rpm) and low (65 rpm) speed agitation. The signal noise in the two plots of Fig. 13 were used as characteristic examples and the signal noise values were used for all the data presented in this report. For a 95% confidence interval the standard deviation of the signal was multiplied by two. The bias was simply added to the signal noise to yield a conservative confidence interval for the liquid level. For high speed agitation the liquid level confidence interval was approximately ± 200 gallons. For low speed agitation the liquid level confidence interval was approximately ± 120 gallons. This estimate of the liquid level confidence interval does not take into account the changes in level indication at different agitation speeds due to vortexing. It should be noted that, for high speed agitation, the lower uncertainty line does not extend below the 4300 gallon level. The feed loops have not operated under 4300 gallons with 130 rpm agitation speed.

The feed loop #1, 130 rpm, window (in Fig. 1) was derived by drawing a straight line between the two lowest known acceptable feed-loop signals and assuming the 4300 gallon liquid level is the minimum liquid level for this agitator speed. The lines outlining the loop #2, 130 rpm, window (in Fig. 2) were derived by drawing a straight line between the lowest known acceptable signals; and by assuming that the feed loop #2 would operate at near full tank level under low wt% conditions. It was also assumed that operation at 130 rpm agitator speed should not occur at liquid levels below 4300 gallons for wt% total solids above the highest wt% total solids test run (51%).

The operating windows, in Figs. 1 & 2, for low speed agitation (65 rpm) were also derived by drawing straight lines that connect the three lowest points for each feed loop in Fig. 11. It was then assumed that, for wt% total solids above 48%, both feed loops could operate acceptably at the same liquid level as the last acceptable signal liquid level. It may be acceptable to operate the feed loops below the liquid level indicated for low speed agitation since there are no unacceptable signals to evaluate where the lower extreme may be. With future (new) data the acceptable operating region for low-speed agitation may be increased.

Figures 3 & 4 show the same operating maps as previously discussed except the wt% total solids has been converted to yield stress using Fig. 1 in Ref. [5], reproduced in this report as Fig. 14. Figures 3 & 4 show very poor operability at yield stresses below 15

dynes/cm² (Insoluble solids <34 wt%: Total solids <44%). Recall that it was stated earlier that the current design bases is 25 - 150 dynes/cm². Operating both feed loops above a yield stress of 90 dynes/cm² is the best condition for operating at low liquid levels and 130 rpm agitator speed. Figure 4 shows the same operating restriction of loop #2 as was seen in Figs. 2 & 12.

It should be noted that these operating maps were generated from the DWPF-FA-10.02 test data. Future testing of the feed loops will add to the scarce information used to generate these maps, and a future report is anticipated under Task Plan SRT-ETF-TT-94-006, Rev. 0. Testing at 100 rpm agitation speed has been performed during the DWPF-FA-10.02 Extended test. There was not enough 100 rpm data to incorporate into this report, however 100 rpm agitator speed is going to be tested in the DWPF-FA-13.01 test and an operating map will need to be generated from that data.

6. Conclusion

The objective of this report was to present, graphically, the variables affecting the operability of the Melter Feed Tank (MFT) during the DWPF-FA-10.02 test. The operability of the feed loops was defined in the Introduction as the ability of the feed loops to feed the melter under acceptable feed-rate signal control. The variables affecting the control of the feed-rate signal are the agitator speed, liquid level, and slurry properties. The graphical presentation of how the feed loops operated during the DWPF-FA-10.02 test was given as a function of wt% total solids in Figs. 1 & 2, or as a function of Yield Stress in Figs. 3 & 4. These figures show two basic facts. The feed loops operate down to a liquid level below the upper impeller blade at low-speed agitation (65 rpm); and, under high-speed agitation, feed loop #2 operates much more poorly than feed loop #1.

A chronological presentation of the wt% total solid was presented in order to link the signal and liquid level with the rheological properties in the tank at an instant in time. Also presented was the methodology used to label and track samples for this test. It was noted that the dates and times at which samples are pulled was not recorded anywhere other than the DWPF-FA-10.02 procedure. Electronic recording of these dates and times is recommended for future tests. The logical location for this to occur is in the Laboratory Information Management System (LIMS) of the laboratory performing the analysis.

It was noted that under no circumstances can one say with 95% confidence that, for any given sample, the slurry in the MFT is within the current design bases. This indicates some systematic problem with the sampling (and/or feed) system.

The sample analysis was performed by DWPT under controls described in SRL-PMC-91-0075, Rev. 4, "The DWPT-TNX QA Program Description (U)"; and WSRC-RP-94-558, Rev. 0, "Baseline Task Technical Plan to Develop Technical Bases For Rheology Control of DWPF Melter Feed Preparation Processes (U)" [1]. The instruments used to record the data at DWPF, into the PIMS system, were governed by 1Q, procedures QAP 12-1, "Control of Measuring and Test Equipment (U)", and QAP 12-2, "Control of Installed Process Instruments (U)". The controls stated above are sufficient for baseline applications and the data presented in this technical report do not require the qualification of any existing data; however because of the limited data available and the

nature of the process it is suspected that the operability maps should still only be used as guidelines for plant operation.

In addition to the previous conclusions is the recommendation that additional data be acquired to develop a complete operability map for the feed loops. This recommendation comes with knowledge that the next testing of the MFT (DWPF-FA-13.01) will be done at a 100 rpm agitator speed. There are very scarce data, at present, to even attempt to generate an operability map for this agitator speed.

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Table 5	Hydragard Sample Results.	Page 29

Figure 1: Operating Map as Function of Wt% Total Solids. (Feed Loop #1)

Figure 2: Operating Map as Function of Wt% Total Solids. (Feed Loop #2)

Figure 3: Operating Map as Function of Yield Stress. (Feed Loop #1)

Figure 4: Operating Map as Function of Yield Stress. (Feed Loop #2)

Figure 5: Melter Feed Tank Schematic.

DEFENSE WASTE PROCESSING FACILITY

MELTER FEED TANK (MFT)

Figure 6: Feed Flow Signal - PIMS Chart.

FIC3308	MLTR FD LOOP 1 FD RATE
FIC3309	MLTR FD LP2 FEED RATE
SIC3191	MFT SMPL PMP SPEED
J13246	MFT AGIT PWR

GPM
GPM
RPM
KW

8 HOURS
TODAY'S DATA

E = EXPAND C = CONTRACT

25 10.2 SEC1.1

CONSOLE 3 ON CDCM
26-FEB-94 15:54:36

Figure 7: Sample Tracking Flow Chart.

Figure 8: Chronology of Wt% Total Solids: All FA-10.02 Samples.

Figure 9:

Chronology of Wt% Total Solids: FA-10.02 Appendix XVII
Samples.

Figure 10: Chronology of Wt% Total Solids: FA-10.02 Appendix XXI Samples.

Figure 11: 65 RPM Feed Flow Signal Graph.

Figure 12: 130 RPM Feed Flow Signal Graph.

Figure 13. Liquid Level Signal Noise.

Figure 14. Yield Stress of DWPF MFT/SME Material.

Table 1:

Low Grab Sample Results.

Vial ID	DATE	TIME	TOTAL TIME	POSITION	WT% #1	WT% #2	AVG. WT% TOT.SO
							LOW
1G02W	1/18/94	14:25	1/18/94	LOW	41.83	41.86	41.845
1G05W	1/18/94	14:44	1/18/94	LOW	43.39	42.57	42.98
1G08W	1/18/94	14:51	1/18/94	LOW	41.16	42.65	41.905
1G11W	1/18/94	14:56	1/18/94	LOW	44.03	43.62	43.825
1G14W	1/18/94	15:12	1/18/94	LOW	38.32	38.06	38.19
1G17W	1/18/94	15:26	1/18/94	LOW	41.41	42.07	41.74
1G20W	1/18/94	15:34	1/18/94	LOW	42.03	43.46	42.745
1G23W	1/18/94	15:37	1/18/94	LOW	42.38	43.18	42.78
G051W	1/20/94	12:37	1/20/94	LOW	41.03	42.11	41.57
G059W	1/20/94	12:56	1/20/94	LOW	41.49	40.76	41.125
G062W	1/20/94	13:03	1/20/94	LOW	41.47	41.66	41.565
G084W	1/20/94	21:44	1/20/94	LOW	39.51	40.55	40.03
G086W	1/20/94	21:53	1/20/94	LOW	41.58	41.59	41.585
G090W	1/20/94	22:02	1/20/94	LOW	40.9	40.43	40.665
G100W	1/20/94	22:27	1/20/94	LOW	40.27	40.91	40.59
G104W	1/20/94	22:34	1/20/94	LOW	41.46	41.73	41.595
G042W	2/22/94	16:34	2/22/94	LOW	47.3	47.5	47.4
G054W	2/22/94	16:45	2/22/94	LOW	47.35	47.65	47.5
G066W	2/22/94	16:59	2/22/94	LOW	47.12	47.35	47.235
G078W	2/22/94	17:09	2/22/94	LOW	46.78	47.5	47.14
G090W	2/22/94	17:19	2/22/94	LOW	47.65	47.86	47.755
G102W	2/22/94	17:30	2/22/94	LOW	47.45	47.74	47.595
G114W	2/22/94	17:39	2/22/94	LOW	48	48.18	48.09
G126W	2/22/94	17:48	2/22/94	LOW	47.2	47.34	47.27
G170W	2/27/94	10:51	2/27/94	LOW	42.56	43.16	42.86
G173W	2/27/94	11:07	2/27/94	LOW	42.61	42.44	42.525
G176W	2/27/94	11:24	2/27/94	LOW	43.03	42.91	42.97
G179W	2/27/94	11:35	2/27/94	LOW	43.33	43.92	43.625

Table 2: High Grab Sample Results.

VIAL I.D.#	DATE	TIME	TOTAL TIME	POSITION	TOT. SOL. wt% #1	TOT. SOL. wt% #2	AVG. wt% TOT. SOL.
1H03W	1/18/94	14:33	1/18/94	HIGH	35.09	35.43	HIGH
1H04W	1/18/94	14:37	1/18/94	HIGH	41.81	40.67	35.26
1H07W	1/18/94	14:48	1/18/94	HIGH	41.48	42.15	41.24
1H12W	1/18/94	14:58	1/18/94	HIGH	45.84	45.21	41.815
1H15W	1/18/94	15:18	1/18/94	HIGH	41.49	42.26	45.525
1H16W	1/18/94	15:22	1/18/94	HIGH	40.55	41.19	41.875
1H19W	1/18/94	15:30	1/18/94	HIGH	40.01	41.42	40.87
1H24W	1/18/94	15:41	1/18/94	HIGH	42.13	42.68	40.715
H049W	1/20/94	12:26	1/20/94	HIGH	40.26	41.8	42.405
H058W	1/20/94	12:53	1/20/94	HIGH	42.29	41.27	41.03
H061W	1/20/94	13:00	1/20/94	HIGH	43.18	42.44	41.78
H083W	1/20/94	21:40	1/20/94	HIGH	39.3	40.54	42.81
H087W	1/20/94	21:56	1/20/94	HIGH	40.64	40.18	39.92
H088W	1/20/94	21:59	1/20/94	HIGH	40.1	40.39	40.41
H101W	1/20/94	22:29	1/20/94	HIGH	39.62	40.56	40.245
H105W	1/20/94	22:43	1/20/94	HIGH	39.79	40.21	40.09
							40

Table 3: Feed Loop #1 Sample Results.

VIAL ID	DATE	TIME	TOTAL TIME	POSITION	WT% #1	WT% #2	AVG. WT%
							LOOP 1
NA	11/10/93	21:00	11/10/93	LOOP 1	39.4	39.4	39.4
NA	12/23/93	15:00	12/23/93	LOOP 1	38.76	38.76	38.76
NA	12/28/93	11:20	12/28/93	LOOP 1	37.15	37.15	37.15
X205W	1/23/94	17:10	1/23/94	LOOP 1	34.44	35.94	35.19
X209W	1/23/94	17:10	1/23/94	LOOP 1	35.5	35.57	35.535
X211W	1/23/94	17:10	1/23/94	LOOP 1	36.47	37.28	36.875
X212W	1/23/94	17:10	1/23/94	LOOP 1	34.44	35.75	35.095
X005W	2/18/94	6:48	2/18/94	LOOP 1	50.43	51.09	50.76
X017W	2/18/94	14:27	2/18/94	LOOP 1	50.51	50.86	50.685
X023W	2/18/94	22:29	2/18/94	LOOP 1	50.29	50.53	50.41
X035W	2/19/94	17:00	2/19/94	LOOP 1	46.82	47.01	46.915
X043W	2/22/94	16:34	2/22/94	LOOP 1	45.84	46.21	46.025
X055W	2/22/94	16:45	2/22/94	LOOP 1	45.68	45.72	45.7
X067W	2/22/94	16:59	2/22/94	LOOP 1	45.8	46.19	45.995
X079W	2/22/94	17:09	2/22/94	LOOP 1	45.46	46.06	45.76
X091W	2/22/94	17:19	2/22/94	LOOP 1	46.32	46.57	46.445
X103W	2/22/94	17:30	2/22/94	LOOP 1	45.87	45.81	45.84
X115W	2/22/94	17:39	2/22/94	LOOP 1	45.99	46.35	46.17
X127W	2/22/94	17:48	2/22/94	LOOP 1	46.34	46.73	46.535
X137W	2/24/94	6:40	2/24/94	LOOP 1	44.03	44.23	44.13
X149W	2/24/94	14:40	2/24/94	LOOP 1	45.91	46.69	46.3
X155W	2/25/94	1:03	2/25/94	LOOP 1	41.63	42.36	41.995
X167W	2/25/94	8:40	2/25/94	LOOP 1	42.93	43.28	43.105

Table 4:

Feed Loop #2 Sample Results.

VIAL ID	DATE	TIME	TOTAL TIME	POSITION	WT% #1	WT% #2	AVG WT%
							LOOP 2
NA	12/22/93	16:20	12/22/93	LOOP 2	36.3	36.3	36.3
Y130W	1/22/94	7:30	1/22/94	LOOP 2	40.23	40.97	40.6
Y132W	1/22/94	7:30	1/22/94	LOOP 2	41	40.41	40.705
Y133W	1/22/94	7:30	1/22/94	LOOP 2	38.8	39.43	39.115
Y139W	1/22/94	7:30	1/22/94	LOOP 2	40.45	41.24	40.845
Y165W	1/22/94	22:00	1/22/94	LOOP 2	37.64	37.73	37.685
Y166W	1/22/94	22:00	1/22/94	LOOP 2	37.56	37.67	37.615
Y167W	1/22/94	22:00	1/22/94	LOOP 2	37.76	37.9	37.83
Y168W	1/22/94	22:00	1/22/94	LOOP 2	39.81	40.02	39.915
Y214W	1/23/94	17:10	1/23/94	LOOP 2	32.51	32.54	32.525
Y215W	1/23/94	17:10	1/23/94	LOOP 2	31.34	32.12	31.73
Y220W	1/23/94	17:10	1/23/94	LOOP 2	34.39	34.07	34.23
Y222W	1/23/94	17:10	1/23/94	LOOP 2	31.9	32.24	32.07
Y006W	2/18/94	6:48	2/18/94	LOOP 2	50.95	51.02	50.985
Y018W	2/18/94	14:27	2/18/94	LOOP 2	50.97	50.96	50.965
Y024W	2/18/94	22:29	2/18/94	LOOP 2	50.61	50.31	50.46
Y036W	2/19/94	17:00	2/19/94	LOOP 2	46.93	47.22	47.075
Y044W	2/22/94	16:34	2/22/94	LOOP 2	45.58	45.71	45.645
Y056W	2/22/94	16:45	2/22/94	LOOP 2	45.1	44.86	44.98
Y068W	2/22/94	16:59	2/22/94	LOOP 2	45.46	45.78	45.62
Y080W	2/22/94	17:09	2/22/94	LOOP 2	44.34	44.76	44.55
Y092W	2/22/94	17:19	2/22/94	LOOP 2	45.78	45.93	45.855
Y104W	2/22/94	17:30	2/22/94	LOOP 2	45.78	45.74	45.76
Y116W	2/22/94	17:39	2/22/94	LOOP 2	45.32	45.8	45.56
Y128W	2/22/94	17:48	2/22/94	LOOP 2	45.59	46.23	45.91
Y138W	2/24/94	6:40	2/24/94	LOOP 2	43.23	43.82	43.525
Y150W	2/24/94	14:40	2/24/94	LOOP 2	45.06	45.07	45.065
Y156W	2/25/94	1:03	2/25/94	LOOP 2	43.24	43.56	43.4
Y168W	2/25/94	8:40	2/25/94	LOOP 2	43.87	44.01	43.94

Table 5: Hydragard Sample Results.

VIAL ID	DATE	TIME	TOTAL TIME	POSITION	WT% #1	WT% #2	AVG. WT%
							HYDRAGUARD
NA	10/22/93	14:20	10/22/93	HYDRAGUARD	42.34	42.89	42.615
NA	10/22/93	14:20	10/22/93	HYDRAGUARD	43.45	44.5	43.975
R050W	1/20/94	12:27	1/20/94	HYDRAGUARD	40.54	40.32	40.43
R060W	1/20/94	12:57	1/20/94	HYDRAGUARD	38.98	37.61	38.295
R063W	1/20/94	13:04	1/20/94	HYDRAGUARD	37.73	37.41	37.57
R082W	1/20/94	21:38	1/20/94	HYDRAGUARD	38.69	39.69	39.19
R085W	1/20/94	21:45	1/20/94	HYDRAGUARD	39.8	39.63	39.715
R089W	1/20/94	21:59	1/20/94	HYDRAGUARD	38.98	39.16	39.07
R102W	1/20/94	22:30	1/20/94	HYDRAGUARD	38.49	39.07	38.78
R103W	1/20/94	22:31	1/20/94	HYDRAGUARD	40.61	40.97	40.79
R154W	1/22/94	22:00	1/22/94	HYDRAGUARD	37.94	38.27	38.105
R157W	1/22/94	22:00	1/22/94	HYDRAGUARD	39.21	39.41	39.31
R159W	1/22/94	22:00	1/22/94	HYDRAGUARD	37.6	37.79	37.695
R150W	1/22/94	22:00	1/22/94	HYDRAGUARD	38.24	38.67	38.455
R192W	1/23/94	17:10	1/23/94	HYDRAGUARD	38.02	38.16	38.09
R193W	1/23/94	17:10	1/23/94	HYDRAGUARD	36.2	37.48	36.84
R196W	1/23/94	17:10	1/23/94	HYDRAGUARD	37.27	37.57	37.42
R197W	1/23/94	17:10	1/23/94	HYDRAGUARD	36.38	37.15	36.765
R004W	2/18/94	6:48	2/18/94	HYDRAGUARD	50.67	50.93	50.8
R016W	2/18/94	14:27	2/18/94	HYDRAGUARD	51.12	51.36	51.24
R022W	2/18/94	22:29	2/18/94	HYDRAGUARD	51.31	51.61	51.46
R034W	2/19/94	17:00	2/19/94	HYDRAGUARD	48.55	48.87	48.71
NA	2/21/94	15:55	2/21/94	HYDRAGUARD	46.82	48.29	47.555
NA	2/21/94	15:55	2/21/94	HYDRAGUARD	45.71	46.23	45.97
R041W	2/22/94	16:34	2/22/94	HYDRAGUARD	44.46	45.09	44.775
R053W	2/22/94	16:45	2/22/94	HYDRAGUARD	46.15	46.55	46.35
R065W	2/22/94	16:59	2/22/94	HYDRAGUARD	44.9	45.07	44.985
R077W	2/22/94	17:09	2/22/94	HYDRAGUARD	44.9	45.17	45.035
R089W	2/22/94	17:19	2/22/94	HYDRAGUARD	44.16	44.59	44.375
R101W	2/22/94	17:30	2/22/94	HYDRAGUARD	46.04	45.84	45.94
R113W	2/22/94	17:39	2/22/94	HYDRAGUARD	45.45	45.93	45.69
R125W	2/22/94	17:48	2/22/94	HYDRAGUARD	45.48	45.71	45.595
R136W	2/24/94	6:40	2/24/94	HYDRAGUARD	44.92	45.46	45.19
R148W	2/24/94	14:40	2/24/94	HYDRAGUARD	43.13	43.61	43.37
R154W	2/25/94	1:03	2/25/94	HYDRAGUARD	43.03	43.78	43.405
R166W	2/25/94	8:40	2/25/94	HYDRAGUARD	44.76	44.85	44.805

Appendix

The charts presented in the appendix were produced from data obtained from PIMS. The table given below summarizes the data points.

Feed Loop	Agitation (RPM)	Date	WT% Total Solids	Liquid Level (Gal)	Signal
2	130	11/15/93	39.4	7579	Unacceptable
2	130	12/1/93	39	7394	Unacceptable
2	130	12/14/93	38.8	7277	Unacceptable
2	130	1/22/94	40	6790	Unacceptable
2	130	1/23/94	39	6400	Unacceptable
2	130	1/24/94	35	5600	Unacceptable
2	130	1/24/94	35	5350	Unacceptable
2	130	2/17/94	52	6400	Acceptable
2	130	2/19/94	51	4300	Acceptable
2	130	2/19/94	51	4000	Unacceptable
2	130	2/22/94	46	8500	Acceptable
2	130	2/23/94	45	6970	Acceptable
2	130	2/23/94	45	6900	Unacceptable
1	130	11/10/93	39.4	7600	Acceptable
1	130	11/24/93	39	7413	Acceptable
1	130	12/15/93	38.8	7170	Acceptable
1	130	1/24/94	35	5600	Unacceptable
1	130	1/24/94	35	5250	Unacceptable
1	130	2/17/94	52	6400	Acceptable
1	130	2/19/94	51	4300	Acceptable
1	130	2/19/94	51	4000	Unacceptable
1	130	2/22/94	46	8500	Acceptable
1	130	2/23/94	45	6300	Acceptable
2	65	12/14/93	38.8	7277	Acceptable
2	65	12/22/93	38.76	7000	Acceptable
2	65	12/28/93	37.15	7260	Acceptable
2	65	1/21/94	41	7080	Acceptable
2	65	1/21/94	41	6900	Acceptable
2	65	1/22/94	40	6790	Acceptable
2	65	1/23/94	39	6400	Acceptable
2	65	1/23/94	39	5600	Acceptable
2	65	1/24/94	35	5110	Acceptable
2	65	1/26/94	35	4070	Acceptable
2	65	1/26/94	35	4030	Plugged Feed Line
2	65	2/20/94	48	3730	Acceptable
2	65	2/20/94	48	3500	Acceptable
2	65	2/26/94	44	3752	Acceptable
2	65	2/27/94	44	3100	Acceptable
2	65	2/27/94	44	3070	Plugged Feed Line
1	65	12/15/93	38.8	7170	Acceptable
1	65	12/23/93	38.76	6932	Acceptable
1	65	12/28/93	37.15	7260	Acceptable
1	65	1/23/94	39	6400	Acceptable
1	65	1/23/94	39	5600	Acceptable
1	65	1/24/94	35	5170	Acceptable
1	65	1/25/94	35	4140	Acceptable
1	65	2/20/94	48	3730	Acceptable
1	65	2/20/94	48	3500	Acceptable
1	65	2/26/94	44	3752	Acceptable
1	65	2/27/94	44	2400	Acceptable

AGITATOR (11/10/93 - 11/14/93)

AGITATOR (11/15/93 - 11/21/93)

AGITATOR (11/22/93 - 11/28/93)

AGITATOR (11/29/93 - 12/5/93)

AGITATOR (12/6/93 - 12/12/93)

AGITATOR (12/13/93 - 12/19/93)

AGITATOR (12/20/93 - 12/26/93)

AGITATOR (12/27/93 - 12/31/93)

AGITATOR (1/1/94 - 1/9/94)

AGITATOR (1/10/94 - 1/16/94)

AGITATOR (1/17/94 - 1/23/94)

AGITATOR (1/24/94 - 1/30/94)

AGITATOR (1/31/94 - 2/6/94)

AGITATOR (2/7/94 - 2/13/94)

AGITATOR (2/14/94 - 2/20/94)

AGITATOR (2/21/94 - 2/28/94)

LIQUID LEVEL

LIQUID LEVEL

LIQUID LEVEL

LIQUID LEVEL

LIQUID LEVEL

LIQUID LEVEL

LIQUID LEVEL

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LIQUID LEVEL

LIQUID LEVEL

LIQUID LEVEL

FEED LOOP #1 (FIC3308) FOR 11/10/93

FEED LOOP #1 (FIC3308) FOR 11/24/93

FEED LOOP #1 (FIC3308) FOR 12/15/93

FEED LOOP #1 (FIC3308) FOR 12/23/93

FEED LOOP #1 (FIC3308) FOR 12/28/93

FEED LOOP #1 (FIC3308) FOR 1/23/94

FEED LOOP #1 (FIC3308) FOR 1/24/94

FEED LOOP #1 (FIC3308) FOR 1/25/94

FEED LOOP #1 (FIC3308) FOR 2/17/94

FEED LOOP #1 (FIC3308) FOR 2/18/94

FEED LOOP #1 (FIC3308) FOR 2/19/94

FEED LOOP #1 (FIC3308) FOR 2/20/94

FEED LOOP #1 (FIC3308) FOR 2/22/94

FEED LOOP #1 (FIC3308) FOR 2/23/94

FEED LOOP #1 (FIC3308) FOR 2/24/94

FEED LOOP #1 (FIC3308) FOR 2/25/94

FEED LOOP #1 (FIC3308) FOR 2/26/94

FEED LOOP #1 (FIC3308) FOR 2/27/94

FEED LOOP #2 (FIC3309) FOR 11/15/93

FEED LOOP #2 (FIC3309) FOR 11/17/93

FEED LOOP #2 (FIC3309) FOR 12/1/93

FEEDLOOP #2 (FIC3309) FOR 12/13/93

FEED LOOP #2 (FIC3309) FOR 12/14/93

FEED LOOP #2 (FIC3309) FOR 12/22/93

FEED LOOP #2 (FIC3309) FOR 12/28/93

FEED LOOP #2 (FIC3309) FOR 1/21/94

FEED LOOP #2 (FIC3309) FOR 1/22/94 (0-12:00)

FEED LOOP #2 (FIC3309) FOR 1/22/94 (12:00 - 18:00)

FEED LOOP #2 (FIC3309) FOR 1/22/94 (18:00 - 24:00)

FEED LOOP #2 (FIC3309) FOR 1/22/94 (ONE HOUR PLOT)

FEED LOOP #2 (FIC3309) FOR 1/23/94 (0 - 6:00)

FEED LOOP #2 (FIC3309) FOR 1/23/94 (6:00 - 12:00)

FEED LOOP #2 (FIC3309) FOR 1/23/94 (12:00 - 18:00)

FEED LOOP #2 (FIC3309) FOR 1/23/94 (18:00 - 24:00)

FEED LOOP #2 (FIC3309) FOR 1/24/94 (0:00 - 6:00)

FEED LOOP #2 (FIC3309) FOR 1/24/94 (6:00-24:00)

FEED LOOP #2 (FIC3309) FOR 1/25/94

FEED LOOP #2 (FIC3309) FOR 1/26/94

FEED LOOP #2 (FIC3309) FOR 2/17/94

FEED LOOP #2 (FIC3309) FOR 2/18/94 (00:00 - 12:00)

FEED LOOP #2 (FIC3309) FOR 2/18/94 (12:00 - 24:00)

FEED LOOP #2 (FIC3309) FOR 2/19/94 (0:00 - 6:00)

FEED LOOP #2 (FIC3309) FOR 2/19/94 (6:00 - 12:00)

FEED LOOP #2 (FIC3309) FOR 2/19/94 (12:00 - 18:00)

FEED LOOP #2 (FIC3309) FOR 2/19/94 (18:00 - 24:00)

FEED LOOP #2 (FIC3309) FOR 2/20/94

FEED LOOP #2 (FIC3309) FOR 2/22/94 (0:00 - 12:00)

FEED LOOP #2 (FIC3309) FOR 2/22/94 (12:00 - 18:00)

FEED LOOP #2 (FIC3309) FOR 2/22/94 (18:00 - 24:00)

FEED LOOP #2 (FIC3309) FOR 2/23/94 (0:00 - 6:00)

FEED LOOP #2 (FIC3309) FOR 2/23/94 (6:00 - 10:00)

FEED LOOP #2 (FIC3309) FOR 2/23/94 (12:00 - 24:00)

FEED LOOP #2 (FIC3309) FOR 2/24/94 (0:00 - 6:00)

FEED LOOP #2 (FIC3309) FOR 2/24/94 (6:00 - 12:00)

FEED LOOP #2 (FIC3309) FOR 2/24/94 (12:00 - 18:00)

FEED LOOP #2 (FIC3309) FOR 2/24/94 (18:00 - 24:00)

FEED LOOP #2 (FIC3309) FOR 2/25/94 (0:00 - 6:00)

FEED LOOP #2 (FIC3309) FOR 2/25/94 (6:00 - 12:00)

FEED LOOP #2 (FIC3309) FOR 2/25/94 (12:00 - 18:00)

FEED LOOP #2 (FIC3309) FOR 2/25/94 (18:00 - 24:00)

FEED LOOP #2 (FIC3309) FOR 2/26/94

FEED LOOP #2 (FIC3309) FOR 2/27/94