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Evaluation of Vitrification Factors from DWPF's Macro-Batch 1

by

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Evaluation of Vitrification Factors from DWPF's Macro-Batch 1 (U)

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Document Approvals

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ABSTRACT

The Defense Waste Processing Facility (DWPF) is evaluating new sampling and analytical methods that may be used to support future Slurry Mix Evaporator (SME) batch acceptability decisions. This report uses data acquired during DWPF's processing of macro-batch 1 to determine a set of vitrification factors covering several SME and Melter Feed Tank (MFT) batches. Such values are needed for converting the cation measurements derived from the new methods to a "glass" basis. The available data from macro-batch 1 were used to examine the stability of these vitrification factors, to estimate their uncertainty over the course of a macro-batch, and to provide a recommendation on the use of a single factor for an entire macro-batch.

The report is in response to Technical Task Request HLW/DWPF/TTR-980015.

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1.0 INTRODUCTION

As the Defense Waste Processing Facility (DWPF) processed the later batches of macro-batch 1, data were being collected on new sampling and analytical methods proposed for future support of Slurry Mix Evaporator (SME) batch acceptability decisions. Today, under production conditions, this acceptability is judged based upon data derived from vitrified SME samples acquired using the Hydragard® sampling system and peanut vials. The new sampling scheme utilizes the Hydragard® but involves the use of 3-mL inserts instead of the 15-mL peanut vials. The new analytical methods (cold chemical and insert fusion) do not rely upon a vitrification step to derive their cation concentration measurements, as do the current production methods (mixed acid and fusion), but they do rely on a vitrification factor that can be used to convert these cation concentration measurements to a "glass" basis.

The cation measurements generated by the new analytical methods need to be converted to a "glass" basis so that they may be used with DWPF's product and process property models. These models, which predict product and process properties critical for SME acceptability decisions, relate these properties to glass composition. Currently, the glass composition for a given SME batch is determined by averaging the compositions of four or more vitrified SME samples. Measurements taken during the normal, production processing of the vitrified samples for a SME batch can be used to determine corresponding vitrification factors. Such measurements were determined using the current, production sampling and analytical procedures for several SME batches, as well as the corresponding batches of the Melter Feed Tank (MFT), processed toward the end of macro-batch 1. These data are the focus of this report. They are to be used to investigate the potential stability of these vitrification factors over the production batches making up a macro-batch and to determine the feasibility of using a single value for this factor over an entire macro-batch.

The report is in response to Technical Task Request HLW/DWPF/TTR-980015 [1] and is one of the deliverables described in the associated Task Technical and QA Plan [2].

2.0 BACKGROUND

Testing of the new sampling and analytical procedures versus the production methods was conducted under simulated conditions in the mock-up facility at DWPF, and the results were reported and analyzed in references [3, 4]. The cation concentration measurements derived from the cold chemical procedure were expressed as weight fractions or weight percents of the solution weight of the sample. These values were then converted to calcined weight using a factor derived from the insert samples that were analyzed via the modified fusion method. The cation concentrations derived from these insert fusion samples were also expressed relative to calcine weight. Average cation concentrations computed from cold chemical and modified fusion values (on a calcine basis) were taken as representative of these concentrations in the corresponding glass form.

The analyses of the data generated by these tests [3, 4] led to modifications of the cold chemical and insert fusion procedures [5, 6]. One such modification dealt with the use of an additional conversion factor. This factor was determined using the current vitrification procedures for other representative samples of the material being processed along with the new sampling and analytical methods. Since the mock-up tests were conducted in a parallel manner, old-versus-new, representative samples were readily available, and their analyses, conducted using the vitrification methods, facilitated the study of impact of this additional conversion factor on the DWPF operability window [7].

As a step along the way toward implementation of the new sampling and analytical procedures, there is a need to explore the vitrification factor for a DWPF macro-batch over several production batches. Macro-batch 1 provides an opportunity for such an investigation. Even though the new procedures were not implemented during this macro-batch, data captured during its processing provide an opportunity to investigate an aspect of the vitrification factor not offered by the mock-up testing, specifically, the variation of this factor due to differences in the material from batch to batch. These differences stem from the less-than-perfect uniformity of the sludge coming from Tank 51 and from variations in processing such as the blending of this sludge and the frit. The simulant used for the mock-up testing remained the same over all runs; the only contributors to the variation of the vitrification factors over these runs were sampling and analytical. There was no variation due to variation in material from one production batch to the other. The data from macro-batch 1 provide an opportunity to assess the impact of this additional source of variation in the uncertainty of the corresponding vitrification factor.

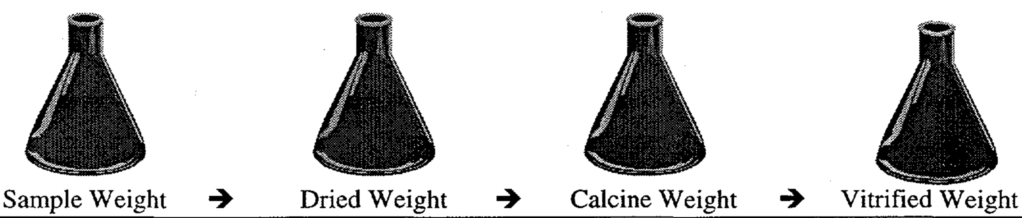
3.0 DISCUSSION

In this section, the data from several recent production batches from macro-batch 1 are presented and reviewed. These data were acquired during the processing of samples taken from the SME and from the MFT over production batches 77 through 92.

3.1 THE MACRO-BATCH 1 DATA

The macro-batch 1 data available for this study that were received from the DWPF are provided in Table A.1 in the Appendix. These data involve various weights of samples taken from the SME and MFT over several production batches. The progression of weights for each sample is illustrated in Figure 1.

Figure 1: An Overview of the Sample Weights Taken



These weights are presented in grams (g) in Table A.1, and the dried, calcine, and vitrified weights are also expressed as weight percents of the corresponding sample weights.

Exhibit A.1in the Appendix provides a look at these weight percent measurements for each vessel and production batch. This exhibit provides plots of these data over the production batches for both the SME and MFT. The means and standard deviations for dried weight percent, calcine weight percent, and vitrified weight percent and other descriptive statistics for the SME and MFT are presented in Exhibit A.2.

The percent coefficient of variation (CV), the sample standard deviation as a percent of the corresponding sample mean, is provided under each the "Moments" section of this exhibit. The values for the MFT are consistently higher than their counterparts in the SME, indicating more variability in samples from the MFT than samples from the SME for these measurements.

3.2 DETERMINATION OF VITRIFICATION FACTORS

The data presented in Table A.1 can be used to determine a vitrification factor for each sample for each production batch for each vessel. Since this factor is to be used to convert cation concentrations that are expressed as dried weight percents (fractions) to "glass" weight percents (fractions), the ratio of dried to vitrified weights from Table A.1 is of primary interest.[1] Exhibit A.3 provides a look the correlations among the dried, calcine, and vitrified weight percents for all of the samples. In addition, scatter plots of these results are also provided in this exhibit. A closer look at the relationship between the dried weight percent versus vitrified weight percent values is provided in Exhibit A.4. In this exhibit, the results of a regression of the dried wt%

1 The weight percents, instead of the actual weights, can be used since both weight percents are determined relative to the sample weight; i.e., the ratios of the two weights and the two weight percents are algebraically equivalent.

values on their corresponding vitrified wt% values are provided. These values are presented in Table 1.

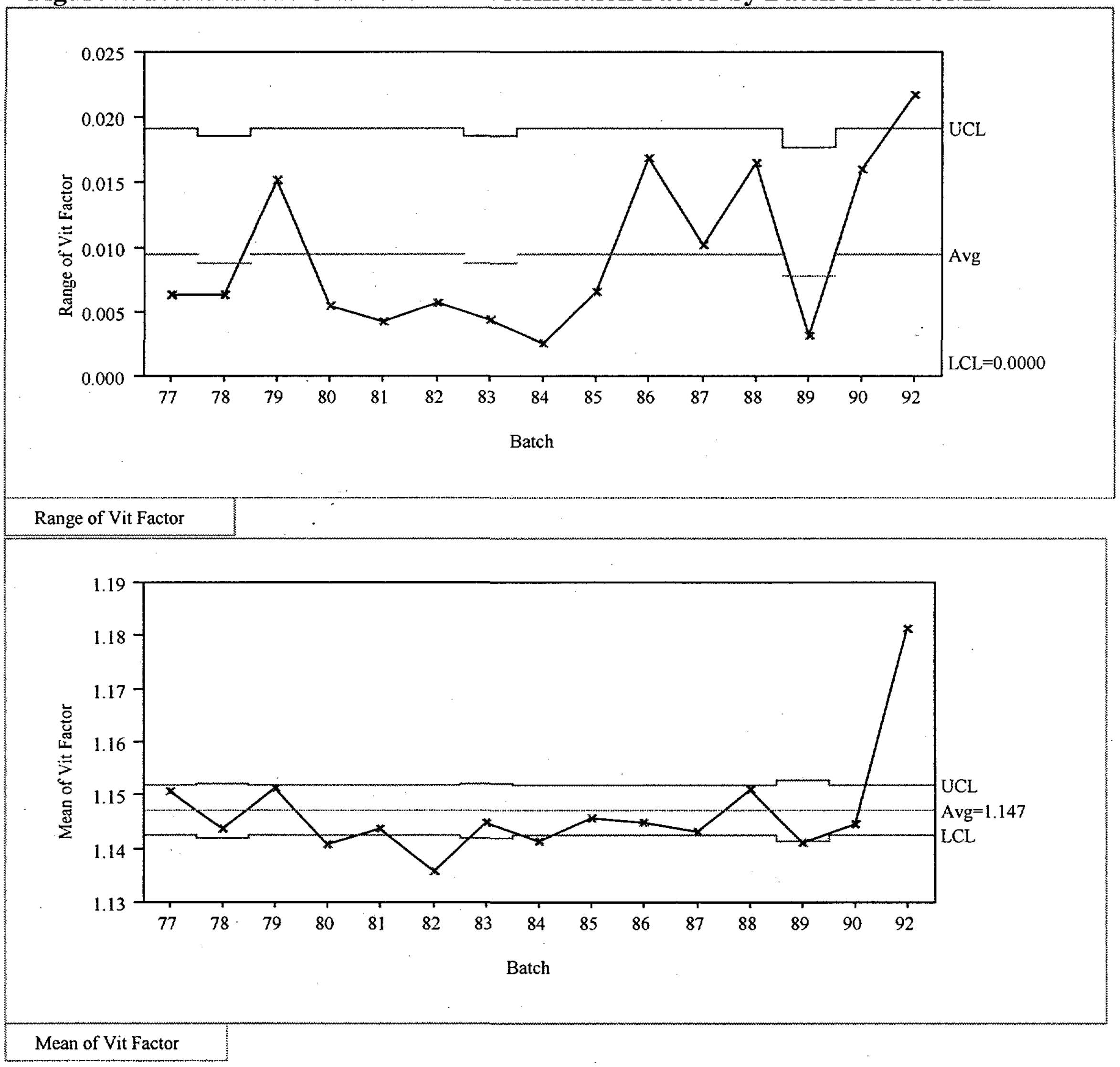
Table 1: Vitrification Factor for Each Sample by Batch-Vessel

Batch-Vessel	Vit Factor	Batch-Vessel	Vit Factor	Batch-Vessel	Vit Factor
77-SME	1.1493	83-SME	1.1452	88-SME	1.1472
77-SME	1.1504	83-SME	1.2212	88-SME	1.1482
77-SME	1.1497	83-SME	1.1478	88-SME	1.1465
77-SME	1.1539	83-SME	1.1442	88-SME	1.1482
77-SME	1.1541	83-SME	1.1445	88-SME	1.1631
77-SME	1.1477	83-SME	1.1434	88-SME	1.1533
77-MFT	0.5698	83-MFT	1.1609	88-MFT	1.1449
77-MFT	1.1450	83-MFT	1.1771	88-MFT	1.1375
77-MFT	1.1445	83-MFT	1.1576	88-MFT	1.1413
77-MFT	1.1392	83-MFT	1.2248	88-MFT	1.1416
77-MFT	1.1434	83-MFT	1.1562	88-MFT	1.1479
77-MFT	1.1496	83-MFT	1.1625	88-MFT	1.1396
78-SME	1.1417	84-SME	1.1406	89-SME	1.1432
78-SME	1.1448	84-SME	1.1428	89-SME	1.1400
78-SME	1.1634	84-SME	1.1406	89-SME	1.1410
78-SME	1.1408	84-SME	1.1407	89-SME	1.1268
78-SME	1.1472	84-SME	1.1411	89-SME	1.1544
78-SME	1.1448	84-SME	1.1432	89-SME	1.1401
78-MFT	1.1542	84-MFT	1.1669	89-MFT	1.1415
78-MFT	1.1493	84-MFT	1.1615	89-MFT	1.1477
78-MFT	1.1513	84-MFT	1.1515	89-MFT	1.1412
78-MFT	1.1595	84-MFT	1.1548	89-MFT	1.1429
78-MFT	1.1450	84-MFT	1.2704	89-MFT	1.1442
78-MFT	1.1428	84-MFT	1.1612	89-MFT	1.1487
79-SME	1.1577	85-SME	1.1414	90-SME	1.1464
79-SME	1.1569	85-SME	1.1469	90-SME	1.1432
79-SME	1.1532	85-SME	1.1480	90-SME	1.1522
79-SME	1.1508	85-SME	1.1454	90-SME	1.1362
79-SME	1.1424	85-SME	1.1466	90-SME	1.1436
79-SME	1.1472	85-SME	1.1477	90-SME	1.1461
80-SME	1.1419	85-MFT	1.1488	90-MFT	1.1353
80-SME	1.1387	85-MFT	1.1421	90-MFT	1.1453
80-SME	1.1420	85-MFT	1.1419	90-MFT	1.1466
80-SME	1.1389	85-MFT	1.1525	90-MFT	1.1427
80-SME	1.1442	85-MFT	1.1467	90-MFT	1.1424
80-SME	1.1401	85-MFT	1.1593	90-MFT	1.1416
81-SME	1.1432	86-SME	1.1478	92-SME	1.1798
81-SME	1.1449	86-SME	1.1421	92-SME	1.1957
81-SME	1.1452	86-SME	1.1463	92-SME	1.1796
81-SME	1.1409	86-SME	1.1507	92-SME	1.1739
81-SME	1.1442	86-SME	1.1338	92-SME	1.1743
81-SME	1.1448	86-SME	1.1495	92-SME	1.1858
81-MFT	2.5348	86-MFT	1.1371	92-MFT	1.1629
81-MFT	2.2075	86-MFT	1.1467	92-MFT	1.1563
81-MFT	1.9489	86-MFT	1.1445	92-MFT	1.1458
81-MFT	1.6136	86-MFT	1.1450	92-MFT	1.1661
81-MFT	3.1494	86-MFT	1.1460	92-MFT	1.1620
81-MFT	2.1467	86-MFT	1.1476	92-MFT	1.1657
82-SME	1.1364	87-SME	1.1404		
82-SME	1.1371	87-SME	1.1413		
82-SME	1.1384	87-SME	1.1449		
82-SME	1.1364	87-SME	1.1474		
82-SME	1.1341	87-SME	1.1379		
82-SME	1.1326	87-SME	1.1481		
82-MFT	1.1412				
82-MFT	1.1435				
82-MFT	1.1392				
82-MFT	1.1444				
82-MFT	1.1425				
82-MFT	1.1389				

3.3 An Evaluation of the Vitrification Factors

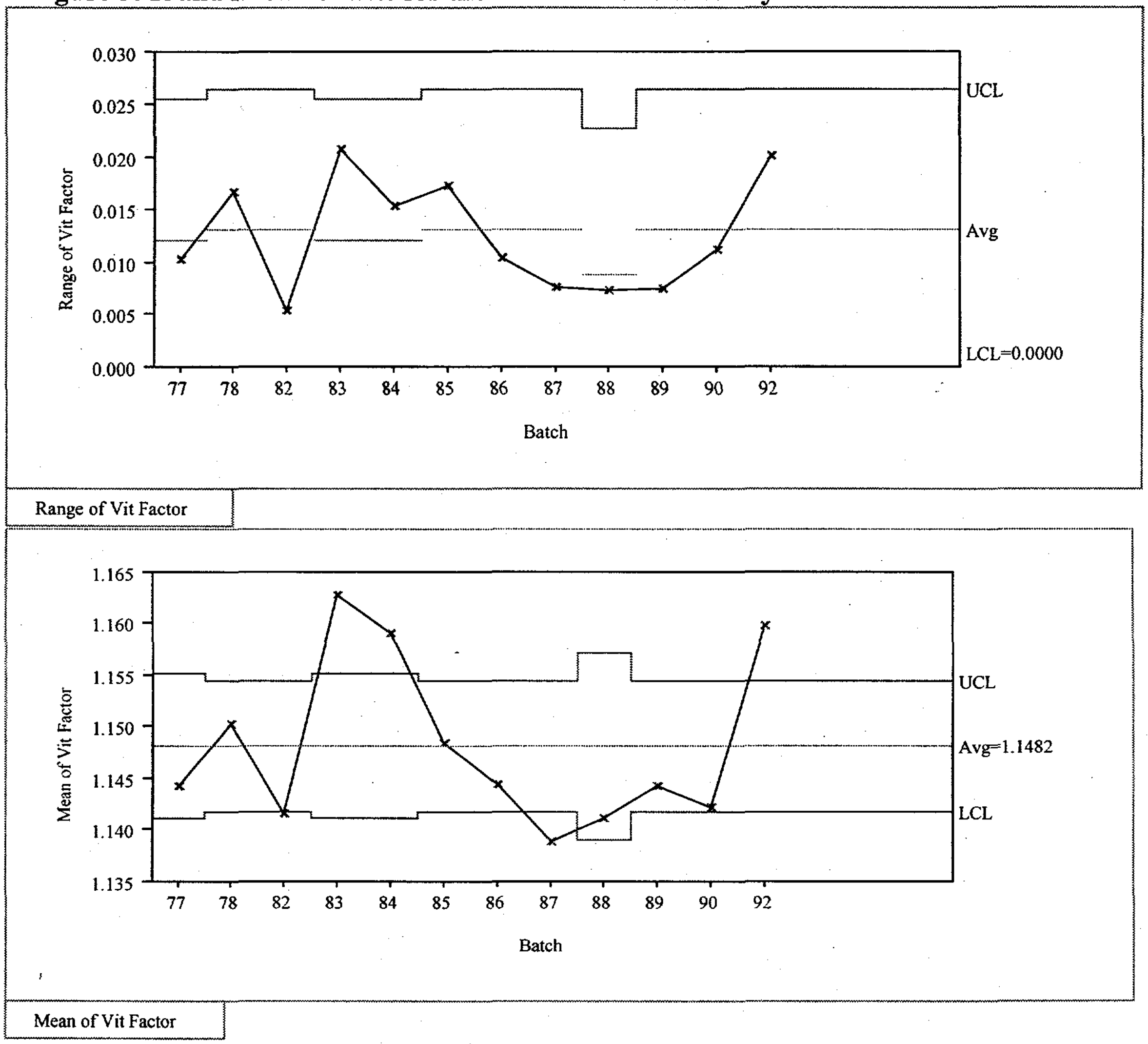
A first look at these vitrification factors determined from the SME data is provided in Figure 2. In this exhibit, $\bar{x}$ and range (R) control chart are provided for the vitrification factors by batch for the SME vessel. The range chart indicates an out-of-control situation for the variability of batch 92. Out-of-control situations for the batch averages of these values are indicated for batches 80, 82, 84, and 92.

Figure 2: R and X-bar Charts for the Vitrification Factor by Batch for the SME



A first look at these vitrification factors determined from the MFT data is provided in Figure 3. In this exhibit, range (R) and $\overline{x}$ control charts are provided for the vitrification factors by batch for the MFT vessel. The range chart indicates no out-of-control situations. Out-of-control situations for the batch averages of these values are indicated for batches 82, 83, 84, 87, and 92.

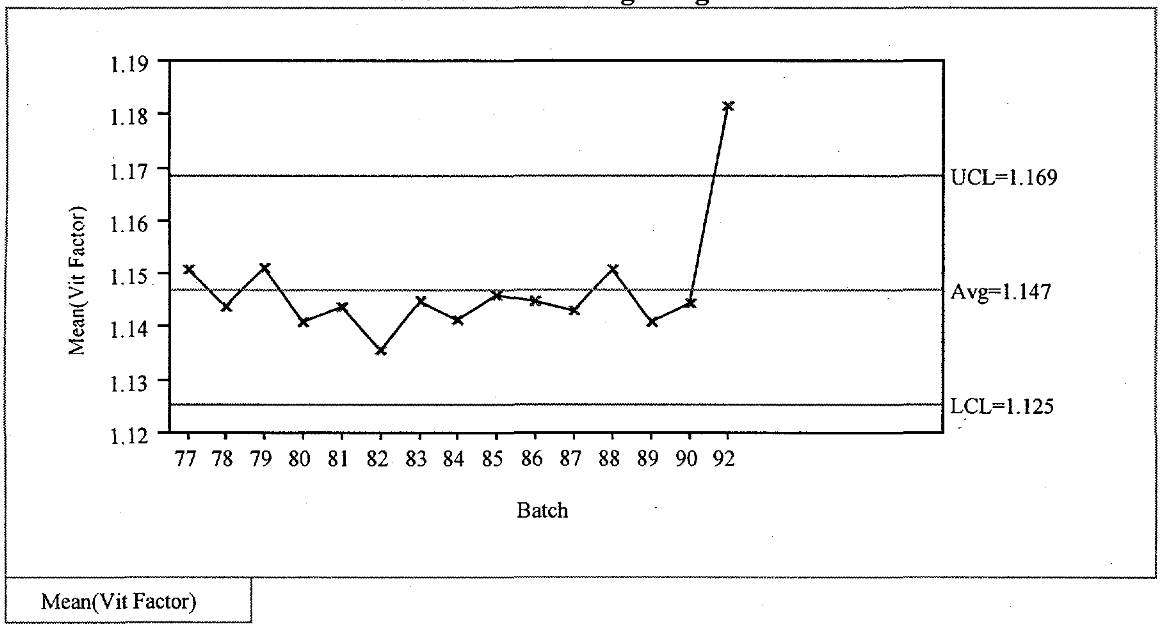
Figure 3: R and X-bar Charts for the Vitrification Factor by Batch for the MFT



The results of Figures 2 and 3 indicate that these processes are not in a state of statistical control. A contributing factor to this large number of out of control situations is related to the development of the control limits for these charts (i.e., the use of the samples from a single SME or MFT batch as the sub-group representing these processes). For each vessel, the control limits are determined using the variability within the samples from each batch. The variability among the vitrification factors determined from the samples of one batch is smaller (on average) than the variation between the batches. This between batch variation is not included in the development of the control limits (i.e., it is not captured in the samples from a single batch, the sub-groups used to determine these limits). Thus, the control limits determined from these sub-groups of the process are not appropriate for judging statistical stability.

To capture the between batch variation in the development of the control limits, an additional set of charts was prepared. Computing the average vitrification factor for each batch and developing an individuals control chart for the resulting values leads to Figures 4 and 5 for the SME and MFT, respectively. Figure 4 also includes a moving range chart for the SME values, and a moving range chart for the MFT data is included in Figure 5.

Figure 4: Control Charts for the Individual Vitrification Factor by SME Batch and for the Moving Range



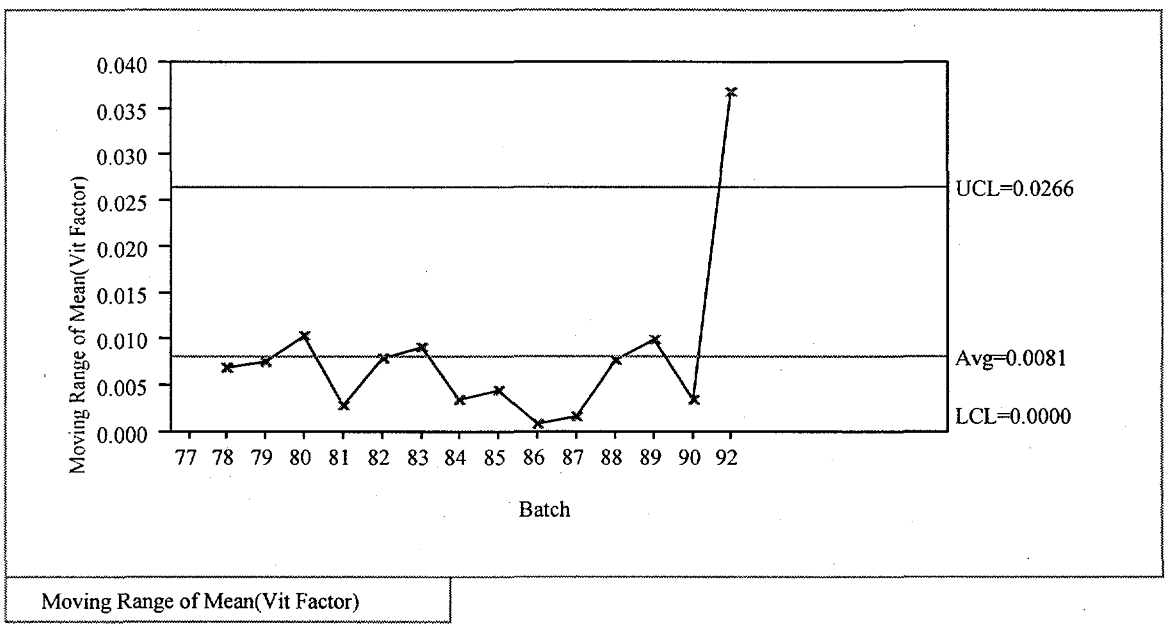
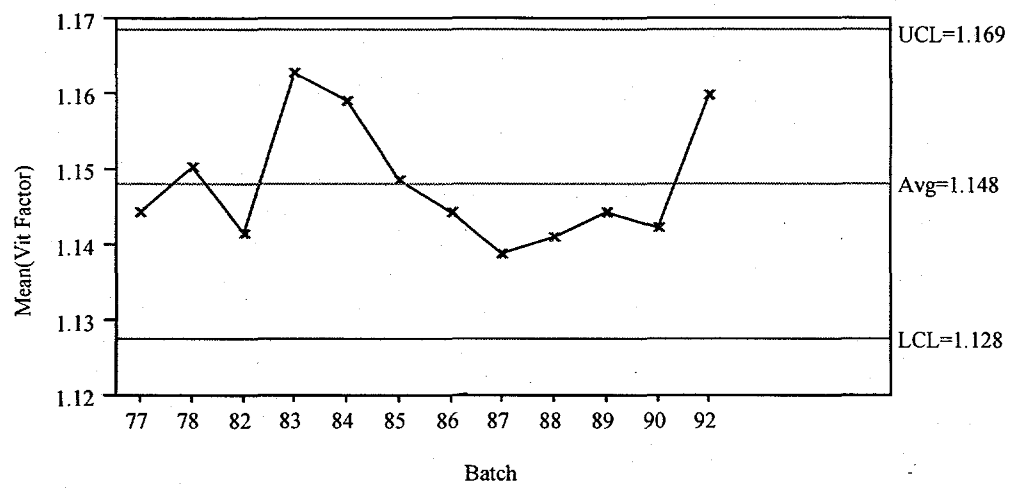
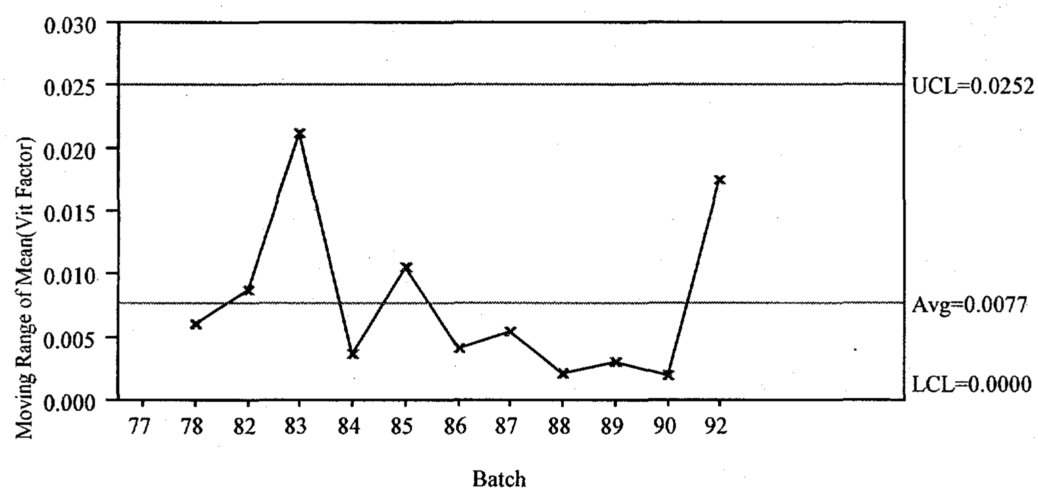


Figure 5: Control Charts for the Individual Vitrification Factor by MFT Batch and for the Moving Range



Mean(Vit Factor)



Moving Range of Mean(Vit Factor)

Figure 4 reveals only one batch, batch 92, outside of the 3-sigma limits for the SME results with no MFT batches out of control for Figure 5. A closer look at all of the available SME vitrification factors and in particular those for batch 92 is provided in Exhibit A.4 in the Appendix. There is no indication of an outlier among the values for batch 92; each of which are larger than all of the values determined for the other batches. The statistical tests presented in Exhibit A.4 indicate statistically significant (at the 5% significance level) differences among the means and variances of the vitrification factors across the SME batches.

The descriptive statistics for the vitrification factors for the SME and the MFT are summarized in Table 2. Unless there is an assignable cause for the out of control situation indicated at the batch 92 results, the results from this batch should be included in the statistics representing the vitrification factor. Thus, these results are included in the summary information shown in Table 2.

Table 2: Descriptive Statistics for Vitrification Factors

Including Batch 92	Sample Size	Mean	Standard Deviation	% Coefficient of Variation
MFT	12	1.1482	0.00815	0.70951
SME	15	1.1471	0.01041	0.90765

3.4 *Vitrification Factors Over the Course of a Macro-Batch*

Using the information from Table 2 and assuming that the vitrification factors for the production batches over a macro-batch follow (approximately) a normal distribution, then a tolerance interval approach can be used to bound the factors likely for these production batches. This leads to the following interval that provides coverage for 95% of the production batches with 95% confidence

$$\bar{x} \pm Ks = 1.1471 \pm 2.954(0.01041) = 1.1471 \pm 0.03075$$
$$(1.11635,\ 1.17785)$$

Or expressing this interval relative to the average value, the tolerance statement becomes

$$1.1471 \pm 2.681\%.$$

Note that (from Exhibit A.1) the vitrification factor value for SME batch 92, 1.1815, is not within this tolerance interval. This reflects the out of control situation for the batch, provides a strong indication of a lack of normality for these values, and echoes the need to identify a special cause for the results from this batch. When a special cause is identified, steps must be taken to eliminate this cause or mitigate its effect. Without an understanding of the cause for the larger than expected value for batch 92, there is an indication of a lack of predictability for the vitrification factors that might be encountered over the course of a processing a macro-batch. This lack of predictability precludes the use a single vitrification factor for a macro-batch leading to the need to develop such a factor for each SME batch.

4.0 *Concluding Comments and Recommendations*

This report used data from DWPF's macro-batch 1 to evaluate the vitrification factors needed for the conversion of cold chemical and insert fusion cation measurements. The available data were used to examine the stability of these values, to estimate their uncertainty over the course of a macro-batch, and to provide a recommendation on the use of a single factor for an entire macro-batch.

The data from one SME production batch (batch 92) indicated an out-of-control situation for the vitrification factor corresponding to this batch as compared to the other available data. The processing of and results from this batch need to be reviewed by DWPF Engineering to identify the reason(s) or assignable cause(s) for this behavior. If no such resolution for the batch 92 results is forthcoming, it is recommended that, in future testing of the new sampling and analytical methods, a vitrification factor be determined for each SME batch and that this factor be used to convert the resulting cation concentrations to a glass basis.

5.0 REFERENCES

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6.0 APPENDIX

Page Number

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Appendix: Tables and Exhibits
Table A.1: Macro-Batch 1A Sample Weights

Print Row ID	Batch-Vessel	Vessel	Batch	LIMS #	Empty Platinum wt (g)	Vial ID	Empty Vial + Cap wt (g)	Filled wt (g)	Zr ID	Empty Zr wt (g)	Dried Vial + Zr wt (g)	Calc wt (g)	Cap wt (g)	Actual Vial + Cap wt (g)	Actual Sample wt (g)	Total Dried wt (g)
1	77-SME	SME	77	50358	90.404	277	27.0720	44.826	6	59.446	82.769	23.323	3.862	27.185	17.754	99.273
2	77-SME	SME	77	50358	89.334	279	27.1085	45.218	5	54.242	77.563	23.321	3.898	27.219	18.110	98.335
3	77-SME	SME	77	50358	96.013	276	27.1667	44.849	2	54.673	78.109	23.436	4.083	27.519	17.682	104.567
4	77-SME	SME	77	50358	86.397	291	27.2898	44.859	1	56.642	80.067	23.425	3.957	27.382	17.569	95.049
5	77-SME	SME	77	50358	87.312	350	27.0853	45.025	4	56.293	79.550	23.257	3.891	27.148	17.940	96.195
6	77-SME	SME	77	50358	90.604	349	27.2523	45.342	3	53.754	77.168	23.414	3.969	27.383	18.090	99.654
7	77-MFT	MFT	77	50572	86.352	433	27.1830	45.372	6	54.585	77.924	23.339	3.909	27.248	18.189	93.586
8	77-MFT	MFT	77	50572	91.947	462	27.0590	45.407	5	56.087	79.319	23.232	3.914	27.146	18.348	100.683
9	77-MFT	MFT	77	50572	90.38	466	27.0570	45.598	4	58.431	81.333	22.902	3.844	26.746	18.541	99.346
10	77-MFT	MFT	77	50572	87.885	463	27.2640	45.075	3	51.667	75.104	23.437	3.976	27.413	17.811	96.038
11	77-MFT	MFT	77	50572	87.56	430	27.2930	45.418	2	60.965	84.414	23.449	3.933	27.382	18.125	96.194
12	77-MFT	MFT	77	50572	90.685	464	27.2640	45.622	1	58.505	81.999	23.494	3.855	27.349	18.358	99.308
13	78-SME	SME	78	50660	91.614	612	27.0470	46.049	2	60.915	84.333	23.418	3.846	27.264	19.002	101.264
14	78-SME	SME	78	50660	87.885	622	25.8670	45.749	1	58.464	80.975	22.511	3.856	26.367	19.882	97.536
15	78-SME	SME	78	50660	91.376	616	27.1580	46.234	4	58.080	81.596	23.516	3.875	27.391	19.076	100.226
16	78-SME	SME	78	50660	90.563	620	27.1870	46.302	6	54.540	78.066	23.526	3.902	27.428	19.115	100.474
17	78-SME	SME	78	50660	91.959	613	27.2030	46.252	3	51.633	75.553	23.920	3.903	27.823	19.049	101.234
18	78-SME	SME	78	50660	89.846	618	27.1090	46.109	0	57.082	81.117	24.035	3.996	28.031	19.000	98.795
19	78-MFT	MFT	78	50741	90.391	671	27.1840	43.992	No #	57.064	80.518	23.454	3.940	27.394	16.808	98.356
20	78-MFT	MFT	78	50741	87.898	678	26.9570	45.641	old 2 *	48.403	71.780	23.377	3.841	27.218	18.684	96.895
21	78-MFT	MFT	78	50741	91.958	675	27.1660	46.201	3	51.632	75.069	23.437	3.950	27.387	19.035	101.067
22	78-MFT	MFT	78	50741	87.397	676	27.8020	44.049	1	58.441	82.516	24.075	3.936	28.011	16.247	95.159
23	78-MFT	MFT	78	50741	91.105	674	27.5270	45.981	6	54.508	78.326	23.818	3.959	27.777	18.454	99.958
24	78-MFT	MFT	78	50741	89.862	679	27.8070	45.306	new 2 *	60.888	84.905	24.017	3.946	27.963	17.499	98.384
25	79-SME	SME	79	50830	91.628	987	27.0670	44.961	No #	50.832	74.028	23.196	3.876	27.072	17.894	100.312
26	79-SME	SME	79	50830	96.027	986	26.9480	44.617	5	55.983	79.185	23.202	3.757	26.959	17.669	104.462
27	79-SME	SME	79	50830	91.947	982	27.5290	45.017	32	52.839	76.666	23.827	3.815	27.642	17.488	100.325
28	79-SME	SME	79	50830	89.85	981	27.0600	44.779	11	54.739	77.946	23.207	3.881	27.088	17.719	98.451
29	79-SME	SME	79	50830	91.11	983	28.0880	45.509	11-Apr	58.121	82.316	24.195	3.955	28.150	17.421	99.676
30	79-SME	SME	79	50830	87.891	988	28.2940	45.928	7	54.768	79.284	24.516	3.868	28.384	17.634	96.308
31	80-SME	SME	80	51002	84.572	421	27.8090	45.542	*	51.584	75.689	24.105	3.815	27.920	17.733	93.149
32	80-SME	SME	80	51002	87.272	422	28.0670	45.332	*	50.831	75.076	24.245	3.912	28.157	17.265	95.697
33	80-SME	SME	80	51002	96.063	419	27.9910	46.092	*	57.307	81.587	24.280	3.894	28.174	18.101	104.570
34	80-SME	SME	80	51002	87.425	420	27.7290	45.866	11	58.151	82.193	24.042	3.792	27.834	18.137	95.852
35	80-SME	SME	80	51002	88.333	417	27.9450	45.457	32	52.855	76.974	24.119	3.881	28.000	17.512	96.809
36	80-SME	SME	80	51002	91.124	418	27.1800	45.088	*	54.652	78.003	23.351	3.905	27.256	17.908	99.891
37	81-SME	SME	81	51249	87.405	920	27.4580	45.259	17	55.069	78.769	23.700	3.868	27.568	17.801	96.235
38	81-SME	SME	81	51249	88.32	924	27.7910	45.265	5	56.309	80.295	23.986	3.931	27.917	17.474	96.958
39	81-SME	SME	81	51249	91.109	929	28.0020	45.419	7	58.739	82.870	24.131	3.931	28.062	17.417	99.762
40	81-SME	SME	81	51249	96.039	923	28.2230	45.519	14	53.240	77.642	24.402	3.916	28.318	17.296	104.664
41	81-SME	SME	81	51249	87.566	919	28.0150	45.566	10	55.500	79.745	24.245	3.846	28.091	17.551	96.336
42	81-SME	SME	81	51249	86.328	921	27.9860	45.603	9	56.600	80.844	24.244	3.849	28.093	17.617	95.102
43	81-MFT	MFT	81	51366	89.858	254	28.0300	42.210	10	52.137	76.413	24.276	3.890	28.166	14.180	102.859
44	81-MFT	MFT	81	51366	89.035	230	28.0530	45.837	14	48.808	73.101	24.293	3.860	28.153	17.784	104.130
45	81-MFT	MFT	81	51366	91.633	260	27.6640	44.649	7	56.018	79.886	23.868	3.867	27.735	16.985	105.123
46	81-MFT	MFT	81	51366	89.311	263	27.7140	45.820	5	56.309	80.212	23.903	3.965	27.868	18.106	101.053
47	81-MFT	MFT	81	51366	87.565	235	27.9360	43.948	4	56.716	80.884	24.168	3.857	28.025	16.012	103.652
48	81-MFT	MFT	81	51366	88.309	219	27.4920	45.424	9	54.613	78.235	23.622	3.983	27.605	17.932	103.765
49	82-SME	SME	82	51510	91.631	579	27.5930	45.679	4	54.710	78.344	23.634	3.861	27.495	18.086	100.404
50	82-SME	SME	82	51510	89.308	601	28.2280	46.467	14	48.387	72.776	24.389	3.877	28.266	18.239	98.066
51	82-SME	SME	82	51510	89.851	580	27.4480	45.872	13	44.526	68.237	23.711	3.839	27.550	18.424	98.744
52	82-SME	SME	82	51510	88.303	586	28.3180	46.303	10	51.927	76.459	24.532	3.910	28.442	17.985	97.012
53	82-SME	SME	82	51510	87.555	603	28.1260	46.389	11	50.842	75.130	24.288	3.886	28.174	18.263	96.484
54	82-SME	SME	82	51510	89.032	584	28.1930	46.511	7	55.597	79.895	24.298	3.921	28.219	18.318	98.018
55	82-MFT	MFT	82	51615	90.373	647	27.6190	45.049	5	56.220	79.973	23.753	3.931	27.684	17.430	98.172
56	82-MFT	MFT	82	51615	87.452	646	28.2650	44.892	16	55.030	79.442	24.412	3.917	28.329	16.627	94.814
57	82-MFT	MFT	82	51615	86.329	648	28.2180	45.487	0	58.225	82.647	24.422	3.977	28.399	17.269	94.112
58	82-MFT	MFT	82	51615	84.573	642	28.4310	43.051	17	55.085	79.685	24.600	3.929	28.529	14.620	91.097
59	82-MFT	MFT	82	51615	89.942	645	28.2200	44.850	0	57.468	81.941	24.473	3.869	28.342	16.630	97.327
60	82-MFT	MFT	82	51615	91.091	649	27.4370	44.849	9	54.143	77.841	23.698	3.823	27.521	17.412	98.543
61	83-SME	SME	83	51654	90.394	183	28.5700	46.089	8	56.391	81.104	24.713	3.896	28.609	17.519	98.589
62	83-SME	SME	83	51654	89.861	174	27.7440	45.739	1	53.005	76.906	23.901	3.896	27.797	17.995	98.450
63	83-SME	SME	83	51654	89.031	170	27.7690	45.073	3	53.382	77.364	23.982	3.879	27.861	17.304	97.269
64	83-SME	SME	83	51654	84.588	172	28.0810	45.890	13	58.311	82.535	24.224	3.925	28.149	17.809	93.087
65	83-SME	SME	83	51654	87.882	994	27.7470	45.829	2	58.722	82.684	23.962	3.869	27.831	18.082	96.461
66	83-SME	SME	83	51654	91.63	176	28.2450	45.955	15	57.237	81.694	24.457	3.865	28.322	17.710	100.019
67	83-MFT	MFT	83	51744	87.613	277	27.5090	45.077	2	58.695	82.835	24.140	3.907	28.047	17.568	94.733

Shaded entries were deemed as unrepresentative by DWPF Engineering and were not included in these analyses.

Table A.1: Macro-Batch 1A Sample Weights

Print Row ID	Batch-Vessel	Vessel	Batch	LIMS #	Empty Platinum wt (g)	Vial ID	Empty Vial + Cap wt (g)	Filled wt (g)	Zr ID	Empty Zr wt (g)	Dried Vial + Zr wt (g)	Calc wt (g)	Cap wt (g)	Actual Vial + Cap wt (g)	Actual Sample wt (g)	Total Dried wt (g)
68	83-MFT	MFT	83	51744	91.82	194	28.5660	44.310	3	53.966	78.247	24.281	4.010	28.291	15.744	98.388
69	83-MFT	MFT	83	51744	84.614	204	28.3580	44.061	8	56.380	81.259	24.879	3.947	28.826	15.703	91.069
70	83-MFT	MFT	83	51744	90.334	291(1)	27.5820	43.832	1	52.975	76.829	23.854	3.980	27.834	16.250	95.292
71	83-MFT	MFT	83	51744	89.903	297	28.4120	45.376	0	44.821	69.662	24.841	3.932	28.773	16.964	96.934
72	83-MFT	MFT	83	51744	87.907	312	28.9970	46.057	15	57.155	82.668	25.513	4.059	29.572	17.060	94.812
73	84-SME	SME	84	51826	91.644	518	28.4680	45.680	17	55.036	79.716	24.680	3.919	28.599	17.212	99.739
74	84-SME	SME	84	51826	89.302	524	27.6710	45.277	3	53.337	77.250	23.913	3.884	27.797	17.606	97.417
75	84-SME	SME	84	51826	88.663	519	28.3860	45.602	10	51.877	76.466	24.589	3.888	28.477	17.216	96.776
76	84-SME	SME	84	51826	90.58	564	28.6110	45.754	8	56.423	81.156	24.733	3.899	28.632	17.143	98.734
77	84-SME	SME	84	51826	91.929	562	28.6010	45.463	16	55.008	79.768	24.760	3.947	28.707	16.862	99.887
78	84-SME	SME	84	51826	88.965	521	28.0970	45.251	0	55.386	79.762	24.376	3.808	28.184	17.154	97.020
79	84-MFT	MFT	84	51923	89.025	570	28.5180	43.403	2	50.447	75.511	25.064	3.993	29.057	14.885	95.274
80	84-MFT	MFT	84	51923	91.951	605	27.8080	44.792	18	59.442	83.757	24.315	4.022	28.337	16.984	99.172
81	84-MFT	MFT	84	51923	88.555	992	28.5390	44.480	10	55.769	80.747	24.978	3.955	28.933	15.941	95.585
82	84-MFT	MFT	84	51923	91.637	568	27.6680	44.874	17	57.312	81.329	24.017	3.989	28.006	17.206	99.188
83	84-MFT	MFT	84	51923	89.31	604	28.3130	45.366	7	58.684	83.339	24.655	3.975	28.630	17.053	96.841
84	84-MFT	MFT	84	51923	91.183	615	27.5910	44.964	5	52.390	76.461	24.071	3.937	28.008	17.373	98.727
85	85-SME	SME	85	51979	84.577	131	27.8090	45.778	18	59.433	83.407	23.974	3.977	27.951	17.969	93.426
86	85-SME	SME	85	51979	87.405	142	27.6740	45.567	2	50.436	74.305	23.869	3.906	27.775	17.893	96.096
87	85-SME	SME	85	51979	89.868	140	27.7360	45.435	10	55.817	79.699	23.882	3.988	27.870	17.699	98.463
88	85-SME	SME	85	51979	87.297	136	27.9340	45.689	17	57.359	81.439	24.080	3.978	28.058	17.755	95.996
89	85-SME	SME	85	51979	88.307	141	27.7260	45.201	12	51.006	74.967	23.961	3.888	27.849	17.475	96.848
90	85-SME	SME	85	51979	86.326	135	27.9920	45.638	7	58.698	82.864	24.166	3.947	28.113	17.646	94.904
91	85-MFT	MFT	85	52072	88.57	369	27.6940	45.178	16	54.402	78.298	23.896	3.896	27.792	17.484	96.860
92	85-MFT	MFT	85	52072	91.147	365	28.5500	46.205	18	59.448	84.185	24.737	3.886	28.623	17.655	99.530
93	85-MFT	MFT	85	52072	89.316	368	28.5480	44.098	10	55.746	80.494	24.748	3.906	28.654	15.550	96.782
94	85-MFT	MFT	85	52072	89.036	362	27.9860	46.193	15	60.891	85.113	24.222	3.917	28.139	18.207	97.605
95	85-MFT	MFT	85	52072	91.982	381	28.0240	45.997	5	52.398	76.638	24.240	3.938	28.178	17.973	100.453
96	85-MFT	MFT	85	52072	91.633	374	28.1420	43.741	17	57.279	81.624	24.345	3.931	28.276	15.599	98.941
97	86-SME	SME	86	52147	89.039	681	28.0260	45.575	5	52.385	76.617	24.232	4.083	28.315	17.549	97.191
98	86-SME	SME	86	52147	91.957	803	27.6440	45.416	10	55.709	79.519	23.810	3.906	27.716	17.772	100.549
99	86-SME	SME	86	52147	88.562	804	28.3780	45.856	14	59.404	83.941	24.537	3.925	28.462	17.478	96.838
100	86-SME	SME	86	52147	91.63	808	28.0240	45.709	17	57.347	81.391	24.044	3.940	27.984	17.685	99.914
101	86-SME	SME	86	52147	89.306	811	28.3990	46.086	18	59.334	83.851	24.517	3.968	28.485	17.687	97.982
102	86-SME	SME	86	52147	91.145	682	27.7180	45.654	19	60.681	84.500	23.819	3.998	27.817	17.936	99.456
103	86-MFT	MFT	86	52225	89.87	619	28.4520	45.978	2	50.429	75.191	24.762	3.760	28.522	17.526	98.329
104	86-MFT	MFT	86	52225	91.977	654	28.3560	46.007	5	52.381	76.946	24.565	3.887	28.452	17.651	100.163
105	86-MFT	MFT	86	52225	88.582	657	28.5390	45.676	10	55.706	80.456	24.750	3.840	28.590	17.137	96.692
106	86-MFT	MFT	86	52225	88.311	655	28.5670	45.877	16	54.367	79.066	24.699	3.929	28.628	17.310	96.412
107	86-MFT	MFT	86	52225	89.306	623	28.5090	45.229	18	59.339	84.046	24.707	3.848	28.555	16.720	97.220
108	86-MFT	MFT	86	52225	91.153	622	27.8820	45.688	19	60.679	84.776	24.097	3.844	27.941	17.806	99.502
109	87-SME	SME	87	52269	91.634	986	27.9080	45.133	13	58.054	82.109	24.055	3.897	27.952	17.225	99.774
110	87-SME	SME	87	52269	87.409	988	27.9830	45.301	3	58.226	82.367	24.141	3.887	28.028	17.318	95.599
111	87-SME	SME	87	52269	89.058	965	28.0110	44.990	8	63.242	87.355	24.113	3.814	27.927	16.979	96.960
112	87-SME	SME	87	52269	88.329	977	28.0340	45.111	15	60.926	85.327	24.401	3.844	28.245	17.077	96.111
113	87-SME	SME	87	52269	86.333	972	28.0280	45.319	2	51.098	75.323	24.225	3.861	28.086	17.291	94.495
114	87-SME	SME	87	52269	87.894	966	27.9610	45.064	11	57.521	81.719	24.198	3.814	28.012	17.103	95.786
115	87-MFT	MFT	87	52406	91.979	411	27.6590	45.153	11	52.316	76.174	23.858	3.753	27.611	17.494	99.951
116	87-MFT	MFT	87	52406	89.411	469	27.4400	44.368	10	53.919	77.412	23.493	3.934	27.427	16.928	97.157
117	87-MFT	MFT	87	52406	89.849	106(601)	27.9990	43.443	5	47.613	71.801	24.188	3.925	28.113	15.444	96.903
118	87-MFT	MFT	87	52406	87.877	586	27.9540	43.518	6	53.963	78.097	24.134	3.924	28.058	15.564	95.059
119	87-MFT	MFT	87	52406	88.562	600	27.7900	43.163	15	59.981	84.081	24.100	3.887	27.987	15.373	95.518
120	87-MFT	MFT	87	52406	91.677	413	27.7490	43.887	12	53.650	77.567	23.917	3.986	27.903	16.138	98.845
121	88-SME	SME	88	52502	91.659	131	27.8150	45.711	8	57.602	81.235	23.633	3.999	27.632	17.896	100.171
122	88-SME	SME	88	52502	92.151	128	27.9010	45.493	1	59.216	83.024	23.808	4.047	27.855	17.592	100.350
123	88-SME	SME	88	52502	89.909	126	27.8740	45.690	0	53.200	76.927	23.727	4.064	27.791	17.816	98.351
124	88-SME	SME	88	52502	89.317	129	28.0460	45.725	7	59.944	83.701	23.757	4.137	27.894	17.679	97.682
125	88-SME	SME	88	52502	89.027	130	27.8480	45.444	3	60.399	84.053	23.654	4.048	27.702	17.596	97.058
126	88-SME	SME	88	52502	88.339	127	27.8190	45.637	22	52.283	76.030	23.747	4.002	27.749	17.818	96.765
127	88-MFT	MFT	88	52561	84.582	202	28.1160	43.978	3	60.082	84.214	24.132	3.875	28.007	15.862	91.742
128	88-MFT	MFT	88	52561	90.036	206	27.8860	44.730	21	55.796	78.521	22.725	3.884	26.609	16.844	97.952
129	88-MFT	MFT	88	52561	87.568	401	27.8590	45.835	6	53.819	77.822	24.003	3.889	27.892	17.976	95.831
130	88-MFT	MFT	88	52561	92.19	415	27.8490	44.959	11	51.760	86.308	34.548	3.916	38.464	17.110	100.115
131	88-MFT	MFT	88	52561	88.394	416	27.8470	45.611	4	54.579	75.699	21.120	3.869	24.989	17.764	96.505
132	88-MFT	MFT	88	52561	89.348	417	27.6290	45.312	9	62.577	79.534	16.957	3.856	20.813	17.683	97.642
133	89-SME	SME	89	52637	91.633	204	27.7440	46.877	3	59.977	83.997	24.020	3.894	27.914	19.133	99.666
134	89-SME	SME	89	52637	88.546	209	27.5810	45.361	8	57.244	81.194	23.950	3.951	27.901	17.780	96.723

Shaded entries were deemed as unrepresentative by DWPF Engineering and were not included in these analyses.

Table A.1: Macro-Batch 1A Sample Weights

Print Row ID	Batch-Vessel	Vessel	Batch	LIMS #	Empty Platinum wt (g)	Vial ID	Empty Vial + Cap wt (g)	Filled wt (g)	Zr ID	Empty Zr wt (g)	Dried Vial + Zr wt (g)	Calc wt (g)	Cap wt (g)	Actual Vial + Cap wt (g)	Actual Sample wt (g)	Total Dried wt (g)
135	89-SME	SME	89	52637	84.572	121	27.7530	45.266	20	54.725	78.833	24.108	3.842	27.950	17.513	92.670
136	89-SME	SME	89	52637	89.895	205	27.9990	46.068	32	53.935	78.157	24.222	4.038	28.260	18.069	98.241
137	89-SME	SME	89	52637	89.396	211	28.0540	45.102	1	51.482	75.919	24.437	4.076	28.513	17.048	94.652
138	89-SME	SME	89	52637	87.57	962	27.8390	45.486	5	58.889	82.996	24.107	3.900	28.007	17.647	95.829
139	89-MFT	MFT	89	52752	84.568	309	27.5570	44.329	4	54.533	78.338	23.805	3.866	27.671	16.772	92.093
140	89-MFT	MFT	89	52752	89.862	314	27.6320	44.889	6	53.852	77.631	23.779	3.942	27.721	17.257	97.413
141	89-MFT	MFT	89	52752	89.031	307	27.5810	45.247	9	58.925	82.742	23.817	3.865	27.682	17.666	96.959
142	89-MFT	MFT	89	52752	88.552	308	27.5300	45.183	10	53.588	77.333	23.745	3.856	27.601	17.653	96.447
143	89-MFT	MFT	89	52752	88.296	316	27.6020	45.214	20	54.764	78.534	23.770	3.919	27.689	17.612	96.072
144	89-MFT	MFT	89	52752	89.312	312	28.1010	44.825	0	59.731	84.068	24.337	3.878	28.215	16.724	96.528
145	90-SME	SME	90	52826	89.86	421	27.5020	45.295	0	53.497	77.937	24.440	3.890	28.330	17.793	96.587
146	90-SME	SME	90	52826	87.404	420	28.0440	45.325	A	59.400	84.143	24.743	3.876	28.619	17.281	94.421
147	90-SME	SME	90	52826	89.315	425	27.7540	45.162	6	53.596	78.635	25.039	3.873	28.912	17.408	95.347
148	90-SME	SME	90	52826	84.576	424	27.6190	45.150	0	45.327	69.211	23.884	3.974	27.858	17.531	92.208
149	90-SME	SME	90	52826	88.683	407	28.1460	45.540	1	58.749	83.530	24.781	4.095	28.876	17.394	95.643
150	90-SME	SME	90	52826	87.27	409	27.8950	45.351	2	54.598	79.117	24.519	4.189	28.708	17.456	93.303
151	90-MFT	MFT	90	53066	89.314	391	27.9470	45.524	9	51.289	75.430	24.141	3.930	28.071	17.577	97.294
152	90-MFT	MFT	90	53066	87.403	398	27.8660	45.538	23	55.018	79.105	24.087	3.939	28.026	17.672	95.193
153	90-MFT	MFT	90	53066	88.359	409	27.2350	43.830	20	54.389	77.810	23.421	3.978	27.399	16.595	95.657
154	90-MFT	MFT	90	53066	88.555	408	27.9320	45.427	21	55.646	79.811	24.165	3.901	28.066	17.495	96.353
155	90-MFT	MFT	90	53066	91.146	405	27.9340	45.165	5	47.228	71.422	24.194	3.891	28.085	17.231	98.777
156	90-MFT	MFT	90	53066	90.577	407	27.8680	45.524	0	53.858	77.979	24.121	3.903	28.024	17.656	98.437
157	92-SME	SME	92	53161	84.576	516	27.8660	44.340	1	53.838	78.008	24.170	3.907	28.077	16.474	91.375
158	92-SME	SME	92	53161	92.162	520	27.9180	44.406	0	58.594	82.866	24.272	3.985	28.257	16.488	98.766
159	92-SME	SME	92	53161	88.96	507	27.3300	43.847	20	54.321	78.149	23.828	3.777	27.605	16.517	95.968
160	92-SME	SME	92	53161	89.74	504	27.7280	44.449	10	53.202	77.459	24.257	3.803	28.060	16.721	96.752
161	92-SME	SME	92	53161	92.034	521	27.3680	44.316	0	51.279	75.044	23.765	3.885	27.650	16.948	99.181
162	92-SME	SME	92	53161	88.549	523	27.4440	44.284	2	55.601	79.431	23.830	3.953	27.783	16.840	95.613
163	92-MFT	MFT	92	53235	87.844	644	25.4280	42.744	30	53.194	76.881	23.687	1.914	25.601	17.316	94.532
164	92-MFT	MFT	92	53235	96.184	646	25.3980	40.877	13	58.609	82.218	23.609	1.818	25.427	15.479	102.457
165	92-MFT	MFT	92	53235	89.074	651	25.8280	42.836	20	54.357	78.475	24.118	1.831	25.949	17.008	96.249
166	92-MFT	MFT	92	53235	89.244	648	25.9090	42.908	73	59.350	83.417	24.067	1.953	26.020	16.999	95.711
167	92-MFT	MFT	92	53235	89.471	653	25.3580	43.289	21	55.712	79.266	23.554	1.847	25.401	17.931	96.364
168	92-MFT	MFT	92	53235	89.625	645	25.9350	42.978	1	53.916	77.920	24.004	1.962	25.966	17.043	95.646

Shaded entries were deemed as unrepresentative by DWPF Engineering and were not included in these analyses.

Appendix: Tables and Exhibits
Table A.1: Macro-Batch 1A Sample Weights

Print Row ID	Batch-Vessel	Vessel	Batch	LIMS #	a Net Dried wt (g)	Total Calcine wt (g)	b Net Calcine wt (g)	Total Vitrified wt (g)	c Net Vitrified wt (g)	d Net Sample wt (g)	=100a/d Dried wt%	=100b/d Calcine wt%	=100c/d Vitrified wt%
1	77-SME	SME	77	50358	8.869	98.247	7.843	98.121	7.717	17.641	50.27	44.46	43.74
2	77-SME	SME	77	50358	9.001	97.302	7.968	97.158	7.824	17.999	50.01	44.27	43.47
3	77-SME	SME	77	50358	8.554	103.640	7.627	103.453	7.440	17.330	49.36	44.01	42.93
4	77-SME	SME	77	50358	8.652	94.046	7.649	93.895	7.498	17.477	49.51	43.77	42.90
5	77-SME	SME	77	50358	8.883	95.148	7.836	95.009	7.697	17.877	49.69	43.83	43.06
6	77-SME	SME	77	50358	9.050	98.650	8.046	98.489	7.885	17.959	50.39	44.80	43.91
7	77-MFT	MFT	77	50572	7.234	99.053	12.701	99.048	12.696	18.124	39.91	70.08	70.05
8	77-MFT	MFT	77	50572	8.736	99.587	7.640	99.577	7.630	18.261	47.84	41.84	41.78
9	77-MFT	MFT	77	50572	8.966	98.237	7.857	98.214	7.834	18.852	47.56	41.68	41.56
10	77-MFT	MFT	77	50572	8.153	95.071	7.186	95.042	7.157	17.662	46.16	40.69	40.52
11	77-MFT	MFT	77	50572	8.634	95.197	7.637	95.111	7.551	18.036	47.87	42.34	41.87
12	77-MFT	MFT	77	50572	8.623	98.316	7.631	98.186	7.501	18.273	47.19	41.76	41.05
13	78-SME	SME	78	50660	9.650	100.185	8.571	100.066	8.452	18.785	51.37	45.63	44.99
14	78-SME	SME	78	50660	9.651	96.426	8.541	96.315	8.430	19.382	49.79	44.07	43.49
15	78-SME	SME	78	50660	8.850	99.062	7.686	98.983	7.607	18.843	46.97	40.79	40.37
16	78-SME	SME	78	50660	9.911	99.323	8.760	99.251	8.688	18.874	52.51	46.41	46.03
17	78-SME	SME	78	50660	9.275	100.141	8.182	100.044	8.085	18.429	50.33	44.40	43.87
18	78-SME	SME	78	50660	8.949	97.741	7.895	97.663	7.817	18.078	49.50	43.67	43.24
19	78-MFT	MFT	78	50741	7.965	97.474	7.083	97.292	6.901	16.598	47.99	42.67	41.58
20	78-MFT	MFT	78	50741	8.997	95.873	7.975	95.726	7.828	18.423	48.84	43.29	42.49
21	78-MFT	MFT	78	50741	9.109	100.053	8.095	99.870	7.912	18.814	48.42	43.03	42.05
22	78-MFT	MFT	78	50741	7.762	94.292	6.895	94.091	6.694	16.038	48.40	42.99	41.74
23	78-MFT	MFT	78	50741	8.853	98.993	7.888	98.837	7.732	18.204	48.63	43.33	42.47
24	78-MFT	MFT	78	50741	8.522	97.444	7.582	97.319	7.457	17.343	49.14	43.72	43.00
25	79-SME	SME	79	50830	8.684	99.263	7.635	99.129	7.501	17.889	48.54	42.68	41.93
26	79-SME	SME	79	50830	8.435	103.474	7.447	103.318	7.291	17.658	47.77	42.17	41.29
27	79-SME	SME	79	50830	8.378	99.339	7.392	99.212	7.265	17.375	48.22	42.54	41.81
28	79-SME	SME	79	50830	8.601	97.465	7.615	97.324	7.474	17.691	48.62	43.04	42.25
29	79-SME	SME	79	50830	8.566	98.712	7.602	98.608	7.498	17.359	49.35	43.79	43.19
30	79-SME	SME	79	50830	8.417	95.286	7.395	95.228	7.337	17.544	47.98	42.15	41.82
31	80-SME	SME	80	51002	8.577	92.223	7.651	92.083	7.511	17.622	48.67	43.42	42.62
32	80-SME	SME	80	51002	8.425	94.835	7.563	94.671	7.399	17.175	49.05	44.03	43.08
33	80-SME	SME	80	51002	8.507	103.678	7.615	103.512	7.449	17.918	47.48	42.50	41.57
34	80-SME	SME	80	51002	8.427	94.993	7.568	94.824	7.399	18.032	46.73	41.97	41.03
35	80-SME	SME	80	51002	8.476	95.915	7.582	95.741	7.408	17.457	48.55	43.43	42.44
36	80-SME	SME	80	51002	8.767	99.002	7.878	98.814	7.690	17.832	49.16	44.18	43.12
37	81-SME	SME	81	51249	8.830	95.310	7.905	95.129	7.724	17.691	49.91	44.68	43.66
38	81-SME	SME	81	51249	8.638	96.028	7.708	95.865	7.545	17.348	49.79	44.43	43.49
39	81-SME	SME	81	51249	8.653	98.834	7.725	98.665	7.556	17.357	49.85	44.51	43.53
40	81-SME	SME	81	51249	8.625	103.757	7.718	103.599	7.560	17.201	50.14	44.87	43.95
41	81-SME	SME	81	51249	8.770	95.437	7.871	95.231	7.665	17.475	50.19	45.04	43.86
42	81-SME	SME	81	51249	8.774	94.180	7.852	93.992	7.664	17.510	50.11	44.84	43.77
43	81-MFT	MFT	81	51366	13.001	95.045	5.187	94.987	5.129	14.044	92.57	36.93	36.52
44	81-MFT	MFT	81	51366	15.095	95.956	6.921	95.873	6.838	17.684	85.36	39.14	38.67
45	81-MFT	MFT	81	51366	13.490	98.656	7.023	98.555	6.922	16.914	79.76	41.52	40.92
46	81-MFT	MFT	81	51366	11.742	96.726	7.415	96.588	7.277	17.952	65.41	41.30	40.54
47	81-MFT	MFT	81	51366	16.087	92.694	5.129	92.673	5.108	15.923	101.03	32.21	32.08
48	81-MFT	MFT	81	51366	15.456	95.660	7.351	95.509	7.200	17.819	86.74	41.25	40.41
49	82-SME	SME	82	51510	8.773	99.545	7.914	99.351	7.720	18.184	48.25	43.52	42.45
50	82-SME	SME	82	51510	8.758	97.182	7.874	97.010	7.702	18.201	48.12	43.26	42.32
51	82-SME	SME	82	51510	8.893	97.834	7.983	97.663	7.812	18.322	48.54	43.57	42.64
52	82-SME	SME	82	51510	8.709	96.172	7.869	95.967	7.664	17.861	48.76	44.06	42.91
53	82-SME	SME	82	51510	8.929	95.630	8.075	95.428	7.873	18.215	49.02	44.33	43.22
54	82-SME	SME	82	51510	8.986	97.097	8.065	96.966	7.934	18.292	49.13	44.09	43.37
55	82-MFT	MFT	82	51615	7.799	97.337	6.964	97.207	6.834	17.365	44.91	40.10	39.36
56	82-MFT	MFT	82	51615	7.362	94.007	6.555	93.890	6.438	16.563	44.45	39.58	38.87
57	82-MFT	MFT	82	51615	7.783	93.283	6.954	93.161	6.832	17.088	45.55	40.70	39.98
58	82-MFT	MFT	82	51615	6.524	90.393	5.820	90.274	5.701	14.522	44.92	40.08	39.26
59	82-MFT	MFT	82	51615	7.385	96.589	6.647	96.406	6.464	16.508	44.74	40.27	39.16
60	82-MFT	MFT	82	51615	7.452	97.730	6.639	97.634	6.543	17.328	43.01	38.31	37.76
61	83-SME	SME	83	51654	8.195	97.670	7.276	97.550	7.156	17.480	46.88	41.62	40.94
62	83-SME	SME	83	51654	8.589	97.466	7.605	96.894	7.033	17.942	47.87	42.39	39.20
63	83-SME	SME	83	51654	8.238	96.299	7.268	96.208	7.177	17.212	47.86	42.23	41.70
64	83-SME	SME	83	51654	8.499	92.085	7.497	92.016	7.428	17.741	47.91	42.26	41.87
65	83-SME	SME	83	51654	8.579	95.446	7.564	95.378	7.496	17.998	47.67	42.03	41.65
66	83-SME	SME	83	51654	8.389	99.042	7.412	98.967	7.337	17.633	47.58	42.03	41.61
67	83-MFT	MFT	83	51744	7.120	93.903	6.290	93.746	6.133	17.030	41.81	36.93	36.01

Shaded entries were deemed as unrepresentative by DWPF Engineering and were not included in these analyses.

Table A.1: Macro-Batch 1A Sample Weights

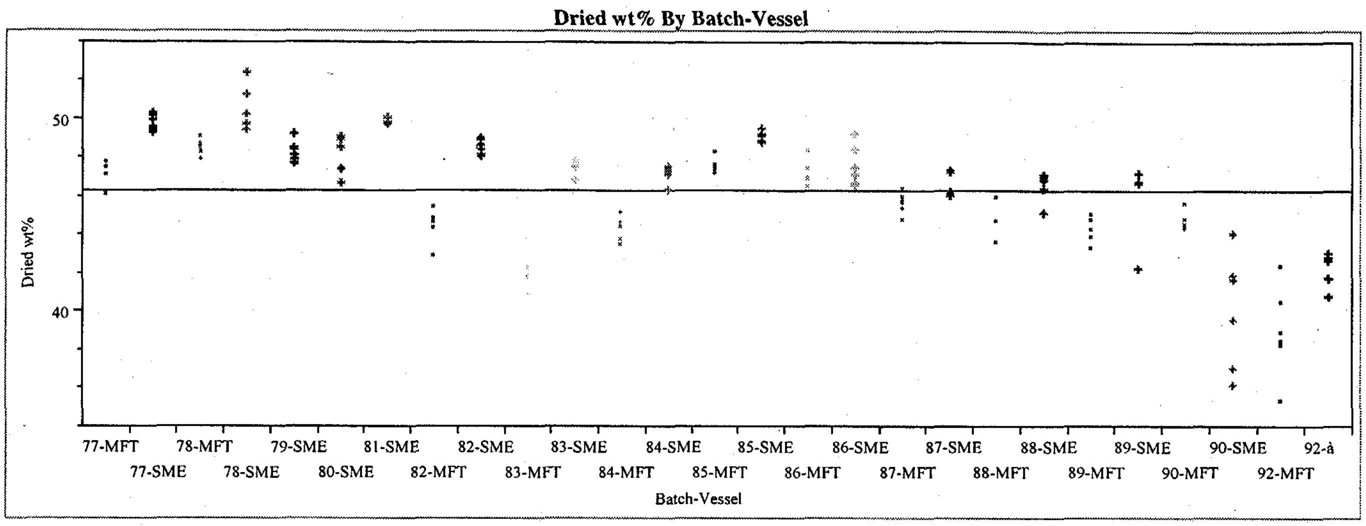
Print Row ID	Batch-Vessel	Vessel	Batch	LIMS #	a Net Dried wt (g)	Total Calcine wt (g)	b Net Calcine wt (g)	Total Vitrified wt (g)	c Net Vitrified wt (g)	d Net Sample wt (g)	=100a/d Dried wt%	=100b/d Calcine wt%	=100c/d Vitrified wt%
68	83-MFT	MFT	83	51744	6.568	97.597	5.777	97.400	5.580	16.019	41.00	36.06	34.83
69	83-MFT	MFT	83	51744	6.455	90.284	5.670	90.190	5.576	15.235	42.37	37.22	36.60
70	83-MFT	MFT	83	51744	4.958	94.506	4.172	94.382	4.048	15.998	30.99	26.08	25.30
71	83-MFT	MFT	83	51744	7.031	96.069	6.166	95.984	6.081	16.603	42.35	37.14	36.63
72	83-MFT	MFT	83	51744	6.905	93.932	6.025	93.847	5.940	16.485	41.89	36.55	36.03
73	84-SME	SME	84	51826	8.095	98.832	7.188	98.741	7.097	17.081	47.39	42.08	41.55
74	84-SME	SME	84	51826	8.115	96.525	7.223	96.403	7.101	17.480	46.42	41.32	40.62
75	84-SME	SME	84	51826	8.113	95.917	7.254	95.776	7.113	17.125	47.38	42.36	41.54
76	84-SME	SME	84	51826	8.154	97.816	7.236	97.728	7.148	17.122	47.62	42.26	41.75
77	84-SME	SME	84	51826	7.958	99.028	7.099	98.903	6.974	16.756	47.49	42.37	41.62
78	84-SME	SME	84	51826	8.055	96.117	7.152	96.011	7.046	17.067	47.20	41.91	41.28
79	84-MFT	MFT	84	51923	6.249	94.462	5.437	94.380	5.355	14.346	43.56	37.90	37.33
80	84-MFT	MFT	84	51923	7.221	98.228	6.277	98.168	6.217	16.455	43.88	38.15	37.78
81	84-MFT	MFT	84	51923	7.030	94.765	6.210	94.660	6.105	15.547	45.22	39.94	39.27
82	84-MFT	MFT	84	51923	7.551	98.219	6.582	98.176	6.539	16.868	44.77	39.02	38.77
83	84-MFT	MFT	84	51923	7.531	95.295	5.985	95.238	5.928	16.736	45.00	35.76	35.42
84	84-MFT	MFT	84	51923	7.544	97.750	6.567	97.680	6.497	16.956	44.49	38.73	38.32
85	85-SME	SME	85	51979	8.849	92.402	7.825	92.330	7.753	17.827	49.64	43.89	43.49
86	85-SME	SME	85	51979	8.691	95.068	7.663	94.983	7.578	17.792	48.85	43.07	42.59
87	85-SME	SME	85	51979	8.595	97.464	7.596	97.355	7.487	17.565	48.93	43.25	42.62
88	85-SME	SME	85	51979	8.699	94.964	7.667	94.892	7.595	17.631	49.34	43.49	43.08
89	85-SME	SME	85	51979	8.541	95.860	7.553	95.756	7.449	17.352	49.22	43.53	42.93
90	85-SME	SME	85	51979	8.578	93.930	7.604	93.800	7.474	17.525	48.95	43.39	42.65
91	85-MFT	MFT	85	52072	8.290	95.907	7.337	95.786	7.216	17.386	47.68	42.20	41.50
92	85-MFT	MFT	85	52072	8.383	98.617	7.470	98.487	7.340	17.582	47.68	42.49	41.75
93	85-MFT	MFT	85	52072	7.466	95.975	6.659	95.854	6.538	15.444	48.34	43.12	42.33
94	85-MFT	MFT	85	52072	8.569	96.673	7.637	96.471	7.435	18.054	47.46	42.30	41.18
95	85-MFT	MFT	85	52072	8.471	99.465	7.483	99.369	7.387	17.819	47.54	41.99	41.46
96	85-MFT	MFT	85	52072	7.308	98.080	6.447	97.937	6.304	15.465	47.26	41.69	40.76
97	86-SME	SME	86	52147	8.152	96.279	7.240	96.141	7.102	17.260	47.23	41.95	41.15
98	86-SME	SME	86	52147	8.592	99.614	7.657	99.480	7.523	17.700	48.54	43.26	42.50
99	86-SME	SME	86	52147	8.276	95.880	7.318	95.782	7.220	17.394	47.58	42.07	41.51
100	86-SME	SME	86	52147	8.284	98.967	7.337	98.829	7.199	17.725	46.74	41.39	40.61
101	86-SME	SME	86	52147	8.676	97.069	7.763	96.958	7.652	17.601	49.29	44.11	43.47
102	86-SME	SME	86	52147	8.311	98.464	7.319	98.375	7.230	17.837	46.59	41.03	40.53
103	86-MFT	MFT	86	52225	8.459	97.437	7.567	97.309	7.439	17.456	48.46	43.35	42.62
104	86-MFT	MFT	86	52225	8.186	99.266	7.289	99.116	7.139	17.555	46.63	41.52	40.67
105	86-MFT	MFT	86	52225	8.110	95.821	7.239	95.668	7.086	17.086	47.47	42.37	41.47
106	86-MFT	MFT	86	52225	8.101	95.512	7.201	95.386	7.075	17.249	46.97	41.75	41.02
107	86-MFT	MFT	86	52225	7.914	96.362	7.056	96.212	6.906	16.674	47.46	42.32	41.42
108	86-MFT	MFT	86	52225	8.349	98.578	7.425	98.428	7.275	17.747	47.04	41.84	40.99
109	87-SME	SME	87	52269	8.140	98.816	7.182	98.772	7.138	17.181	47.38	41.80	41.55
110	87-SME	SME	87	52269	8.190	94.681	7.272	94.585	7.176	17.273	47.42	42.10	41.54
111	87-SME	SME	87	52269	7.902	96.095	7.037	95.960	6.902	17.063	46.31	41.24	40.45
112	87-SME	SME	87	52269	7.782	95.221	6.892	95.111	6.782	16.866	46.14	40.86	40.21
113	87-SME	SME	87	52269	8.162	93.591	7.258	93.506	7.173	17.233	47.36	42.12	41.62
114	87-SME	SME	87	52269	7.892	94.906	7.012	94.768	6.874	17.052	46.28	41.12	40.31
115	87-MFT	MFT	87	52406	7.972	99.123	7.144	98.966	6.987	17.542	45.45	40.73	39.83
116	87-MFT	MFT	87	52406	7.746	96.346	6.935	96.226	6.815	16.941	45.72	40.94	40.23
117	87-MFT	MFT	87	52406	7.054	96.147	6.298	96.021	6.172	15.330	46.01	41.08	40.26
118	87-MFT	MFT	87	52406	7.182	94.322	6.445	94.190	6.313	15.460	46.46	41.69	40.83
119	87-MFT	MFT	87	52406	6.956	94.769	6.207	94.661	6.099	15.176	45.84	40.90	40.19
120	87-MFT	MFT	87	52406	7.168	98.136	6.459	97.991	6.314	15.984	44.84	40.41	39.50
121	88-SME	SME	88	52502	8.512	99.214	7.555	99.079	7.420	18.079	47.08	41.79	41.04
122	88-SME	SME	88	52502	8.199	99.436	7.285	99.292	7.141	17.638	46.48	41.30	40.49
123	88-SME	SME	88	52502	8.442	97.357	7.448	97.272	7.363	17.899	47.16	41.61	41.14
124	88-SME	SME	88	52502	8.365	96.719	7.402	96.602	7.285	17.831	46.91	41.51	40.86
125	88-SME	SME	88	52502	8.031	96.065	7.038	95.932	6.905	17.742	45.27	39.67	38.92
126	88-SME	SME	88	52502	8.426	95.806	7.467	95.645	7.306	17.888	47.10	41.74	40.84
127	88-MFT	MFT	88	52561	7.160	90.875	6.293	90.836	6.254	15.971	44.83	39.40	39.16
128	88-MFT	MFT	88	52561	7.916	97.050	7.014	96.995	6.959	18.121	43.68	38.71	38.40
129	88-MFT	MFT	88	52561	8.263	94.864	7.296	94.808	7.240	17.943	46.05	40.66	40.35
130	88-MFT	MFT	88	52561	7.925	99.208	7.018	99.132	6.942	6.495	122.02	108.05	106.88
131	88-MFT	MFT	88	52561	8.111	95.557	7.163	95.460	7.066	20.622	39.33	34.73	34.26
132	88-MFT	MFT	88	52561	8.294	96.720	7.372	96.626	7.278	24.499	33.85	30.09	29.71
133	89-SME	SME	89	52637	8.033	98.745	7.112	98.660	7.027	18.963	42.36	37.50	37.06
134	89-SME	SME	89	52637	8.177	95.781	7.235	95.719	7.173	17.460	46.83	41.44	41.08

Shaded entries were deemed as unrepresentative by DWPF Engineering and were not included in these analyses.

Table A.1: Macro-Batch 1A Sample Weights

Print Row ID	Batch-Vessel	Vessel	Batch	LIMS #	a Net Dried wt (g)	Total Calcine wt (g)	b Net Calcine wt (g)	Total Vitrified wt (g)	c Net Vitrified wt (g)	d Net Sample wt (g)	=100a/d Dried wt%	=100b/d Calcine wt%	=100c/d Vitrified wt%
135	89-SME	SME	89	52637	8.098	91.728	7.156	91.669	7.097	17.316	46.77	41.33	40.99
136	89-SME	SME	89	52637	8.346	97.275	7.380	97.302	7.407	17.808	46.87	41.44	41.59
137	89-SME	SME	89	52637	5.256	94.004	4.608	93.949	4.553	16.589	31.68	27.78	27.45
138	89-SME	SME	89	52637	8.259	94.883	7.313	94.814	7.244	17.479	47.25	41.84	41.44
139	89-MFT	MFT	89	52752	7.525	91.266	6.698	91.160	6.592	16.658	45.17	40.21	39.57
140	89-MFT	MFT	89	52752	7.551	96.532	6.670	96.441	6.579	17.168	43.98	38.85	38.32
141	89-MFT	MFT	89	52752	7.928	96.090	7.059	95.978	6.947	17.565	45.14	40.19	39.55
142	89-MFT	MFT	89	52752	7.895	95.553	7.001	95.460	6.908	17.582	44.90	39.82	39.29
143	89-MFT	MFT	89	52752	7.776	95.177	6.881	95.092	6.796	17.525	44.37	39.26	38.78
144	89-MFT	MFT	89	52752	7.216	95.715	6.403	95.594	6.282	16.610	43.44	38.55	37.82
145	90-SME	SME	90	52826	6.727	95.841	5.981	95.728	5.868	16.965	39.65	35.25	34.59
146	90-SME	SME	90	52826	7.017	93.693	6.289	93.542	6.138	16.706	42.00	37.65	36.74
147	90-SME	SME	90	52826	6.032	94.654	5.339	94.550	5.235	16.250	37.12	32.86	32.22
148	90-SME	SME	90	52826	7.632	91.443	6.867	91.293	6.717	17.292	44.14	39.71	38.84
149	90-SME	SME	90	52826	6.960	94.928	6.245	94.769	6.086	16.664	41.77	37.48	36.52
150	90-SME	SME	90	52826	6.033	92.652	5.382	92.534	5.264	16.643	36.25	32.34	31.63
151	90-MFT	MFT	90	53066	7.980	96.395	7.081	96.343	7.029	17.453	45.72	40.57	40.27
152	90-MFT	MFT	90	53066	7.790	94.319	6.916	94.205	6.802	17.512	44.48	39.49	38.84
153	90-MFT	MFT	90	53066	7.298	94.788	6.429	94.724	6.365	16.431	44.42	39.13	38.74
154	90-MFT	MFT	90	53066	7.798	95.490	6.935	95.379	6.824	17.361	44.92	39.95	39.31
155	90-MFT	MFT	90	53066	7.631	97.906	6.760	97.826	6.680	17.080	44.68	39.58	39.11
156	90-MFT	MFT	90	53066	7.860	97.588	7.011	97.462	6.885	17.500	44.91	40.06	39.34
157	92-SME	SME	92	53161	6.799	90.622	6.046	90.339	5.763	16.263	41.81	37.18	35.44
158	92-SME	SME	92	53161	6.604	97.879	5.717	97.685	5.523	16.149	40.89	35.40	34.20
159	92-SME	SME	92	53161	7.008	95.213	6.253	94.901	5.941	16.242	43.15	38.50	36.58
160	92-SME	SME	92	53161	7.012	95.943	6.203	95.713	5.973	16.389	42.78	37.85	36.45
161	92-SME	SME	92	53161	7.147	98.443	6.409	98.120	6.086	16.666	42.88	38.46	36.52
162	92-SME	SME	92	53161	7.064	94.800	6.251	94.506	5.957	16.501	42.81	37.88	36.10
163	92-MFT	MFT	92	53235	6.688	93.757	5.913	93.595	5.751	17.143	39.01	34.49	33.55
164	92-MFT	MFT	92	53235	6.273	101.655	5.471	101.609	5.425	15.450	40.60	35.41	35.11
165	92-MFT	MFT	92	53235	7.175	95.447	6.373	95.336	6.262	16.887	42.49	37.74	37.08
166	92-MFT	MFT	92	53235	6.467	94.925	5.681	94.790	5.546	16.888	38.29	33.64	32.84
167	92-MFT	MFT	92	53235	6.893	95.484	6.013	95.403	5.932	17.888	38.53	33.61	33.16
168	92-MFT	MFT	92	53235	6.021	94.905	5.280	94.790	5.165	17.012	35.39	31.04	30.36

Shaded entries were deemed as unrepresentative by DWPF Engineering and were not included in these analyses.


Dried wt% By Batch-Vessel
Dried wt%
50
40
77-MFT 78-MFT 79-SME 81-SME 82-SME 83-SME 84-SME 85-SME 86-SME 87-SME 88-SME 89-SME 90-SME 92-à
77-SME 78-SME 80-SME 82-MFT 83-MFT 84-MFT 85-MFT 86-MFT 87-MFT 88-MFT 89-MFT 90-MFT 92-MFT
Batch-Vessel

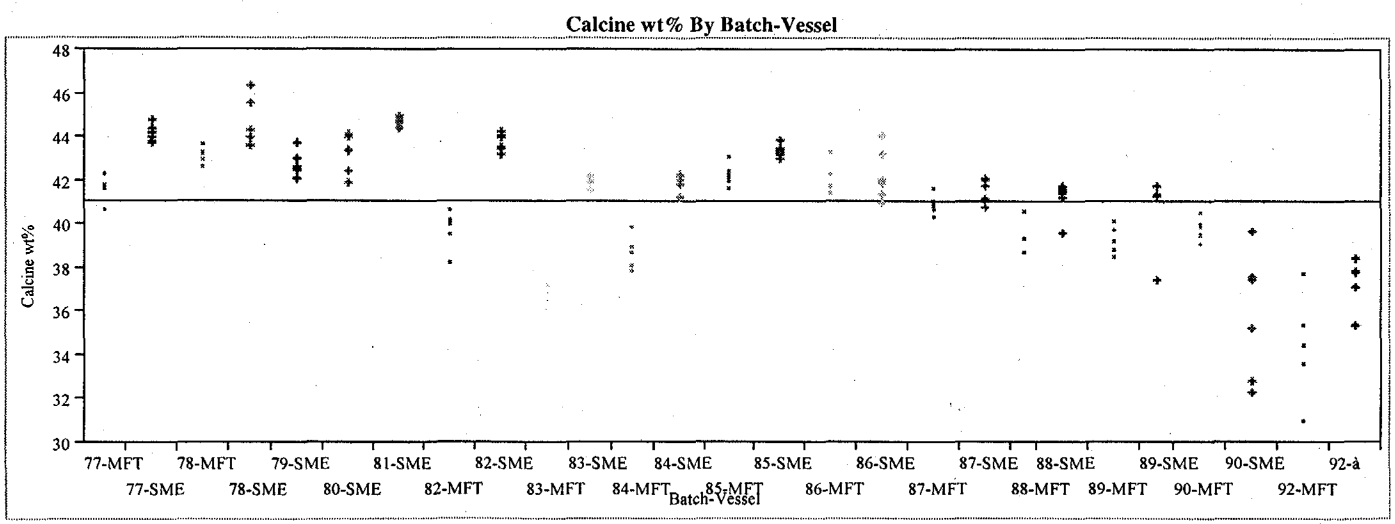

Calcine wt% By Batch-Vessel
Calcine wt%
48
46
44
42
40
38
36
34
32
30
77-MFT 78-MFT 79-SME 81-SME 82-SME 83-SME 84-SME 85-SME 86-SME 87-SME 88-SME 89-SME 90-SME 92-à
77-SME 78-SME 80-SME 82-MFT 83-MFT 84-MFT 85-MFT 86-MFT 87-MFT 88-MFT 89-MFT 90-MFT 92-MFT
Batch-Vessel

Exhibit A.1: Plots of Sample Weights by Batch and Vessel

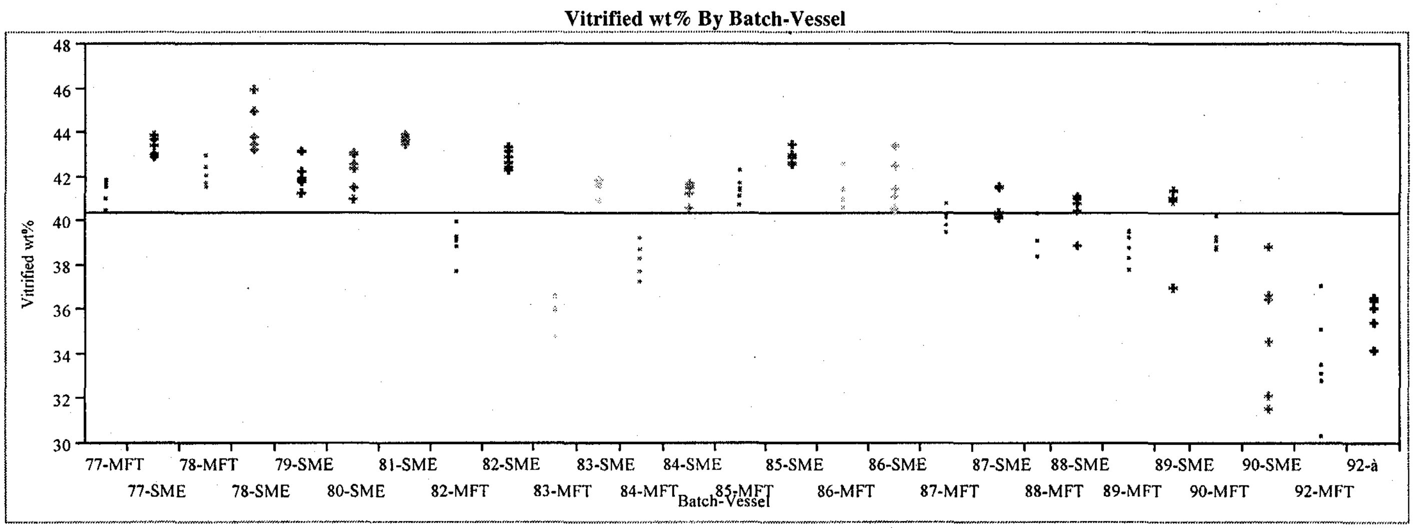
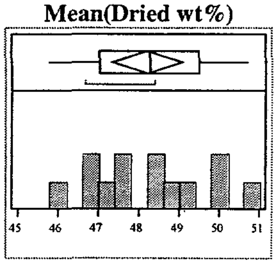


Exhibit A2: Descriptive Statistics for the Sample Weights by Vessel

Vessel=SME

Mean(Dried wt%)



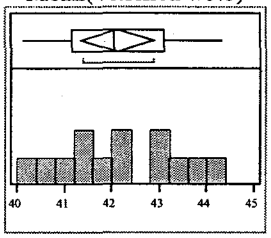
Quantiles

maximum	100.0%	50.701
	97.5%	50.701
	90.0%	50.420
quartile	75.0%	49.513
median	50.0%	48.276
quartile	25.0%	47.033
	10.0%	46.149
	2.5%	45.803
minimum	0.0%	45.803

Moments

Mean	48.21746
Std Dev	1.44395
Std Error Mean	0.40048
Upper 95% Mean	49.09003
Lower 95% Mean	47.34489
N	13.00000
Sum	626.82703
Variance	2.08499
Skewness	0.14789
CV	2.99466

Mean(Vitrified wt%)



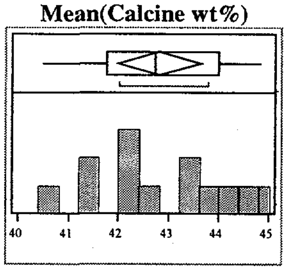
Quantiles

maximum	100.0%	44.326
	97.5%	44.326
	90.0%	44.080
quartile	75.0%	43.114
median	50.0%	42.049
quartile	25.0%	41.171
	10.0%	40.304
	2.5%	40.142
minimum	0.0%	40.142

Moments

Mean	42.12762
Std Dev	1.25340
Std Error Mean	0.34763
Upper 95% Mean	42.88504
Lower 95% Mean	41.37019
N	13.00000
Sum	547.65900
Variance	1.57102
Skewness	0.15083
CV	2.97525

Mean(Calcine wt%)



Quantiles

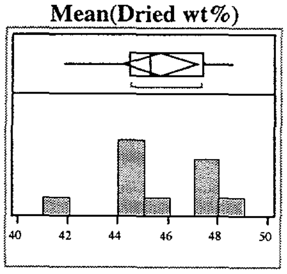
maximum	100.0%	44.835
	97.5%	44.835
	90.0%	44.793
quartile	75.0%	43.998
median	50.0%	42.731
quartile	25.0%	41.788
	10.0%	40.824
	2.5%	40.527
minimum	0.0%	40.527

Moments

Mean	42.82350
Std Dev	1.35107
Std Error Mean	0.37472
Upper 95% Mean	43.63995
Lower 95% Mean	42.00706
N	13.00000
Sum	556.70554
Variance	1.82539
Skewness	-0.00781
CV	3.15497

Vessel=MFT

Mean(Dried wt%)



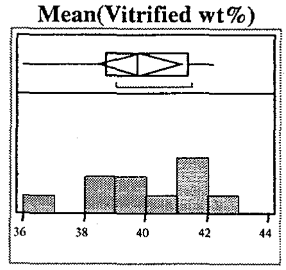
Quantiles

maximum	100.0%	48.568
	97.5%	48.568
	90.0%	48.477
quartile	75.0%	47.419
median	50.0%	45.288
quartile	25.0%	44.472
	10.0%	42.133
	2.5%	41.883
minimum	0.0%	41.883

Moments

Mean	45.68293
Std Dev	2.02922
Std Error Mean	0.64169
Upper 95% Mean	47.13455
Lower 95% Mean	44.23130
N	10.00000
Sum	456.82925
Variance	4.11772
Skewness	-0.33038
CV	4.44196

Mean(Vitrified wt%)



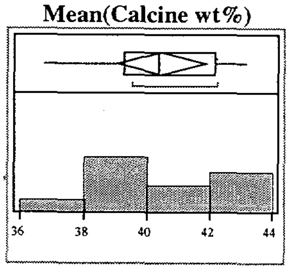
Quantiles

maximum	100.0%	42.222
	97.5%	42.222
	90.0%	42.149
quartile	75.0%	41.397
median	50.0%	39.722
quartile	25.0%	38.740
	10.0%	36.248
	2.5%	36.021
minimum	0.0%	36.021

Moments

Mean	39.81483
Std Dev	1.88264
Std Error Mean	0.59534
Upper 95% Mean	41.16160
Lower 95% Mean	38.46806
N	10.00000
Sum	398.14830
Variance	3.54433
Skewness	-0.69457
CV	4.72849

Mean(Calcine wt%)



Quantiles

maximum	100.0%	43.172
	97.5%	43.172
	90.0%	43.084
quartile	75.0%	42.217
median	50.0%	40.398
quartile	25.0%	39.297
	10.0%	36.977
	2.5%	36.780
minimum	0.0%	36.780

Moments

Mean	40.47147
Std Dev	1.94326
Std Error Mean	0.61451
Upper 95% Mean	41.86161
Lower 95% Mean	39.08133
N	10.00000
Sum	404.71471
Variance	3.77627
Skewness	-0.46697
CV	4.80156

Exhibit A.3: Correlations and Scatter Plots for Sample Weight Percents

Correlations

Variable	Dried wt%	Calcine wt%	Vitrified wt%
Dried wt%	1.0000	0.9938	0.9945
Calcine wt%	0.9938	1.0000	0.9941
Vitrified wt%	0.9945	0.9941	1.0000

Scatterplot Matrix

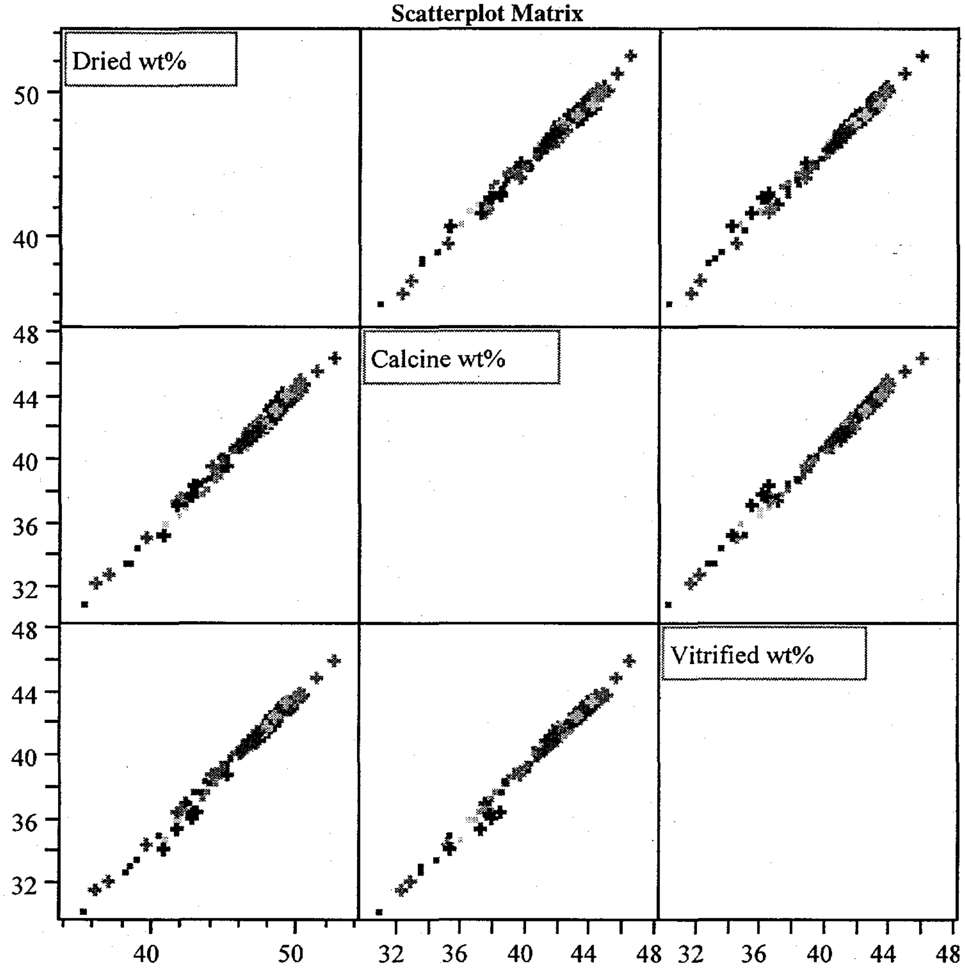


Exhibit A.3: Correlations and Scatter Plots for Sample Weight Percents
(Continued)

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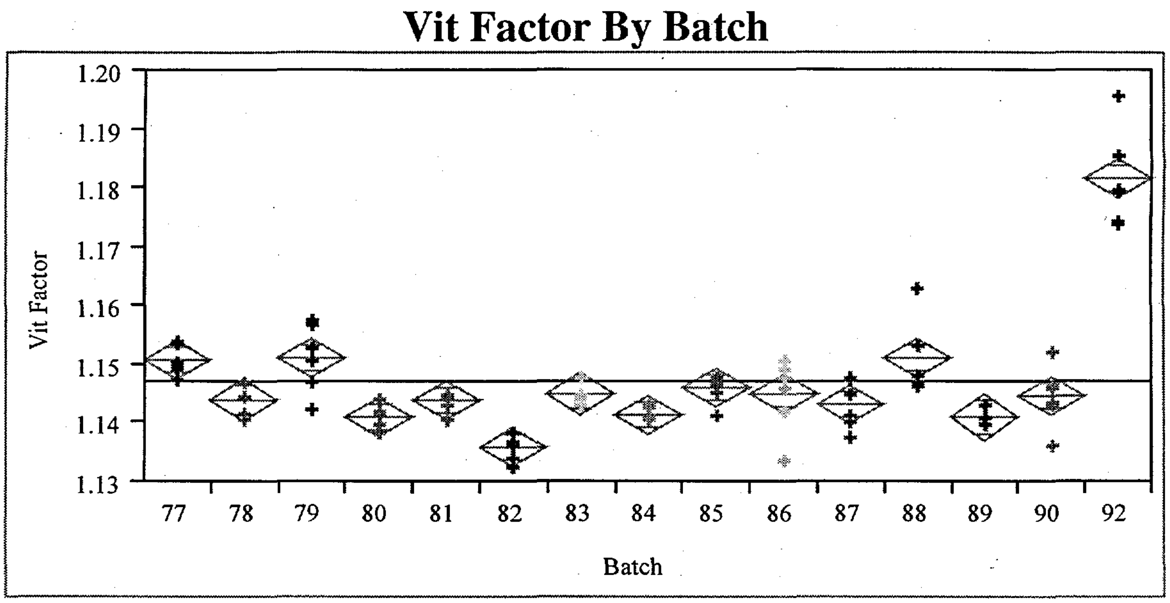
Exhibit A.4: Analysis of Vitrification Factors by Batch for the SME



Oneway Anova

Summary of Fit

RSquare	0.874001
RSquare Adj	0.849156
Root Mean Square Error	0.004279
Mean of Response	1.147263
Observations (or Sum Wgts)	86

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	14	0.00901565	0.000644	35.1783
Error	71	0.00129973	0.000018	**Prob>F**
C Total	85	0.01031538	0.000121	<.0001

Means for Oneway Anova

Level	Number	Mean	Std Error
77	6	1.15086	0.00175
78	5	1.14387	0.00191
79	6	1.15137	0.00175
80	6	1.14096	0.00175
81	6	1.14385	0.00175
82	6	1.13583	0.00175
83	5	1.14501	0.00191
84	6	1.14151	0.00175
85	6	1.14598	0.00175
86	6	1.14504	0.00175
87	6	1.14333	0.00175
88	6	1.15108	0.00175
89	4	1.14107	0.00214
90	6	1.14463	0.00175
92	6	1.18153	0.00175

Std Error uses a pooled estimate of error variance

Exhibit A.4: Analysis of Vitrification Factors by Batch for the SME (Continued)

Tests that the Variances are Equal

Level	Count	Std Dev	MeanAbsDif to Mean	MeanAbsDif to Median
77	6	0.0025816	0.0020880	0.0019446
78	5	0.0025968	0.0020917	0.0019086
79	6	0.0058606	0.0045653	0.0045653
80	6	0.0021235	0.0017448	0.0017448
81	6	0.0016227	0.0012128	0.0011092
82	6	0.0021014	0.0016432	0.0014680
83	5	0.0017043	0.0011992	0.0011504
84	6	0.0011767	0.0009947	0.0008575
85	6	0.0024456	0.0017472	0.0015424
86	6	0.0062630	0.0047222	0.0043163
87	6	0.0041144	0.0034785	0.0034785
88	6	0.0063420	0.0047351	0.0037911
89	4	0.0014719	0.0010444	0.0010306
90	6	0.0052338	0.0036137	0.0036137
92	6	0.0081992	0.0061630	0.0055738

Test	F Ratio	DF Num	DF Den	Prob>F
O'Brien[.5]	1.3743	14	71	0.1887
Brown-Forsythe	1.4780	14	71	0.1421
Levene	2.8455	14	71	0.0020
Bartlett	3.0588	14	?	<.0001

Warning: Small sample sizes. Use Caution.

Welch Anova testing Means Equal, allowing Std's Not Equal

F Ratio	DF Num	DF Den	Prob>F
17.3060	14	26.5	<.0001

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