

Compositional Variation Tests on DuraMelter 100 with LAW Sub-Envelope B1 Feed in Support of the LAW Pilot Melter, VSL-02R62N0-5, Rev. 0

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management



**P.O. Box 450
Richland, Washington 99352**

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Final Report
“Compositional Variation Tests on DuraMelter 100 with LAW Sub-Envelope B1 Feed in Support of the LAW Pilot Melter”

VSL-02R62N0-5, Rev. 0
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Final Report

**Compositional Variation Tests on DuraMelter 100 with LAW
Sub-Envelope B1 Feed in Support of the LAW Pilot Melter**

prepared by

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for

Duratek, Inc.

and

Bechtel National, Inc.

ACCEPTED FOR
WTP PROJECT USE

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SECTION 1.0 INTRODUCTION

The Vitreous State Laboratory at The Catholic University of America (VSL) is developing and testing glass formulations for RPP-WTP waste envelopes to provide data to meet the RPP-WTP contract requirements and to support system design activities [1]. That work is based upon small-scale batch melts ("crucible melts") using waste envelope simulants. Selected formulations have also been tested in small-scale continuously-fed joule-heated melters (DM10 and DM100 systems) [2-7] and, ultimately, in the LAW Pilot Melter [8-10]. Such melter tests provide information on key process factors such as feed processing behavior, dynamic effects during processing, sulfate incorporation, processing rates, off-gas amounts and compositions, foaming control, etc., that cannot be reliably obtained from crucible melts. This sequential scale-up approach in the vitrification testing program ensures that maximum benefit is obtained from the more costly pilot-scale tests and that the most effective use is made of that resource. The principal objective of the work described in this report was to collect the necessary small-scale melter test data with a LAW Sub-Envelope B1 waste simulant in order to support the next series of tests with the same melter feed on the LAW Pilot Melter. This work was conducted under a corresponding Test Specification [11], Test Plan [12], and subsequently modified by a Test Exception [13].

A previous series of tests on the LAW Pilot Melter was directed toward demonstration of the ability to process flow-sheet levels of sulfate following the decision to delete the sulfate removal process from pretreatment [8-10]. Those tests were based on supporting crucible and small-scale melter tests [1-3, 14] as well as previous experience with high-sulfate feeds [15, 16]. High-sulfate feeds based on a representative tank composition from each waste envelope (A, B, and C) were used for those tests. The present work is based on the composition of tank AZ-101, which is designated Sub-Envelope B1 [1]. While the earlier tests were based on nominal feed compositions, the objective of the present work and the parallel LAW Pilot Melter tests was to determine the effects of process variations around the nominal composition and, in particular, to evaluate variations in the ratio of waste to glass formers. The motivation for these tests is that the process should be robust enough to accommodate reasonable variations in the feed make-up without deleterious consequences such as the formation of a salt layer on the molten glass pool, unfavorable processing behavior, or adverse feed rheology or melt and glass product properties.

The two tests described in this report utilized blended feed (glass formers plus waste simulant) prepared by Optima Chemicals according to VSL specifications; about 1.7 metric tons of glass was produced. Sugar was added (at VSL) to the nominal feed at a ratio of 0.5 (1 mole sucrose per 16 mole NO_x) for each of the two variation tests; however, since the sugar addition is assumed to be "blind" to the variations, the actual sugar ratio for the test with 15% excess simulant was 0.41. The DM100-WV melter was used in order to provide a direct comparison with the LAW tests previously conducted on the same melter [2-5]. Two 100-hour melter tests were conducted: one with nominal feed and one with 15% excess simulant. The Test Plan [12] also provided for a third test using feed with a 15% deficiency in simulant. That test was not conducted at the direction of the RPP-WTP Project [13] due to low perceived risk to the Pilot Plant and schedule constraints. Key operating parameters including cold cap coverage, feed rate,

and glass pool temperature were held constant to investigate the effects of the glass compositional changes on processing characteristics (including molten sulfate salt formation) and the product glass. The bubbling rate was adjusted to provide the desired glass production rate with a near-complete cold cap (90-100% of melt surface covered with feed). Quantitative measurements of glass production rates, melter operating conditions (temperatures, pressures, power, flows, etc.), and off-gas characteristics (NO_x, SO₂, CO, particulate load and composition, and acid gases) were made for each test.

1.1 Test Objectives

The principal objective of the DM100 tests was to demonstrate the robustness of the vitrification process with respect to feed and glass compositional changes resulting from variations in the simulant-to-additive ratio. The DM100-WV unit was selected for these tests; this melter was used for all of the Part B1 tests on LAW Envelopes A, B, and C sulfate incorporation [2, 3] that were used to support the subsequent tests on the Pilot Melter [8-10] as well as for the more recent LAW Sub-Envelope A1, A2, A3 and C1 tests [4-7]. The same melter was selected for the present tests in order to maintain comparisons between the data sets. In addition, the somewhat smaller glass volume for the same melt surface area as compared to the DM100-BL melter means that more glass turnovers are achieved for a given test duration.

The DM100 tests used nominal feed and feed with a 15% surplus in waste simulant. Previous Pilot Melter tests on Envelope A with 10% variations (but with sulfate removal) showed significant impacts on glass production rates that were ultimately corrected by adjustments in the sugar additions. Consequently, robustness with respect to throughput as well as sulfate tolerance are important motivations for these tests. Subsequent to the successful outcome of these tests, the same melter feeds were tested at a larger scale in tests that were conducted on the LAW Pilot Melter. The RPP-WTP Project has developed the underlying technical basis for the selected 15% variations. The amount of glass produced from an individual batch of pretreated waste is expected to be a function of either the sodium or sulfur content of that waste. The Project's estimates for the uncertainty of these analyses that have been used in the error assessments conducted by Process Engineering are 10%. These models have also assumed an error for volume transfer measurements of 5%. The 15% variation represents the sum of these errors assuming that both occur simultaneously in the same direction, i.e., combined low sulfate or sodium analysis and high volume transfer error for the high waste concentration case. Supporting crucible melt studies have indicated that no sulfate phase separation is expected for such variations. However, one of the objectives of these tests was to confirm that only single-phase glass is being produced prior to exposing the LAW Pilot Melter to the high-sulfate feed. The DM100 melter was examined at the end of each feeding period to verify that no sulfate phase was detectable or otherwise to determine an appropriate mitigating response.

Thus, the major objectives of these tests were to:

- Perform tests on the DM100-WV system using the nominal and 15% surplus simulant Sub-Envelope B1 feeds to ascertain the sensitivity of the vitrification process to variations in simulant-additive ratio.
- Demonstrate sustained processability and product quality (composition, absence of secondary sulfate phase) for glass generated from nominal and 15% surplus simulant Sub-Envelope B1 feeds.
- Collect melter emissions data to determine the effect of composition on melter emissions.
- Provide supporting data necessary to ensure the success of the larger-scale Pilot Melter tests.
- Characterize the properties of the melter feed (rheological properties, composition, etc.)

The completion of the objectives discussed above is addressed in Section 6.0.

1.2 Quality Assurance

This work was conducted under an NQA-1 (1989) and NQA-2a (1990) Part 2.7 based quality assurance program that is in place at the VSL. This program is supplemented by a VSL Quality Assurance Project Plan (QAPP) for RPP-WTP work [17]. Test and procedure requirements by which the testing activities are planned and controlled are also defined in this plan. The program is supported by VSL standard operating procedures that were used for this work [18].

The controlling test specification for this work, TSP-W375-00-00015, LAW DM10 and DM100 Melter Tests, imposed the following QA requirements: 1) Quality Level 3 requirements, 2) the current revision of the quality assurance program approved by the RPP-WTP project, 3) Quality Assurance Project Plan for the Testing Programs: Vitreous State Laboratory (VSL), QP-W375-EN00003, and 4) QAPP for Testing Programs Generating Environmental Data, PL-W375-Q00002. In the intervening time between approval of the test specification and approval of the test plans, programmatic requirements changed. The Test Plans were approved with the updated QA requirements, and all work was conducted according to the updated QA requirements as specified in the Test Plans. The change to programmatic requirements had no impact on the data.

The scope of this test did not include the collection of data for environmental regulatory purposes. Therefore, the "Quality Assurance Project Plan (QAPjP) for Testing Programs Generating Environmental Regulatory Data", PL-24590-QA00001, Rev 0, does not apply.

Material departures from the Test Plan or QAPP, if any, are documented in this report.

1.3 Melter System Description

1.3.1 Feed System

A schematic diagram of the DM100 vitrification system is shown in Figure 1.1. The melter feed is introduced in batches into a feed container that is mounted on a load cell for weight monitoring. The feed is stirred with a variable speed mixer and constantly recirculated except for periodic, momentary interruptions during which the weight is recorded. The way in which the feed is introduced into the melter is designed to mimic the operation of an ADS pump, which is the present RPP-WTP baseline. The recirculation loop extends to the top of the melter where feed is diverted from the recirculation loop into the melter through a Teflon-lined feed line and water-cooled feed tube. Two computer operated pinch valves, one on the feed line and one on the recirculation loop, are activated in a timed sequence to introduce feed into the melter at the desired rate. The feed rate is regulated by adjusting the length of each pulse, the time between each pulse, and the pressure applied to the recirculation loop. A compressed air line is attached to the feed line and can be used to automatically clear the feed line into the melter after each pulse. The mixed feed enters the melter through a water-cooled, vertical feed tube.

1.3.2 Melter System

Cross-sectional diagrams through the DM100-WV melter are shown in Figures 1.2a-c. The DM100-WV unit is a ceramic refractory-lined melter fitted with a pair of opposing Inconel 690 plate electrodes as well as a bottom electrode. The melter can be operated with either three-phase or single-phase power. However, the standard mode of operation, which was used for these tests, is single-phase with voltage applied to the side electrodes only. The bubbler used for stirring the melt pool enters from the top and is removable. The glass product is removed from the melter by means of an air-lift discharge system. The DM100-WV has a melt surface of 12 X 14 inches, giving a melt surface area of 0.108 m². The nominal depth of the melt pool is about 19 inches, which gives a typical glass inventory of between 115 and 120 kg. The plenum height is 27.5 inches. Temperatures are monitored by means of a series of thermocouples located in the melt pool, the electrodes, the plenum space, and the discharge chamber.

1.3.3 Off-Gas System

For operational simplicity, the DM100-WV is equipped with a dry off-gas treatment system involving gas filtration operations only. Exhaust gases leave the melter plenum through a film cooler device that minimizes the formation of solid deposits. The film-cooler air has constant flow rate and its temperature is thermostatically controlled. Consequently, under steady-state operating conditions, the exhaust gases passing through the transition line (between the melter and the first filtration device) can be sampled at constant temperature and airflow rate. The geometry of the transition line conforms to the requirements of the 40-CFR-60 air sampling techniques. Immediately downstream of the transition line are cyclonic filters followed by conventional pre-filters and HEPA filters. The temperature of the cyclonic filters is maintained

above 150°C while the temperatures in the HEPAs are kept sufficiently high to prevent moisture condensation. The entire train of gas filtration operations is duplicated and each train is used alternately. An induced draft fan completes the system.

SECTION 2.0 WASTE SIMULANT AND GLASS FORMULATIONS

2.1 Waste Simulants

The Sub-Envelope B1 waste simulant was based on composition data for tank AZ-101 derived from the TF COUP, Rev. 2 [19]. Data from waste sample characterization [20] were used as the basis for the concentration of waste organics. Based on this information oxalate was the only waste organic added to the stimulant; this information was consistent with the total organic carbon (TOC) concentration given in TF COUP, Rev. 2 [19]. The sodium concentration in the simulant was increased by 5.33 % to account for sodium additions in pretreatment [1, 21]. This increased the sodium concentration in the nominal glass from 5.10 wt% to 5.37 wt%. The sulfate content in the simulant was then increased to represent recycle from the off-gas treatment system to the melter feed assuming that 20% of the sulfur in the feed reports to the off-gas stream [2-6]. The nominal concentration, expressed in terms of the sodium molarity, was determined on the basis of melter feed rheology tests on similar formulations [22]. The results of those tests led to the selection of 2.75 molar sodium as the nominal simulant concentration for Sub-Envelope B1.

The nominal simulant formulation is shown in Table 2.1. The resulting waste simulant is a solution of predominantly sodium, aluminum, hydroxide, nitrate, nitrite, sulfate, and carbonate. Samples of the simulant were prepared according to Table 2.1, tested at the VSL and found suitable for melter testing.

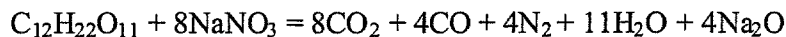
2.2 Glass Formulation

The feed additives were selected on the basis of glass formulation studies, which included optimization with respect to sulfate incorporation and salt formation [1-3, 14], and rheological testing [22]. LAWB83 was identified as a suitable glass composition for the Sub-Envelope B1, AZ-101 waste. The composition of LAWB83 glass and the waste and additive fractions are shown in Table 2.2; the additive sources are shown in Table 2.3. Glass formulations used in this work were the nominal formulation and a formulation containing 15 wt% excess simulant, as shown in Table 2.2.

2.3 Sugar Additions

With high nitrate feeds, the addition of reductants is necessary in order to control melt foaming. Sugar, which was used for this purpose at West Valley, has also been selected as the baseline reductant for the WTP. The amount of sugar required increases with the amount of nitrates present in the feed and decreases with the amount of waste organics present in the feed, which themselves act as reductants. Excessive additions of reductants can be deleterious, leading to over-reduction of the melt and formation of sulfides and molten metals. Consequently, the

oxidants and reductants in the feed must be suitably balanced. The basis for achieving this balance was developed by VSL and Duratek for the vitrification of high-sodium-nitrate feeds at Savannah River's M-Area and has been successfully applied to the processing of a wide variety of simulated RPP-WTP feeds over the past six years. In developing this approach, we elected to conservatively adopt the most reducing potential reaction as the basis for the *definition* of a "sugar ratio" of 1.0 as a result of concerns for over-reducing the melt. Such a reaction, using sodium salts as an example, is:



Fundamentally, the basis that is selected is simply a convention, since the precise stoichiometry of the reactions involved is neither known nor constant under the conditions prevailing in the melter. However, with this convention, a sugar ratio of 1.0 corresponds to one mole of sucrose per eight moles of nitrate or, more generally, 1.5 moles of organic carbon per mole of nitrate. It is then expected that significantly less sugar than this will be required in practice. The empirically determined amount required to successfully control melt foaming without significantly reducing the glass melt was found to correspond to a ratio of 0.5 when any nitrites present were counted as nitrates (i.e., 0.75 moles of organic carbon per mole of nitrate + nitrite). This approach has been employed for all WTP melter testing. It is, however, expected that slight variations around the nominal value of 0.5 may be necessary to account for differences in the reducing power of waste organics in comparison to sugar, particularly for LAW streams that are high in organics.

As an example, the calculation of the amount of sugar needed for the present Sub-Envelope B1 feed to achieve a sugar ratio of 0.5 proceeds as follows:

- One liter of simulant contains 0.7725 moles of nitrite and 0.6645 moles of nitrate, giving a total of 1.437 moles of NO_x (see Table 2.1)
- Required total amount of organic carbon for a sugar ratio of 0.5 is $1.437 \times 0.75 = 1.078$ moles
- One liter of simulant contains 0.0648 moles of organic carbon (see Table 2.1)
- Therefore, $1.078 - 0.0648 = 1.013$ moles of organic carbon must be added.

Since the molecular weight of sucrose is 342 g per mole, $1.013 \times 342/12 = 28.87$ g sugar must be added per liter of simulant, as shown in Table 2.3.

2.4 Preparation of Melter Feed

Optima Chemicals, which has supplied all of the LAW simulants for the previous DM100 and LAW Pilot Melter studies, prepared the simulant and added most of the glass forming chemicals for the feed compositions before shipment to VSL in 55-gallon drums. The remaining glass forming chemicals (principally boric acid) and sugar were added at VSL. Optima also provided a batch of simulant without glass formers for addition at VSL to prepare the feed for the test with 15% excess simulant. Potassium iodide (KI) at sufficient concentration to provide

0.1 wt% in the product glass (if all of it were retained in the glass) was added to the feed at VSL to determine the partitioning of iodine between the glass phase and the gas phase.

2.5 Analysis of Feed Samples

2.5.1 General Properties

Feed samples were analyzed from each received feed batch and from each test that was conducted to confirm physical properties and chemical composition. When sampling feed during DM100 tests, the samples are taken from the feed tank itself. The sampling protocol consists of manual sampling using a dip method and access from the top of the tank. The sample is typically about 1 liter in volume.

Sample names, sampling dates, and measured properties are provided in Table 2.4. As expected, both the feed density and glass conversion ratio were higher for the nominal feed (Test 1) and lower for the +15% simulant feed (Test 2). Feed pH also followed the anticipated trend, with feed with the higher simulant content having the higher pH.

2.5.2 Rheology

Samples of the melter feeds that were used for these tests were also subjected to rheological characterization. The results from rheological characterization of a variety of other melter feeds and waste simulants, as well as the effects of a range of test variables, are described in detail in a separate report [22]. Melter feeds were characterized using a Haake RS75 rheometer, which was equipped with either a Z40DIN or a FL22-SZ40 sensor. A typical set of measurements consists of identifying the flow characteristics of the slurry by measuring the shear stress on the slurry at controlled shear rates and temperatures. In these measurements, the shear rate values are preset and are increased stepwise from 0.01 s^{-1} to 200 s^{-1} (70 s^{-1} for FL22-SZ40) with a sufficient delay (typically 15 to 30 seconds) between steps to ensure that shear stress is allowed to fully relax and therefore measured at equilibrium. This approach is somewhat different than the "flow curve" approach in which the shear rate is ramped up to some maximum value and then ramped back down to produce a hysteresis curve that is dependent on the selected ramp rate. The viscosity of the sample as a function of the shear rate is then calculated as the ratio of the shear stress to the shear rate. The yield stress data for the melter feeds were measured using a controlled-stress mode in which the torque on the rotor was slowly increased while the resulting deformation of the fluid was monitored. The discontinuity in the measured deformation-torque curve was identified as the yield stress. It should be noted that this direct measurement of the yield stress can be quite different from the value that is often reported as the yield stress, which is obtained by extrapolation of the shear stress-shear rate curve to zero shear rate. All of the measurements in this work were made at 25°C ; previous work [22], which examined a range of temperatures, showed a relatively weak effect of temperature.

Rheograms for the melter feeds, which show the feed viscosity versus shear rate, are presented in Figure 2.1; measured values for viscosity at selected shear rates and the yield stress

are shown in Table 2.4. As expected, the highest measured viscosities were for samples from the nominal test and the lowest for the samples from the +15% simulant test; the yield stress values exhibited the same trend. These data, in terms of shear stress vs. shear rate, are compared with the presently proposed WTP Project bounds in Figure 2.2.

2.5.3 Chemical Composition

The chemical compositions of the feed samples were determined by first making a glass from the feed via crucible melt. The glass was subsequently crushed and analyzed directly by X-Ray Fluorescence Spectroscopy (XRF). Boron and lithium oxide target values were used for normalizing the XRF data since those elements were not determined by XRF. Data are compared to the target compositions in Table 2.5. These results generally corroborate the consistency of the feed composition and show good agreement with the target composition for the major elements. Only one oxide with a target composition greater than one percent, TiO_2 , had a deviation greater than 10% for both the nominal and +15% simulant formulations. The 13-17% excess in TiO_2 was also observed in glasses produced during the melter tests, although the magnitude was smaller (see Section 4.1). A slight surplus in titanium has been observed previously in LAW melter feeds [4-7]. Sodium and zirconium oxides showed deviations from their respective target values that were marginally greater than 10% for one of the two formulations. However, both of these components deviated by less than 10% from target in the product glasses (see Section 4.1) and therefore the small deviations were probably due to feed sampling variations. Volatile minor elements such as sulfur, cesium, and halogens are below target due to loss during crucible melting.

SECTION 3.0 MELTER OPERATIONS

Melter tests were conducted on the DM100-WV with the LAW Sub-Envelope B1 simulant between 6/17/02 and 6/29/02. These tests produced over 1700 kg of glass from approximately 3,500 kg of feed. The tests were divided as follows:

- Test 1: Nominal, Sugar Ratio = 0.5
- Test 2: +15% Simulant, Sugar Ratio = 0.5 (nominal), 0.41 (actual)

Note that since the sugar additions are assumed to be "blind" to the +15% variation, the actual sugar ratio for this test differs from the nominal. The nominal sugar addition results in a lower than nominal sugar ratio when there is more than the nominal amount of nitrates in the feed as a result of the +15% variation.

Summaries are provided in Table 3.1 for both tests. Attempts were made to replicate the melter configuration and operating conditions used for the corresponding tests conducted earlier [2, 3] plus the previous LAW Sub-Envelope [4-7] tests. These conditions include a near complete cold cap, which is between 80-95% melt surface coverage for the DM100, since a 100% cold cap tends to lead to "bridging" in smaller melters. The target production rates were approximated for both tests, as depicted in Figures 3.1 and 3.2, although the instantaneous rates varied by about 25% as a result of variable feed pulse sizes. The slightly lower bubbling rate for the +15% simulant feed, as shown in Table 3.1, is likely a consequence of the reduced bubbling rate needed for the target glass production rate when the feed is less dense (less solids). The feeds met the acceptance criteria in that the required processing rates were achieved, no processing problems were observed, and a secondary sulfate phase was not observed. The feeds were, therefore, accepted for further tests on the LAW Pilot Melter.

The results of various operational measurements that were made during these tests are given in Table 3.2. Glass temperatures are shown in Figures 3.3 and 3.4, and plenum temperatures in Figures 3.5 - 3.6. Bulk glass temperatures were only slightly below (1140-1147°C) the target glass temperature of 1150°C. Glass temperatures at the extreme bottom and top of the melt pool are not reliable indicators of bulk glass temperatures as a result of gradients near those boundaries. Plenum temperatures typically ranged from 600 to 650°C, within the 450 to 650°C target. This is deliberately somewhat higher than for the larger melters (DM1200 and LAW Pilot Melter) in order to reduce cold cap bridging that occurs in the smaller melters. The differences in plenum thermocouple measurements between the nominal and +15% simulant feeds, shown in Figures 3.3 and 3.4 may be due to slight differences in melt level.

The electrode and bubbler temperatures are shown in Figures 3.7 - 3.8. The East and West electrode temperatures averaged between 1120-1130°C while the bottom electrode was typically about 150°C cooler than the West electrode. The bubbler temperature was comparable to the East and West electrode temperatures in Test 1 and was about 30 degrees higher in Test 2. Power supplied to the electrodes typically varied within only 2 kW from the average value. As

expected, the average bubbling rate was higher for Test 1 in order to achieve the higher glass production rate.

Gas temperatures at the film cooler typically averaged between 301 and 311°C, depending on the plenum temperature, the amount of added film cooler air, and the temperature of the added film cooler air. Little or no drop in gas temperature was observed across the (insulated) transition line; this temperature is maintained in order to prevent condensation in the downstream filtration units.

SECTION 4.0 GLASS PRODUCTS

Over 1700 kg of glass was produced in these tests. The glass was discharged from the melter periodically into 5-gallon pails using an airlift system. The discharged product glass was sampled at the end of each test by removing sufficient glass from the top of the cans for total inorganic analysis. Selected samples were also analyzed with wet chemical techniques for iron redox state and with optical microscopy for secondary phases. Product glass masses, discharge date, and analysis performed are given in Table 4.1. Glass samples were also obtained by dipping a rod into the glass pool at the beginning and end of each test. These "dip samples" underwent visual examinations to detect the presence of a separate sulfate phase on the glass surface as well as total inorganic compositional analysis.

4.1 Compositional Analysis

Discharge and dip glass samples were crushed and analyzed directly by XRF. The target values for boron and lithium oxides, which are not determined by XRF, were used for normalizing the XRF data to 100 wt%. The XRF analyzed compositions of discharged glass samples are provided in Table 4.2. Analysis results for dip samples by XRF are provided in Table 4.3. All discharged glass samples were subjected to XRF analysis. The majority of the XRF analysis results compared very favorably to their corresponding target values. The only significant oxides with a greater than 10% deviation from target were TiO_2 and CaO , which were about 11% above and below their respective target values. Compositional trends for selected oxides shown in Figures 4.1-4.3 illustrate the closeness to target and the consistency over the course of the tests. The majority of the oxides comprising the product glass change very little during testing due to the small changes in target compositions, which in turn are a function of the low waste loading. For example, the target composition of the principal constituents in the simulant, sodium and sulfate, vary by less than 13% as a result of the intended changes in the simulant-to-additives ratio. Changes of greater magnitude can be observed at the beginning of the testing during the transition from the previous LAW Sub-Envelope C1 formulation for oxides of sodium, magnesium, and iron.

The concentrations of chlorine, cesium, and sulfur, all of which are relatively volatile, are plotted over the course of the tests in Figure 4.4. Notice that even though about one-third of the sulfur is volatilized from the glass pool and cold cap, the concentration of SO_3 is stable over each test. Also observe the increase in SO_3 in the glass product as the concentration in the feed increases. The chlorine concentrations are higher at the beginning of test due to the higher concentrations in the previous LAW Sub-Envelope C1 formulation. Cesium concentrations also remained consistent throughout each test segment and were at target or slightly above target. No iodine was detected in any of the glasses in keeping with observations on other low alkali glasses [5, 23].

Glass dip samples were obtained at the beginning and end of each test, primarily to ascertain whether a secondary sulfate layer had formed on the surface of the glass melt. These samples were particularly important in these tests given the high sulfate content of the LAW Sub-Envelope B wastes. Table 4.3 provides a listing of all the dip samples together with their analyzed compositions and whether or not a separate salt phase was evident. Dip samples taken immediately after both tests (WVJ-D-113A, WVK-D-42A) were all free of secondary phases, whereas dip samples taken after a period of idling at about 1050°C (WVJ-D-113C, WVK-D-49A) often showed clear visual evidence of sulfate, indicating that a salt layer was present on the melt surface. After a secondary phase was detected, the melt pool was bubbled at about 2 lpm for approximately two hours while increasing the temperature to 1150°C. Additional dip samples taken after this process (WVJ-D-119B, WVK-D-49B) indicated that the sulfate on the melt surface had been reincorporated into the glass pool or volatilized. This process was repeated several times after the last test until no sulfur was detected during idling periods. Some of the secondary deposits on dip samples were observed as nodules of several millimeters in diameter. This morphology had not been observed in previous tests and therefore additional analysis was performed. The results shown in Figures 4.5 – 4.7 indicate that the nodules are composed of sodium sulfate with lesser amounts of calcium and cesium. The analyzed compositions of the dip samples from the end of each segment were close to the glass target values with the exceptions of sulfur and chlorine, which have frequently been observed to be above target on dip samples as compared to discharged glass samples.

SECTION 5.0 MONITORED OFF-GAS EMISSIONS

5.1 Particulate Sampling

The melter exhaust was sampled for metals/particles according to 40-CFR-60 Methods 3, 5, and 29 at steady-state operating conditions during each test segment. The concentrations of off-gas species that are present as particulates and gaseous species that are collected in impinger solutions were derived from laboratory data on solutions extracted from air samples (filters and various solutions) together with measurements of the volume of air sampled. Particulate collection required isokinetic sampling, which entails removing gas from the exhaust at the same velocity that the air is flowing in the duct (40-CFR-60, Methods 1-5). Typically, a sample size of 30 dscf was taken at a rate of between 0.5 and 0.75 dscfm. Total particulate loading was determined by combining gravimetric analysis of the standard particle filter and chemical analysis of probe rinse solutions. An additional impinger containing 2 N NaOH was added to the sampling train to ensure complete scrubbing of all acid gases and, particularly, iodine. The collected materials were analyzed using the following: direct current plasma atomic emission spectroscopy (DCP-AES) for the majority of the constituents, atomic absorption spectroscopy (AA) for cesium, and ion chromatography (IC) for anions. Melter emission fluxes are compared to feed fluxes in Table 5.1. Notice the distinction that is made between constituents sampled as particles and as "gas". The "gaseous" constituents are operationally defined as those species that are scrubbed in the impinger solutions after the air stream has passed through a 0.45 μm heated filter.

Particulate emissions from the melter were low, at only 0.11% of feed solids. Particulate melter emissions increase with increasing alkali feed content [2-7] and therefore it is not surprising that the LAW Sub-Envelope B formulations, which have the lowest sodium and halide content, also have the lowest percent of particulate carry-over. As expected, the feed elements emitted at the lowest melter DF were clearly halogens and sulfur, with values between 1 and 10. Iodine was detected exclusively as gaseous emissions in both tests. Chlorine and fluorine emissions were difficult to evaluate due to the low feed concentrations and ubiquity of these halogens as contaminants in water and raw materials. A total of about one third of feed sulfur was emitted in each test in the form of both particles and gas. Other elements exhibiting volatile behavior include cesium and boron. Emissions were similar for both tests due to the similarity in feed composition and consistency in melter operation throughout testing. Boron, sulfur, and the halides were the only elements detected in the impinger solutions collected downstream of the heated particle filter in the sampling train, which constitutes the "gas" fraction of the melter emissions.

5.2 Gases Monitored by FTIR

Melter emissions were monitored in each test for a variety of gaseous components, most notably CO and nitrogen species, by Fourier Transform Infra Red Spectroscopy (FTIR). The off-gas system temperature is maintained well above 100°C beyond the sampling port downstream of the HEPA filter to prevent analyte loss due to condensation prior to monitoring. A summary of average concentrations monitored during each test is provided in Table 5.2. Concentrations of various monitored species are plotted in Figures 5.1 - 5.5. The analytes listed in Table 5.2 are those that were thought likely to be observed during the test, based on previous work; no other species were detected in the off-gas stream by FTIR. The most abundant gas monitored was NO, which is consistent with previous tests in which nitrates and nitrites were present in the feed. The concentration of NO was about fifteen times higher than that of NO₂ and significantly more than that for all other nitrogen oxide species. As expected, nitrogen oxide emissions for the test with excess simulant (Test 2) were higher, since the simulant contains the nitrates and the increase was not compensated with additional sugar. Unlike previous DM100, LAW Sub-Envelope tests [4-7], significant amounts of SO₂ were detected throughout each test. Concentrations of SO₂ in Test 2 were about twice that in Test 1 due presumably to the higher amount of sulfur in the feed. The concentrations of CO, NH₃, and HCN typically increase with the sugar ratio, and therefore are higher in Test 1. As expected, given the low- or below-detectable concentrations of gaseous chlorine and fluorine observed using the Method 5-type sampling discussed earlier, no HF or HCl were observed by FTIR. The variations in emissions over the course of each test segment are due in part to the pulsed feed system and changes in the melt pool cold cap. Hydrogen concentrations, monitored by gas chromatography near the end of the tests, were very low and similar for both tests.

A nitrogen mass balance is summarized in Table 5.3. In both tests, about half of the feed nitrogen oxides were reduced to diatomic nitrogen in keeping with the expectation for feed with a sugar ratio of 0.5. Similar results were obtained in both tests. In the +15% simulant test, the sugar addition was blind to the variation in nitrate-rich simulant (i.e., it assumes that the feed is on-target when, in fact, it is off by 15%) and, therefore, the actual ratio is less than 0.5 for surplus simulant feed. The expected and observed result was that more feed nitrates and nitrites were emitted as NO_x in Test 2 than in Test 1.

5.3 Mass Balance of Volatile Constituents

Table 5.3 provides the percentages of volatile feed constituents with target glass concentrations greater than 0.1 wt% (iodine, sulfur, and cesium) that were retained in the glass product or identified in the various off-gas stream samples for each of the tests. The total recovery of each of the three volatile feed constituents was within 13% of that present in the batched feed. Table 5.3 shows that cesium was retained in the glass at the highest rate, with greater than target values reporting to the glass. Both tests had a total sulfur recovery of 102% with about two thirds of the feed sulfur retained in the glass, a quarter emitted as gaseous species and the balance emitted as particles. A variable amount (from 40 to 68%) of the gaseous sulfur was detected by the FTIR as SO₂. Iodine was observed exclusively as gaseous emissions. Iodine

mass balance closure was good for these tests, in contrast to previous tests [4-7] where substantial percentages of feed iodine could not be accounted for in the glass product and emissions. It is believed that the improved iodine recovery is due to the increase in sodium hydroxide concentration from 0.1 N to 2 N in the sampling train impinger solution for this purpose.

SECTION 6.0 CONCLUSIONS

Two tests were conducted on a DM100 vitrification system to assess the robustness of the nominal LAW Sub-Envelope B1 formulation using an AZ-101 waste simulant with respect to variations in feed make-up. The nominal and the 15% excess simulant variations investigated in the present tests are expected to be the most likely variations to lead to secondary sulfate phases on the melt surface and are therefore the most conservative tests. In these tests, the nominal LAW Sub-Envelope B1 formulation as well as the 15% excess waste simulant formulation were processed without forming a separate sulfate phase on the melt pool surface. A separate sulfate phase did form after idling at 1050°C; however, this phase disappeared on bubbling of the melt pool while increasing the temperature to 1150°C. The test results also showed that the system tolerated the feed variations with respect to feed properties, processing behavior, glass production rate, and product quality. As a result, these formulations were subsequently accepted for larger-scale testing on the LAW Pilot Melter. Completion of the objectives for the tests performed in this work is detailed in Table 6.1. A separate R&T activity is planned to further investigate development of sulfate layers during idling, and potential remote detection methods.

During the present tests, total particulate emissions from the melter were only 0.11 wt%. This low relative carryover can be attributed to the low feed concentrations of sodium and halides. Melter DFs were determined for each element in the feed for the two tests that were performed. Of the more volatile species, DFs for halogens and sulfur were less than 4. Good mass balance closure was obtained for volatile constituents, including sulfur and iodine. Essentially all of the iodine in the feed was accounted for by the gaseous fraction in the melter off-gas and no iodine was detected in the glass product.

SECTION 7.0 REFERENCES

- [1] "Glass Formulation and Testing with RPP-WTP LAW Simulants," Final Report, I.S. Muller, A.C. Buechele, and I.L. Pegg, VSL-00R3560-2, Rev. 0, 2/23/01.
- [2] "Melter Tests with LAW Envelope B Simulants to Support Enhanced Sulfate Incorporation," Final Report, K.S. Matlack, S.P. Morgan, and I.L. Pegg, VSL-00R3501-1, Rev. 0, 11/27/00.
- [3] "Melter Tests with LAW Envelope A and C Simulants to Support Enhanced Sulfate Incorporation," K.S. Matlack, S. Morgan, and I.L. Pegg, VSL-01R3501-2, 1/26/01.
- [4] "Compositional Variation Tests on a DuraMelter 100 with LAW Sub-Envelope A3 Feed in Support of the LAW Pilot Melter," K.S. Matlack, W. Gong, and I.L. Pegg, Final Report, VSL-01R62N0-01, Rev. 0, 1/8/02.
- [5] "Compositional Variation Tests on a DuraMelter 100 with LAW Sub-Envelope C1 Feed (LAWC22 Glass) in Support of the LAW Pilot Melter," K.S. Matlack, W. Gong, and I.L. Pegg, Final Report, VSL-02R62N0-2, Rev. 0, 2/11/02.
- [6] "Compositional Variation Tests on DuraMelter 100 with LAW Sub-Envelope A1 Feed (LAWA44 glass) in Support of the LAW Pilot Melter," K.S. Matlack, W. Gong, and I.L. Pegg, VSL-02R62N0-4, Rev.0, 07/18/02.
- [7] "Compositional Variation Tests on DuraMelter 100 with LAW Sub-Envelope A2 Feed (LAWA88 Glass) in Support of the LAW Pilot Melter," K.S. Matlack, W. Gong, and I.L. Pegg, Final Report, VSL-02R62N0-3, Rev. 0, 6/26/02.
- [8] "RPP-WTP Pilot Melter Envelope A and C Throughput Test Results Report," GTS Duratek, Inc., TRR-PLT-54, 10/13/00.
- [9] "RPP-WTP Pilot Melter Envelope B Throughput Test Results Report," GTS Duratek, Inc., TRR-PLT-57, 10/13/00.
- [10] "RPP-WTP Pilot Melter Off-Gas System Sampling (High Sulfate Envelope C) Test Results Report," GTS Duratek, Inc., TRR-PLT-56B, 10/11/00.
- [11] "LAW DM10 and DM100 Melter Tests," RPP-WTP Test Specification, TSP-W375-00-00015, Rev. 1.
- [12] "Tests on DuraMelter 100 with LAW Sub-Envelope B1 Feed in Support of the LAW Pilot Melter," K.S. Matlack, I.S. Muller, and I.L. Pegg, Test Plan, VSL-02T62NO-2, Rev. 0, June 13, 2002.

- [13] Test Exception, 24590-WTP-TEF-02-039, 7/22/02.
- [14] "Summary of Preliminary Results on Enhanced Sulfate Incorporation during Vitrification of LAW Feeds," I.L. Pegg, H. Gan, I.S. Muller, D.A. McKeown and K.S. Matlack, Interim Report, VSL-00R3630-1, Rev. 1, 4/5/00.
- [15] "Vitrification Testing for Fernald CRU4 Silo Wastes," S.S. Fu, K.S. Matlack, R.K. Mohr, M.C. Paul, I.L. Pegg, and P.B. Macedo, Vitreous State Laboratory, Final Report to FERMC0, May 24, 1996.
- [16] "Minimelter Runs On Mixed Wastes High in Lead, Barium, Sulfur, and Phosphorus," S.S. Fu, W. Luo, H. Hojaji, M. Brandys, R.K. Mohr, K.S. Matlack, I.L. Pegg, and P.B. Macedo, Environmental Issues and Waste Management Technologies in the Ceramic and Nuclear Industries, Eds. V. Jain, and D. Peeler, Ceramic Transactions, vol. 72, pp. 27, American Ceramic Society, 1996.
- [17] "Quality Assurance Project Plan for RPP-WTP Support Activities Conducted by VSL," Vitreous State Laboratory, QAPP Rev. 4, 8/2/2001.
- [18] "Master List of Controlled VSL Manuals and Standard Operating Procedures in Use," QA-MLCP, Rev. 3, May 7, 2002.
- [19] "Tank Farm Contractor Operation and Utilization Plan," R.A. Kirkbride, et al., CH2M Hill Hanford Group Inc., Richland, WA, HNF-SD-SP-012, Rev. 2, 4/19/00.
- [20] "Tank 241-AZ-101 Cores, 266 and 269 Analytical Results for the Final Report," F.H. Steen, Fluor Hanford, Richland, WA, HNF-1701, Rev. 0, 7/28/2000.
- [21] "Basis of Design," BNFL report, DB-W375-EG00001, Rev. 0, November 23, 1998.
- [22] "Physical and Rheological Properties of Waste Simulants and Melter Feeds for RPP-WTP LAW Vitrification," Final Report, I.S. Muller, H. Gan, and I.L. Pegg, VSL-00R3520-1, Rev. 0, 1/16/01.
- [23] "Tests on the DuraMelter 1200 HLW Pilot Melter System Using AZ-101 HLW Simulants," K.S. Matlack, W.K. Kot, T. Bardakci, W. Gong, N.A. D'Angelo, T.R. Schatz, and I.L. Pegg, VSL-02R0100-1, Rev. 0, 07/11/02.

Table 2.1. LAW Sub-Envelope B1 Simulant Recipe at 2.75 Molar Sodium (Including Recycled Sodium Sulfate).

Envelope Constituents	Simulant AZ-101 including pretreatment		Glass Oxides Loading	LAW B1 Simulant as Oxides (wt%)	Waste Contribution to Glass	Recycled Sodium Sulfate	Waste and Recycle Contribution	Source in Simulant	Order for Addition	Formula Weight	Assay	Target Weight (g)
	mg/L	M										
-				100.00%	7.090 %	0.229 %	7.319 %	In 800 ml below water add following compounds in the order listed				
Al	5927	0.2197	Al ₂ O ₃	9.957	0.706	-	0.706	Al(NO ₃) ₃ ·9H ₂ O, 60% sol.	1	375.14	0.6069	130.39
Al	-	-	-	-	-	-	-	Al(OH) ₃	4	78	0.765	0.68
Cr	419	0.0081	Cr ₂ O ₃	0.545	0.039	-	0.039	Na ₂ CrO ₄ ·4H ₂ O	7	234.04	0.985	1.92
Cs spike*	2300	0.0173	Cs ₂ O	2.168	0.154	-	0.154	CsNO ₃	2	194.91	0.998	3.38
Fe	6	0.0001	Fe ₂ O ₃	0.008	0.001	-	0.001	Fe(NO ₃) ₃ ·9H ₂ O	3	404.01	0.999	0.04
K	2548	0.0652	K ₂ O	2.729	0.194	-	0.194	KOH	6	56.098	0.908	4.03
Na	63223	2.7500	Na ₂ O	75.770	5.372	0.100	5.472	NaOH, 50% sol. D=1.53	5	40	0.5013	79.31
Cl	108	0.0030	Cl	0.096	0.007	-	0.007	NaCl	8	58.45	0.99	0.18
F	1019	0.0537	F	0.906	0.064	-	0.064	NaF	9	42	0.99	2.28
PO ₄	795	0.0084	P ₂ O ₅	0.528	0.037	-	0.037	Na ₃ PO ₄ ·12H ₂ O	10	380.12	0.99	3.21
SO ₄	12302	0.1281	SO ₃	7.293	0.517	0.129	0.646	Na ₂ SO ₄ with recycled off-gas	11	142.06	0.99	18.38
NO ₂	35536	0.7725	-	-	-	-	-	NaNO ₂	14	69	0.995	53.57
NO ₃	41196	0.6645	-	-	-	-	-	NaNO ₃	-	84.99	0.99	0.00
CO ₃	18476	0.3079	-	-	-	-	-	Na ₂ CO ₃	15	105.99	1	32.63
NH ₃	238	0.0140	-	-	-	-	-	NH ₄ NO ₃	13	80.04	1	1.12
OH	18452	1.0854	-	-	-	-	-	KOH+NaOH	-	-	-	-
Org. Carbon	778	0.0648	-	-	-	-	-	-	-	-	-	-
Oxalate	2853	0.0324	-	-	-	-	-	Sodium Oxalate (C2)	12	134	0.99	4.39
-	-	-	-	-	-	-	-	Target Glass	-	-	-	1586.42
-	-	-	SUM	100.000	7.090	0.229	7.319	Total simulant weight	-	-	-	1135.52

* Sufficient cesium is added so that it can be measured in the glass and off-gas to provide a mass balance (≈ 0.15 wt% Cs₂O in the glass).

- Empty data field

Table 2.2. Oxide Composition of LAW Sub-Envelope B1 Simulant and Corresponding Glass Compositions.

Glass Oxides	AZ-101 in glass @ 5.10 wt % Na ₂ O	Additives Mix	Recycled Sodium Sulfate	LAWB83 Variations		
				Nominal	+15 wt% Simulant	- 15wt% Simulant
Loading	7.09 %	92.68 %	0.23%	7.32 %	8.31 %	6.31 %
Al ₂ O ₃	0.71	5.47	-	6.17	6.21	6.13
B ₂ O ₃	-	10.01	-	10.01	9.90	10.12
CaO	-	6.77	-	6.77	6.69	6.84
Cr ₂ O ₃	0.04	-	-	0.04	0.04	0.03
Cs ₂ O	0.15	-	-	0.15	0.17	0.13
Fe ₂ O ₃	0.00	5.28	-	5.28	5.23	5.34
K ₂ O	0.19	-	-	0.19	0.22	0.17
Li ₂ O	-	4.30	-	4.30	4.26	4.35
MgO	-	2.97	-	2.97	2.93	3.00
Na ₂ O	5.37	-	0.10	5.47	6.21	4.72
SiO ₂	-	48.52	-	48.52	48.01	49.04
TiO ₂	-	1.39	-	1.39	1.38	1.41
ZnO	-	4.83	-	4.83	4.78	4.88
ZrO ₂	-	3.15	-	3.15	3.12	3.19
Cl	0.01	-	-	0.01	0.01	0.01
F	0.06	-	-	0.06	0.07	0.06
P ₂ O ₅	0.04	-	-	0.04	0.04	0.03
SO ₃	0.52	-	0.13	0.65	0.72	0.57
Total	7.09	92.68	0.23	100.00	100.00	100.00

- Empty data field

Table 2.3. Glass Forming Additives for 1 Liter of Simulant (Nominal) and Corresponding Melter Feed Properties.

Additives Source	Feed LAWB83
Additives in Glass (wt%)	92.68 %
Kyanite (Al ₂ SiO ₅) 325 Mesh (Kyanite Mining) (g)	162.27
H ₃ BO ₃ (US Borax – Technical Granular) (g)	286.05
Wollastonite NYAD 325 Mesh (NYCO Minerals) (g)	227.56
Fe ₂ O ₃ (97% Alfa) (g)	74.47
Li ₂ CO ₃ (Chemetall Foote Co. Tech. Gr.) (g)	170.57
Olivine (Mg ₂ SiO ₄) 325 Mesh (#180 Unimin) (g)	99.01
SiO ₂ (Sil-co-Sil 75 US Silica) (g)	517.72
TiO ₂ (Rutile Airfloated Chemaloy) (g)	23.12
ZnO (KADOX – 920 Zinc Corp. of America) (g)	76.83
Zircon ZrSiO ₄ (Flour) Mesh 325 (AM. Mineral) (g)	75.08
Addition of Sucrose as Reductant (nominal) (g)	28.87
+Potassium Iodide spike (g)	2.08
Simulant Weight for 1 liter (g)	1136
Sum of Additives (g)	1713
Sum of Complete Batch (less sugar) (g)	2850
Final Volume (l) (estimated based on density)	1.66
Density – measured (g/ml)	1.73
Expected Glass Produced (g); i.e., Glass Yield (g/l of simulant)	1586
Weight % Water in Slurry Feed	37.2
Weight % Additives in Slurry	60.1
Glass Yield (g/kg of Feed)	557
Glass Yield – estimated (g/l of Feed)	957
Total Solids (g/l of Feed)	1182
Additives – estimated (g/l of Feed)	1034

Table 2.4. Measured Properties of Melter Feed Samples.

Test	Date	Name	Water	Density	Glass Yield		pH	Yield Stress	Viscosity (Poise)		
			(wt%)	(g/ml)	(kg/kg)	(g/l)		(Pa)	@1/s	@10/s	@100/s
Nominal	06/17/02	WVJ-F-50A	38.76	1.69	0.524	886	7.31	NA	NA	NA	NA
	06/18/02	WVJ-F-60A	38.93	1.70	0.526	895	7.30	NA	NA	NA	NA
	06/19/02	WVJ-F-76A	38.80	1.71	0.527	900	7.40	13.8	23.2	4.4	1.4
		WVJ-F-83A	38.67	1.72	0.507	872	7.68	NA	NA	NA	NA
	06/20/02	WVJ-F-93A	38.86	1.73	0.536	928	7.63	NA	NA	NA	NA
	06/21/02	WVJ-F-100A	38.60	1.70	0.537	914	7.63	NA	NA	NA	NA
	Average			38.77	1.71	0.526	899	7.49	13.8	23.2	4.4
+15% Simulant	06/25/02	WVJ-F-133A	40.75	1.67	0.496	828	7.79	4.4	10.7	2.1	0.9
	06/26/02	WVJ-F-145A	40.88	1.67	0.505	844	7.75	NA	NA	NA	NA
	06/27/02	WVK-F-12A	40.04	1.67	0.505	844	7.80	2.5	4.0	0.8	0.4
	06/28/02	WVK-F-28A	39.94	1.63	0.521	850	8.03	NA	NA	NA	NA
	Average			40.40	1.66	0.507	842	7.84	3.5	7.4	1.5

NA: Not Analyzed

Table 2.5. XRF Analyzed Compositions for Melter Feed Samples (wt%).

Test	Nominal									+15% Simulant						
	Target	WVJ-F-50A	WVJ-F-60A	WVJ-F-76A	WVJ-F-83A	WVJ-F-93A	WVJ-F-100A	Avg.	%Dev**	Target	WVJ-F-133A	WVJ-F-145A	WVK-F-12A	WVK-F-28A	Avg.	%Dev**
Al ₂ O ₃	6.16	6.16	6.30	6.53	6.36	6.33	6.69	6.39	3.71	6.20	6.54	6.72	6.58	6.35	6.55	5.55
B ₂ O ₃ *	10.00	10.00	10.00	10.00	10.00	10.00	10.00	NC	NC	9.89	9.89	9.89	9.89	9.89	NC	NC
CaO	6.76	6.16	6.23	6.15	6.29	6.18	6.11	6.19	-8.51	6.68	6.01	6.14	6.08	6.25	6.12	-8.43
Cl	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	NC	0.01	0.01	0.01	0.01	0.02	0.02	NC
Cr ₂ O ₃	0.04	0.11	0.10	0.09	0.09	0.09	0.08	0.09	NC	0.04	0.10	0.11	0.10	0.10	0.10	NC
Cs ₂ O	0.15	0.17	0.13	0.18	0.18	0.18	0.17	0.17	NC	0.17	0.20	0.21	0.19	0.22	0.20	NC
F	0.06	NA	NA	NA	NA	NA	NA	NC	NC	0.07	NA	NA	NA	NA	NC	NC
Fe ₂ O ₃	5.27	5.39	5.38	5.36	5.36	5.38	5.24	5.35	1.48	5.23	4.87	5.44	5.30	5.54	5.29	1.20
I	0.10	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC	NC	0.10	<0.01	<0.01	<0.01	0.01	NC	NC
K ₂ O	0.19	0.32	0.32	0.31	0.32	0.33	0.34	0.32	NC	0.22	0.39	0.39	0.36	0.36	0.38	NC
Li ₂ O*	4.30	4.30	4.30	4.30	4.30	4.30	4.30	NC	NC	4.26	4.26	4.26	4.26	4.26	NC	NC
MgO	2.97	3.22	3.12	2.92	2.87	3.13	3.10	3.06	3.13	2.93	2.63	2.72	2.89	2.83	2.77	-5.43
Na ₂ O	5.46	6.16	6.12	6.31	5.77	5.87	5.85	6.02	10.08	6.20	6.81	6.68	6.35	6.10	6.48	4.52
P ₂ O ₅	0.04	0.08	0.07	0.07	0.07	0.07	0.07	0.07	NC	0.04	0.07	0.07	0.08	0.07	0.07	NC
SiO ₂	48.47	47.97	47.86	47.88	48.05	48.04	48.16	47.99	-0.99	47.97	48.01	47.41	47.63	46.87	47.48	-1.01
SO ₃	0.65	0.42	0.35	0.40	0.39	0.41	0.41	0.40	NC	0.72	0.47	0.41	0.45	0.41	0.44	NC
TiO ₂	1.39	1.54	1.58	1.60	1.61	1.58	1.55	1.58	13.64	1.38	1.59	1.55	1.60	1.68	1.61	16.45
ZnO	4.83	4.59	4.67	4.61	4.83	4.67	4.56	4.65	-3.55	4.78	4.79	4.72	4.82	5.21	4.88	2.27
ZrO ₂	3.15	3.40	3.46	3.26	3.48	3.41	3.36	3.40	7.97	3.12	3.36	3.27	3.39	3.82	3.46	11.01
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	NC	NC	100.00	100.00	100.00	100.00	100.00	NC	NC

* Target values

** % deviation from target

NA – Not Analyzed

NC – Not Calculated

Table 3.1. Summary of Test Conditions and Results.

Sub-Envelope		B1	
LAW Simulant		AZ-101	
Nominal Target Glass Formulation		LAWB83	
Simulant Content of Feed		Nominal	+ 15 wt%
	Target wt% SO ₃	0.65	0.72
	Target wt% Na ₂ O	5.47	6.21
	Target wt% I	0.1	0.1
Time	Feed Start	6/17/02 15:45	6/25/2 06:32
	Feed End	6/21/02 20:15	6/29/2 11:26
	Water Feeding (hr)	0.5	1.0
	Net Slurry Feeding (hr)	100.0	100.0
	Cold Cap Burn-Off (hr)	1.0	1.4
Reductant	Type	Sugar	Sugar
	Sugar Ratio	0.5	0.41 [#]
	Mol. NO _x : Mol. Total Organic Carbon	1: 0.75	1: 0.63
Measured Glass Yield (g/l)		899	842
Production Rate (kg/m ² /day)		2033	1895
Bubbling Rate (lpm)		16.9	14.0
Product	Measured wt% SO ₃	0.45	0.48
	Measured wt% I	<0.01	<0.01
	Test End Sulfate Gall?	NO	NO
	% Feed Sulfur in Glass Product	69	67

- Target ratio is 0.5 but the +15% variation results in the actual ratio given.

Table 3.2. Summary of Measured Melter Parameters.

			Nominal			+15% Simulant		
			Avg	Min	Max	Avg	Min	Max
TEMPERATURE(C)	Electrode	East	1121	1099	1140	1131	1093	1153
		West	1119	1099	1140	1127	1089	1153
		Bottom	965	935	975	963	940	973
	Glass *	19"	966	698	1062	858	169	1036
		16"	1097	956	1142	1116	1043	1164
		10"	1140	1106	1163	1142	1094	1170
		4"	1147	1103	1164	1144	1098	1168
		Plenum (thermowell)	629	563	716	629	391	763
		Bubbler	1126	1075	1170	1158	1095	1187
	Discharge	Chamber	1023	995	1047	1027	990	1049
		Air Lift	1072	983	1147	1082	952	1160
		Film Cooler Outlet	301	290	332	311	277	365
		Transition Line Outlet	310	297	353	329	299	391
		Lance Bubbling (lpm)	16.9	4.7	27.3	14.0	1.5	27.3
	Electrode	Voltage (V)	59	0	64	57	0	64
Total Power (kW)		24	0	27	24	0	27	

* Locations are distances from melter floor

Table 4.1. Listing of Glass Discharged, Masses, and Analysis Performed.

Test	Date	Name	Analysis	Mass (kg)	Cumulative Mass (kg)	
Nominal	06/17/02	WVJ-G-48A		31.5	31.5	
		WVJ-G-50A	XRF			
		WVJ-G-50B		20.4	51.9	
		WVJ-G-51A	XRF			
		WVJ-G-51B				
	06/18/02	WVJ-G-53A	XRF	27.3	105.9	
		WVJ-G-53B				
		WVJ-G-57A	XRF	18.3	124.2	
		WVJ-G-57B				
		WVJ-G-58A	XRF			
		WVJ-G-58B		23.3	147.5	
		WVJ-G-59A	XRF			
		WVJ-G-59B		22.9	170.4	
		WVJ-G-59C	XRF			
		WVJ-G-60A				
		WVJ-G-62 A	XRF	25.7	224.2	
		WVJ-G-62B				
		WVJ-G-62C	XRF	25.9	250.1	
		WVJ-G-62D				
		WVJ-G-62E	XRF			
		WVJ-G-66A		25.9	276	
		WVJ-G-66B	XRF			
		06/19/02	WVJ-G-66C		23.4	299.4
			WVJ-G-67A	XRF		
			WVJ-G-68A		23.4	322.8
	WVJ-G-69A		XRF			
	WVJ-G-73A					
	WVJ-G-74A		XRF	23.4	346.2	
	WVJ-G-76A					
	WVJ-G-76B		XRF			
	WVJ-G-77A			29.8	376.0	
	WVJ-G-77B		XRF			
	WVJ-G-77C			27.1	403.1	
	WVJ-G-80A		XRF			
	WVJ-G-80B					
	WVJ-G-80C		XRF	29.5	455.5	
	WVJ-G-80D		XRF			
	06/20/02	WVJ-G-83A		26.1	503.4	
		WVJ-G-85A	XRF			
		WVJ-G-86A		29.3	532.7	
WVJ-G-86B		XRF				
WVJ-G-87B						
WVJ-G-90A	XRF	29.9	562.6			

Table 4.1. Listing of Glass Discharged, Masses, and Analysis Performed. (continued).

Test	Date	Name	Analysis	Mass (kg)	Cumulative Mass (kg)
Nominal	06/20/02	WVJ-G-91A		27.9	590.5
		WVJ-G-93A	XRF		
		WVJ-G-93B		27.0	617.5
		WVJ-G-94A	XRF		
		WVJ-G-94B		23.8	641.3
		WVJ-G-97A	XRF		
		WVJ-G-97B		23.5	664.8
		WVJ-G-97C	XRF		
		WVJ-G-97D		24.8	689.6
		WVJ-G-99A	XRF		
	06/21/02	WVJ-G-99B		25.0	714.6
		WVJ-G-99C	XRF		
		WVJ-G-100A		24.9	739.5
		WVJ-G-101A	XRF		
		WVJ-G-101B		28.3	767.8
		WVJ-G-105A	XRF		
		WVJ-G-105B		24.8	792.5
		WVJ-G-106A	XRF		
		WVJ-G-108A		24.1	816.6
		WVJ-G-108B	XRF		
WVJ-G-109 A		27.6	844.2		
WVJ-G-109B	XRF				
WVJ-G-109 C		26.6	870.8		
WVJ-G-109D	XRF				
WVJ-G-113 A	XRF	10.5	881.3		
+15% Simulant	06/25/02	WVJ-G-131A		30.6	911.9
		WVJ-G-132A	XRF		
		WVJ-G-133A		24.7	936.6
		WVJ-G-134A	XRF		
		WVJ-G-134B		32.3	968.9
		WVJ-G-136A	XRF		
		WVJ-G-136B		26.1	995.0
		WVJ-G-139A	XRF		
		WVJ-G-139B		25.2	1020.2
	WVJ-G-141A	XRF			
	06/26/02	WVJ-G-141B		24.9	1045.1
		WVJ-G-142A	XRF		
		WVJ-G-142B		24.2	1069.3
		WVJ-G-145A	XRF		
		WVJ-G-145B		23.8	1093.1
		WVJ-G-147A	XRF		
		WVJ-G-147B		33.4	1126.6
		WVJ-G-148A	XRF		

Table 4.1. Listing of Glass Discharged, Masses, and Analysis Performed. (continued).

Test	Date	Name	Analysis	Mass (kg)	Cumulative Mass (kg)	
+15% Simulant	06/26/02	WVJ-G-149A		26.1	1152.7	
		WVJ-G-149B	XRF			
		WVJ-G-149 C		26.4	1179.1	
		WVJ-G-153A	XRF			
		WVJ-G-153B				
	06/27/02	WVJ-G-153C	XRF	29.8	1208.9	
		WVJ-G-154A		23.7	1232.6	
		WVJ-G-154B	XRF			
		WVK-G-6A		25.8	1258.4	
		WVK-G-6B	XRF			
		WVK-G-11A	XRF	22.3	1280.7	
		WVK-G-11B		27.3	1308.0	
		WVK-G-11C	XRF			
		WVK-G-12A				
		WVK-G-12B	XRF	34.9	1342.9	
		WVK-G-16A		30.5	1373.4	
		WVK-G-17A	XRF			
		WVK-G-18A				
		WVK-G-18B	XRF	24.0	1397.4	
		06/28/02	WVK-G-18C		25.6	1423.0
			WVK-G-20A	XRF		
			WVK-G-20B		26.4	1449.4
	WVK-G-21A		XRF			
	WVK-G-24A			25.4	1474.8	
	WVK-G-24B		XRF			
	WVK-G-27A			21.3	1496.1	
	WVK-G-27B		XRF			
	WVK-G-27C					
	WVK-G-28A		XRF	24.3	1520.4	
	WVK-G-30A			27.6	1548.0	
	WVK-G-30B		XRF			
	WVK-G-30C			25.2	1573.1	
	WVK-G-33A		XRF			
	WVK-G-33B					
	WVK-G-34A	XRF	28.1	1601.2		
	06/29/02	WVK-G-34B		26.6	1627.8	
		WVK-G-36A	XRF			
		WVK-G-36B		26.3	1654.1	
		WVK-G-37A	XRF			
		WVK-G-37B		24.8	1678.9	
		WVK-G-41A	XRF			
		WVK-G-41B				
WVK-G-42A		XRF	26.8	1705.7		
WVK-G-42B	XRF	9.1	1714.8			

Table 4.2. XRF Analyzed Compositions for Discharged Glass Samples (wt%).

Test	Nominal																	
	Glass (kg)	31.5	51.9	78.6	105.9	124.2	147.5	170.4	198.5	224.2	250.1	276.0	299.4	322.8	346.2	376.0	403.1	426.0
Element	Target	WVJ-G-50A	WVJ-G-51A	WVJ-G-53A	WVJ-G-57A	WVJ-G-58A	WVJ-G-59A	WVJ-G-59C	WVJ-G-62A	WVJ-G-62C	WVJ-G-62E	WVJ-G-66B	WVJ-G-67A	WVJ-G-69A	WVJ-G-74A	WVJ-G-76B	WVJ-G-77B	WVJ-G-80A
Al ₂ O ₃	6.16	6.48	6.46	6.66	6.51	6.21	6.41	6.16	6.59	6.61	6.65	6.37	6.73	6.90	6.72	6.72	6.58	6.64
B ₂ O ₃ *	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
CaO	6.76	6.48	6.45	6.21	6.36	6.32	6.27	6.23	6.15	6.24	6.17	6.13	6.10	6.09	6.05	5.98	6.04	6.05
Cl	0.01	0.06	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01
Cr ₂ O ₃	0.04	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.09
Cs ₂ O	0.15	0.14	0.17	0.16	0.15	0.15	0.16	0.18	0.17	0.14	0.17	0.19	0.19	0.16	0.21	0.19	0.20	0.19
F	0.06	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fe ₂ O ₃	5.27	4.52	4.67	4.63	4.84	4.96	4.96	5.02	5.02	5.21	5.14	5.16	5.15	5.22	5.14	5.06	5.19	5.24
I	0.10	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
K ₂ O	0.19	0.30	0.30	0.30	0.32	0.31	0.31	0.30	0.32	0.33	0.33	0.32	0.33	0.34	0.32	0.32	0.33	0.32
Li ₂ O*	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30
MgO	2.97	1.81	2.05	2.32	2.39	2.64	2.65	2.80	2.80	2.87	3.02	3.00	3.02	3.03	3.06	3.24	3.17	3.14
Na ₂ O	5.46	11.04	9.84	9.66	8.75	8.67	8.39	8.12	7.49	7.03	7.20	6.95	6.45	6.40	6.54	6.50	6.33	6.26
P ₂ O ₅	0.04	0.14	0.13	0.12	0.12	0.10	0.10	0.10	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.07	0.08
SiO ₂	48.47	45.87	46.45	46.69	46.87	46.78	46.91	47.14	47.52	47.44	47.24	47.70	47.98	47.67	47.84	48.06	48.05	47.95
SO ₃	0.65	0.45	0.46	0.46	0.47	0.47	0.49	0.47	0.49	0.47	0.45	0.47	0.48	0.47	0.46	0.47	0.46	0.47
TiO ₂	1.39	1.32	1.34	1.35	1.40	1.43	1.43	1.45	1.45	1.50	1.48	1.48	1.48	1.50	1.47	1.48	1.52	1.53
ZnO	4.83	3.85	3.97	3.88	4.12	4.25	4.22	4.27	4.23	4.39	4.34	4.38	4.32	4.40	4.36	4.29	4.37	4.42
ZrO ₂	3.15	3.15	3.27	3.13	3.26	3.29	3.30	3.37	3.27	3.28	3.31	3.38	3.30	3.32	3.33	3.22	3.28	3.30
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Target values

Table 4.2. XRF Analyzed Compositions for Discharged Glass Samples (wt%), continued.

Test	Nominal															
Glass (kg)		455.5	477.3	503.4	532.7	562.6	590.5	617.5	641.3	664.8	689.6	714.6	739.5	767.8	792.5	816.6
Element	Target	WVJ-G-80C	WVJ-G-80D	WVJ-G-85A	WVJ-G-86B	WVJ-G-90A	WVJ-G-92A	WVJ-G-94A	WVJ-G-97A	WVJ-G-97C	WVJ-G-99A	WVJ-G-99C	WVJ-G-101A	WVJ-G-105A	WVJ-G-106A	WVJ-G-108B
Al ₂ O ₃	6.16	6.61	6.57	6.86	6.82	7.05	6.86	6.71	6.55	6.75	6.66	6.32	6.63	6.67	6.45	6.69
B ₂ O ₃ *	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
CaO	6.76	6.07	6.05	6.18	6.15	5.99	6.08	6.13	6.15	6.11	5.99	6.26	6.05	5.99	6.09	6.15
Cl	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.02	0.01	0.02	0.01	0.01	0.02	0.02	0.02	0.02
Cr ₂ O ₃	0.04	0.09	0.09	0.09	0.09	0.08	0.09	0.09	0.09	0.09	0.08	0.09	0.09	0.09	0.09	0.09
Cs ₂ O	0.15	0.18	0.19	0.16	0.18	0.16	0.16	0.17	0.19	0.18	0.19	0.17	0.18	0.18	0.18	0.17
F	0.06	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fe ₂ O ₃	5.27	5.30	5.23	5.47	5.39	5.25	5.36	5.42	5.37	5.35	5.20	5.52	5.19	5.19	5.32	5.44
I	0.10	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
K ₂ O	0.19	0.32	0.33	0.37	0.34	0.37	0.37	0.34	0.33	0.36	0.33	0.32	0.32	0.33	0.32	0.33
Li ₂ O*	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30
MgO	2.97	3.13	3.17	2.98	3.10	3.23	3.12	3.19	3.25	3.26	3.25	3.33	3.24	3.33	3.24	3.17
Na ₂ O	5.46	6.25	6.20	5.71	5.71	5.90	6.01	5.58	6.00	5.60	6.09	5.49	6.11	5.88	5.95	5.92
P ₂ O ₅	0.04	0.07	0.07	0.08	0.07	0.07	0.07	0.07	0.08	0.07	0.08	0.08	0.07	0.08	0.07	0.07
SiO ₂	48.47	48.00	48.16	47.76	47.84	48.08	47.79	47.96	47.83	48.04	48.20	47.84	48.20	48.39	48.11	47.62
SO ₃	0.65	0.46	0.46	0.44	0.46	0.42	0.44	0.46	0.45	0.45	0.45	0.46	0.45	0.46	0.45	0.44
TiO ₂	1.39	1.54	1.53	1.58	1.59	1.51	1.54	1.57	1.56	1.56	1.53	1.60	1.52	1.51	1.54	1.57
ZnO	4.83	4.44	4.40	4.65	4.57	4.40	4.53	4.62	4.52	4.54	4.40	4.72	4.38	4.37	4.52	4.60
ZrO ₂	3.15	3.24	3.23	3.35	3.36	3.18	3.27	3.36	3.32	3.33	3.24	3.49	3.25	3.23	3.35	3.40
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Target values

NA – Not Analyzed

Table 4.2. XRF Analyzed Compositions for Discharged Glass Samples (wt%), continued.

Test	Nominal							+15% Simulant									
	Target	844.2	870.8	881.3	Overall Avg.	Steady State Avg.#	%Dev from Target	Target	936.6	968.9	995.0	1020.2	1045.1	1069.3	1093.1	1126.6	1152.7
Element	Target	WVJ-G-109B	WVJ-G-109D	WVJ-G-113A	Overall Avg.	Steady State Avg.#	%Dev from Target	Target	WVJ-G-134A	WVJ-G-136A	WVJ-G-139A	WVJ-G-141A	WVJ-G-142A	WVJ-G-145A	WVJ-G-147A	WVJ-G-148A	WVJ-G-149B
Al ₂ O ₃	6.16	6.63	6.85	6.60	6.62	6.69	8.51	6.20	6.51	6.46	6.64	6.21	6.20	6.46	6.22	6.25	6.26
B ₂ O ₃ *	10.00	10.00	10.00	10.00	NC	NC	NC	9.89	9.89	9.89	9.89	9.89	9.89	9.89	9.89	9.89	9.89
CaO	6.76	6.15	6.10	6.09	6.15	6.09	-10.02	6.68	6.01	6.01	5.98	6.01	5.98	5.91	6.05	5.97	5.89
Cl	0.01	0.02	0.01	0.01	0.02	0.02	NC	0.01	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02
Cr ₂ O ₃	0.04	0.09	0.09	0.09	0.09	0.09	NC	0.04	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Cs ₂ O	0.15	0.19	0.16	0.19	0.17	0.18	NC	0.17	0.18	0.18	0.24	0.18	0.20	0.15	0.18	0.19	0.19
F	0.06	NA	NA	NA	NC	NC	NC	0.07	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fe ₂ O ₃	5.27	5.36	5.42	5.33	5.18	5.30	0.54	5.23	5.26	5.24	5.24	5.20	5.20	5.17	5.31	5.27	5.29
I	0.10	<0.01	<0.01	<0.01	NC	NC	NC	0.10	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
K ₂ O	0.19	0.35	0.37	0.33	0.33	0.34	NC	0.22	0.34	0.34	0.36	0.33	0.33	0.34	0.35	0.34	0.34
Li ₂ O*	4.30	4.30	4.30	4.30	NC	NC	NC	4.26	4.26	4.26	4.26	4.26	4.26	4.26	4.26	4.26	4.26
MgO	2.97	3.16	3.08	3.21	2.98	3.18	7.08	2.93	3.27	3.24	3.19	3.25	3.32	3.24	3.13	3.30	3.32
Na ₂ O	5.46	5.78	5.50	5.86	6.78	5.98	9.45	6.20	6.40	6.24	5.83	6.65	6.50	6.87	6.49	6.68	7.10
P ₂ O ₅	0.04	0.08	0.07	0.06	0.08	0.07	NC	0.04	0.08	0.08	0.07	0.08	0.08	0.06	0.07	0.07	0.08
SiO ₂	48.47	47.97	48.20	48.01	47.66	47.98	-1.01	47.97	47.85	48.20	47.97	48.04	48.11	47.96	48.09	48.02	47.80
SO ₃	0.65	0.44	0.43	0.43	0.46	0.45	NC	0.72	0.51	0.52	0.50	0.51	0.49	0.49	0.50	0.49	0.50
TiO ₂	1.39	1.57	1.54	1.56	1.50	1.54	10.92	1.38	1.54	1.53	1.55	1.53	1.53	1.51	1.55	1.51	1.50
ZnO	4.83	4.56	4.56	4.55	4.38	4.49	-7.01	4.78	4.48	4.46	4.69	4.47	4.49	4.43	4.54	4.39	4.36
ZrO ₂	3.15	3.37	3.31	3.37	3.30	3.31	5.17	3.12	3.30	3.24	3.48	3.27	3.28	3.14	3.26	3.24	3.10
Sum	100.00	100.00	100.00	100.00	100.00	NC	NC	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Target values

Calculated from samples after initial 300 kg of glass production

NA – Not Analyzed

NC – Not Calculated

Table 4.2. XRF Analyzed Compositions for Discharged Glass Samples (wt%), continued.

Test	+15% Simulant															
Glass (kg)		1179.1	1208.9	1232.6	1258.4	1280.7	1308.0	1342.9	1373.4	1397.4	1423.0	1449.4	1474.8	1496.1	1520.4	1548.0
Element	Target	WVJ-G-153A	WVJ-G-153C	WVJ-G-154B	WVK-G-6B	WVK-G-11A	WVK-G-11C	WVK-G-12B	WVK-G-17A	WVK-G-18B	WVK-G-20A	WVK-G-21A	WVK-G-24B	WVK-G-27B	WVK-G-28A	WVK-G-30B
Al ₂ O ₃	6.20	6.55	6.55	6.26	6.68	6.28	6.17	6.58	6.23	6.21	6.35	6.52	6.52	6.62	6.62	6.87
B ₂ O ₃ *	9.89	9.89	9.89	9.89	9.89	9.89	9.89	9.89	9.89	9.89	9.89	9.89	9.89	9.89	9.89	9.89
CaO	6.68	5.89	5.90	6.10	5.87	6.04	6.13	5.95	6.05	6.03	5.98	5.91	5.99	5.93	5.89	5.98
Cl	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02
Cr ₂ O ₃	0.04	0.10	0.10	0.11	0.09	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.09	0.09	0.10
Cs ₂ O	0.17	0.22	0.22	0.20	0.21	0.22	0.21	0.20	0.18	0.22	0.20	0.20	0.22	0.22	0.22	0.20
F	0.07	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fe ₂ O ₃	5.23	5.28	5.42	5.62	5.31	5.61	5.61	5.42	5.45	5.42	5.38	5.29	5.37	5.27	5.25	5.29
I	0.10	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
K ₂ O	0.22	0.36	0.36	0.35	0.38	0.34	0.35	0.37	0.34	0.34	0.35	0.37	0.37	0.38	0.38	0.39
Li ₂ O*	4.26	4.26	4.26	4.26	4.26	4.26	4.26	4.26	4.26	4.26	4.26	4.26	4.26	4.26	4.26	4.26
MgO	2.93	3.14	3.20	3.08	3.09	3.19	3.16	3.15	3.26	3.12	3.08	3.17	3.12	3.05	3.05	3.08
Na ₂ O	6.20	6.70	6.52	6.41	6.81	6.63	6.36	6.32	6.58	6.64	6.59	6.65	6.39	6.41	6.56	6.10
P ₂ O ₅	0.04	0.07	0.07	0.08	0.07	0.07	0.08	0.07	0.09	0.08	0.08	0.07	0.06	0.07	0.07	0.07
SiO ₂	47.97	47.78	47.66	47.79	47.71	47.57	47.70	47.74	47.88	47.93	48.05	47.69	47.61	47.82	47.72	47.71
SO ₃	0.72	0.47	0.46	0.49	0.48	0.50	0.52	0.48	0.49	0.49	0.50	0.49	0.48	0.48	0.49	0.47
TiO ₂	1.38	1.51	1.52	1.53	1.49	1.53	1.56	1.53	1.52	1.52	1.52	1.53	1.54	1.53	1.54	1.54
ZnO	4.78	4.48	4.51	4.54	4.44	4.50	4.54	4.59	4.48	4.46	4.43	4.54	4.66	4.60	4.60	4.67
ZrO ₂	3.12	3.28	3.32	3.29	3.20	3.24	3.34	3.33	3.20	3.27	3.22	3.29	3.40	3.35	3.33	3.36
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Target values

NA - Not Analyzed

Table 4.2. XRF Analyzed Compositions for Discharged Glass Samples (wt%), continued.

Test	+15% Simulant										
	Glass (kg)	1573.1	1601.2	1627.8	1654.1	1678.9	1705.7	1714.8	Overall Avg.	Steady State Avg.#	%Dev from Target
Element	Target	WVK-G-33A	WVK-G-34A	WVK-G-36A	WVK-G-37A	WVK-G-41A	WVK-G-42A	WVK-G-42B			
Al ₂ O ₃	6.20	6.33	6.69	6.53	6.61	6.63	6.66	6.41	6.46	6.48	4.52
B ₂ O ₃ *	9.89	9.89	9.89	9.89	9.89	9.89	9.89	9.89	NC	NC	NC
CaO	6.68	6.02	5.94	5.94	5.98	6.02	5.94	6.07	5.98	5.98	-10.60
Cl	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	NC
Cr ₂ O ₃	0.04	0.10	0.10	0.10	0.10	0.10	0.09	0.10	0.10	0.10	NC
Cs ₂ O	0.17	0.24	0.21	0.22	0.20	0.24	0.22	0.23	0.21	0.21	NC
F	0.07	NA	NA	NA	NA	NA	NA	NA	NC	NC	NC
Fe ₂ O ₃	5.23	5.37	5.25	5.18	5.29	5.28	5.16	5.32	5.32	5.35	2.44
I	0.10	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC	NC	NC
K ₂ O	0.22	0.35	0.37	0.37	0.38	0.39	0.39	0.38	0.36	0.37	NC
Li ₂ O*	4.26	4.26	4.26	4.26	4.26	4.26	4.26	4.26	NC	NC	NC
MgO	2.93	3.20	3.19	3.11	3.01	3.10	3.00	2.92	3.15	3.12	6.65
Na ₂ O	6.20	6.37	6.53	6.47	6.41	6.24	6.29	6.54	6.49	6.50	4.84
P ₂ O ₅	0.04	0.08	0.07	0.07	0.06	0.07	0.07	0.06	0.07	0.07	NC
SiO ₂	47.97	47.42	47.47	47.91	47.70	47.58	48.00	47.50	47.81	47.73	-0.50
SO ₃	0.72	0.49	0.48	0.49	0.47	0.48	0.47	0.47	0.49	0.48	NC
TiO ₂	1.38	1.58	1.54	1.55	1.57	1.57	1.55	1.58	1.54	1.54	11.54
ZnO	4.78	4.78	4.61	4.57	4.67	4.72	4.61	4.79	4.55	4.57	-4.26
ZrO ₂	3.12	3.51	3.37	3.30	3.37	3.45	3.37	3.47	3.31	3.32	6.51
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	NC	NC	NC

* Target values

Calculated from samples after initial 300 kg of glass production

NA – Not Analyzed

NC – Not Calculated

Table 4.3. XRF Analyzed Compositions for Dip Samples.

Test	Nominal					+15% Simulant							
	Element	Target	WVJ-D-113A	WVJ-D-113B	WVJ-D-113C	WVJ-D-119B	Target	WVK-D-42A	WVK-D-49A	WVK-D-49B	WVK-D-49C	WVK-D-50A	WVK-D-50B
Al ₂ O ₃	6.16	6.50	NA	NA	6.92	6.20	6.40	6.44	6.53	NA	6.43	6.61	6.71
B ₂ O ₃ *	10.00	10.00	NA	NA	10.00	9.89	9.89	9.89	9.89	NA	9.89	9.89	9.89
CaO	6.76	6.04	NA	NA	6.12	6.68	6.14	5.99	6.06	NA	6.05	5.92	6.01
Cl	0.01	0.02	NA	NA	0.02	0.01	0.01	0.01	0.01	NA	0.01	0.01	<0.01
Cr ₂ O ₃	0.04	0.26	NA	NA	0.12	0.04	0.10	0.10	0.10	NA	0.10	0.09	0.09
Cs ₂ O	0.15	0.16	NA	NA	0.17	0.17	0.21	0.23	0.20	NA	0.24	0.25	0.21
F	0.06	NA	NA	NA	NA	0.07	NA	NA	NA	NA	NA	NA	NA
Fe ₂ O ₃	5.27	5.26	NA	NA	5.39	5.23	5.38	5.15	5.35	NA	5.29	5.09	5.19
I	0.10	<0.01	NA	NA	<0.01	0.10	<0.01	<0.01	<0.01	NA	<0.01	<0.01	<0.01
K ₂ O	0.19	0.33	NA	NA	0.34	0.22	0.36	0.36	0.38	NA	0.35	0.38	0.38
Li ₂ O*	4.30	4.30	NA	NA	4.30	4.26	4.26	4.26	4.26	NA	4.26	4.26	4.26
MgO	2.97	3.24	NA	NA	3.14	2.93	2.93	2.98	3.01	NA	3.11	3.01	3.03
Na ₂ O	5.46	6.07	NA	NA	5.60	6.20	6.51	6.67	6.18	NA	6.55	6.87	6.48
P ₂ O ₅	0.04	0.07	NA	NA	0.07	0.04	0.07	0.07	0.08	NA	0.07	0.07	0.08
SiO ₂	48.47	47.90	NA	NA	47.81	47.97	47.28	46.64	47.59	NA	47.31	47.67	47.82
SO ₃	0.65	0.49	NA	NA	0.46	0.72	0.48	1.74	0.50	NA	0.51	0.49	0.54
TiO ₂	1.39	1.52	NA	NA	1.58	1.38	1.60	1.55	1.59	NA	1.59	1.55	1.54
ZnO	4.83	4.55	NA	NA	4.59	4.78	4.87	4.59	4.83	NA	4.78	4.55	4.49
ZrO ₂	3.15	3.29	NA	NA	3.36	3.12	3.52	3.31	3.44	NA	3.48	3.29	3.27
Sum	100.00	100.00	NA	NA	100.00	100.00	100.00	100.00	100.00	NA	100.00	100.00	100.00
Sampling Date		6/21/02	6/21/02	6/24/02	6/24/02	-	6/29/02	7/1/02	7/1/02	7/3/02	7/3/02	7/3/02	8/5/02
Sulfate Visible?		No	No	Yes	No	-	No	Yes	No	Yes	No	No	No

* Target values
NA - Not analyzed
- Empty data field

Table 5.1. Results from Melter Off-Gas Emission Samples.

		Test #1 06/20/02				Test #2 06/28/02			
		Feed Flux (mg/min)	Run 1 (mg/min)	Percent of Feed Emitted	DF Across Melter	Feed Flux (mg/min)	Run 2 (mg/min)	Percent of Feed Emitted	DF Across Melter
Particles	Total ^s	166750	191.69	0.11	869.9	166883	187.15	0.11	891.7
	Al	4660	1.60	0.03	2917.9	4690	1.07	0.02	4371.1
	B	4431	6.19	0.14	715.5	4383	4.42	0.10	992.5
	Ca	6903	2.69	0.04	2562.2	6821	1.59	0.02	4282.5
	Cl*	14	5.64	40.29	2.48	14	4.17	29.79	3.4
	Cr	39	0.26	0.67	149.2	39	0.26	0.66	151.6
	Cs	202	3.06	1.51	66.0	229	3.31	1.45	69.2
	F*	86	2.54	2.95	33.9	100	1.70	1.70	58.8
	Fe	5267	1.72	0.03	3061.0	5217	1.07	0.02	4876.7
	I*	143	< 0.10	< 0.10	> 1430	143	< 0.10	< 0.10	> 1430
	K	225	1.14	0.51	196.6	261	1.00	0.38	260.0
	Li	2849	2.53	0.09	1126.6	2823	1.93	0.07	1464.7
	Mg	2555	0.12	0.00	22210.7	2520	< 0.10	< 0.10	> 25550
	Na	5789	10.88	0.19	532.2	6572	9.94	0.15	661.4
	P	25	< 0.10	< 0.40	> 250	25	< 0.10	< 0.40	> 250
	S*	372	29.62	7.96	12.6	412	32.10	7.80	12.8
	Si	32354	9.83	0.03	3292.1	32014	6.55	0.02	4888.9
	Ti	1189	1.11	0.09	1067.0	1180	0.74	0.06	1586.2
	Zn	5535	5.57	0.10	994.2	5478	3.81	0.07	1439.0
Zr	3326	0.30	0.01	11032.8	3295	0.19	0.01	16999.0	
Gas	B	4431	38.62	0.87	114.7	4383	44.57	1.02	98.3
	Cl	14	31.23	218.95	0.5	14	34.54	242.15	0.4
	F	86	31.81	37.17	2.7	100	42.34	42.41	2.4
	I	143	125.99	88.32	1.1	143	155.59	109.07	0.9
	S	372	92.75	24.96	4.0	412	110.97	26.96	3.7

* - Calculation based on water dissolution of filter particulate

^s - From gravimetric analysis of filters and front-half nitric acid rinse.

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**Table 5.2. Average Concentration (ppmv) of Selected Species
in Off-Gas Measured by FTIR.**

Test	Nominal	+15%
NO	414	532
NO ₂	28	36
N ₂ O	60	63
NH ₃	0.7	0.4
SO ₂	9.2	19
H ₂ O [%]	6.1	6.8
CO ₂	2805	2888
CO	24	18
Acetonitrile	1.7	0.8
HCl	0.7	1.6
HCN	1.2	1.0
H ₂ #	16.0	10.2

#Values obtained by Gas Chromatography, not FTIR.

Table 5.3. Average NO_x Fluxes in Off-Gas Measured by FTIR Spectroscopy.

Test #	Feed [mol/hr]	Sugar Ratio	Emissions [mol/h]			% Feed NO _x Emitted as Nitrogen Oxides
			N ₂ O [mol/hr]	NO [mol/hr]	NO ₂ [mol/hr]	
1	8.17	0.50	0.45	3.13	0.21	46
2	8.86	0.44	0.48	4.02	0.27	54

Table 5.4. Mass Balance of Volatile Constituents (% of Feed).

Analyte		Test		
		Nominal	(+15 wt% Simulant)	
Glass	Cs	> 100	> 100	
	I	< 1	< 1	
	S	69	67	
Particulate Emissions	Cs	1.51	1.45	
	I	< 0.10	< 0.10	
	S	7.96	7.80	
Gaseous Emissions	Cs	< 0.1	< 0.1	
	I	88.32	109.07	
	S	as SO ₂	9.97	18.59
		Total	24.96	26.96
Total	Cs	> 100	> 100	
	I	88	109	
	S	102	102	

Table 6.1. Completion of Test Objectives.

Test Objective	Objective Met?	Discussion Section
Demonstrate that the nominal Sub-Envelope B1 feed is processable in the DM100	Yes	Section 3.0. Nominal operating conditions were maintained and the full test duration was completed.
Demonstrate that Sub-Envelope B1 feed with +15% simulant is processable in the DM100	Yes	Section 3.0. Nominal operating conditions were maintained and the full test duration was completed.
Demonstrate that no separate sulfate phase forms for Sub-Envelope B1 feed with nominal and +15% simulant in the DM100	Yes	Section 3.0. No separate sulfate phase was detected at the end of either test. A separate sulfate phase was formed after idling at 1050°C but disappeared after gentle bubbling at 1150°C.
Demonstrate that target feed rate can be achieved with the nominal Sub-Envelope B1 feed in the DM100	Yes	Section 3.0. Target glass production rate achieved while maintaining nominal operating temperatures.
Demonstrate that target feed rate can be achieved for Sub-Envelope B1 feed with +15% simulant in the DM100	Yes	Section 3.0. Target glass production rate achieved while maintaining nominal operating temperatures.
Demonstrate target product compositions are achieved for Sub-Envelope B1 feed with nominal and +15% simulant in the DM100	Yes	Section 4.0. The analyzed glass product compositions agreed well with the target compositions.
Report melter emissions data for the DM100 for Sub-Envelope B1 feed with nominal and +15% simulant	Yes	Section 5.0. Particulate and gaseous emissions were determined for a variety of species and DF values computed.
Characterize the properties of the melter feed for Sub-Envelope B1 feed with nominal and +15% simulant	Yes	Section 2.0. Samples of the melter feeds were characterized with respect to chemical composition and physical properties, including rheology.

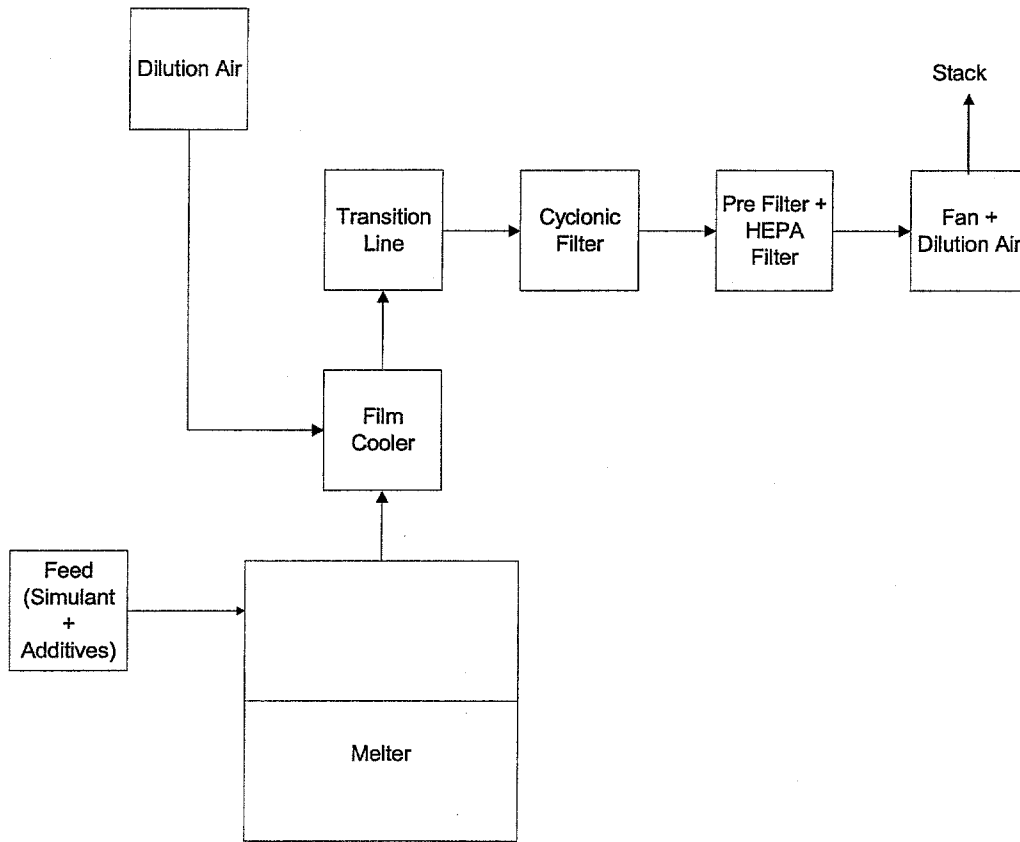
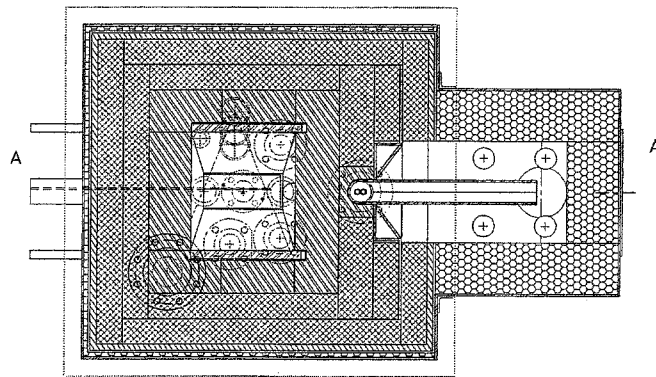


Figure 1.1. Schematic diagram of DuraMelter 100-WV vitrification system.



SECTION B-B
(BACKGROUND OMITTED)

Figure 1.2(a). Cross-section through the DM100-WV melter—Plan View.

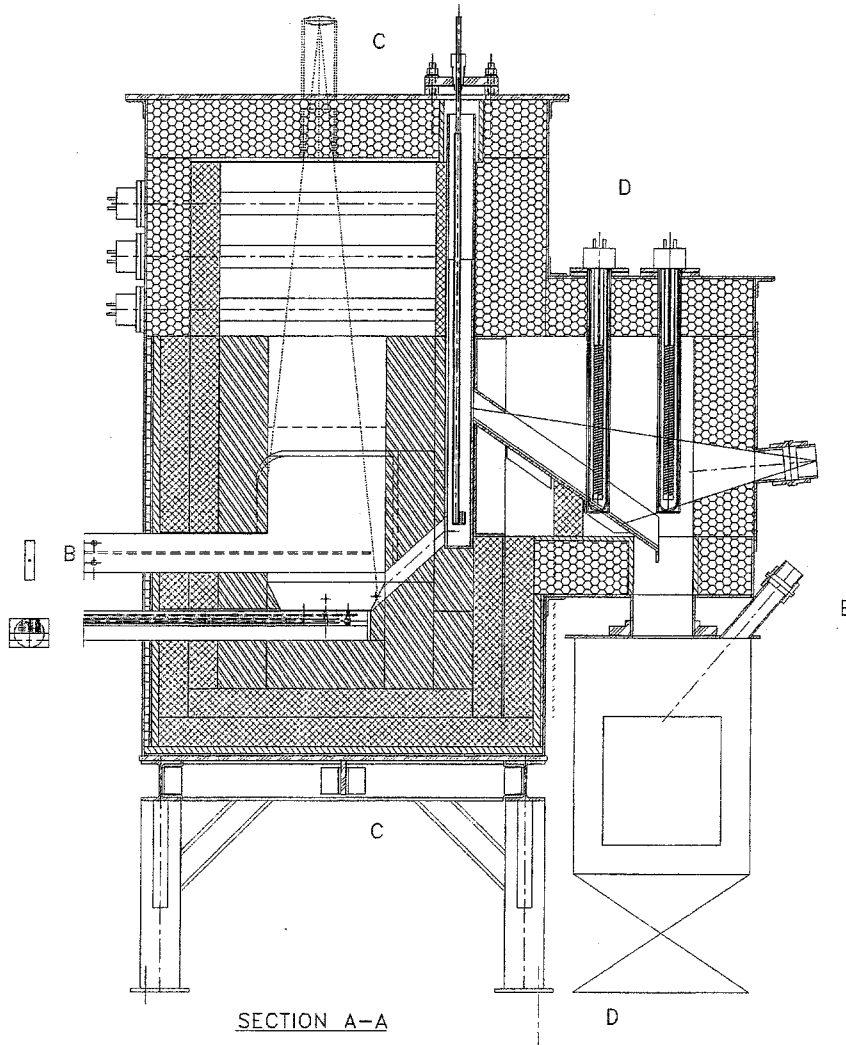


Figure 1.2(b). Cross-section through the DM100-WV melter—Section AA.

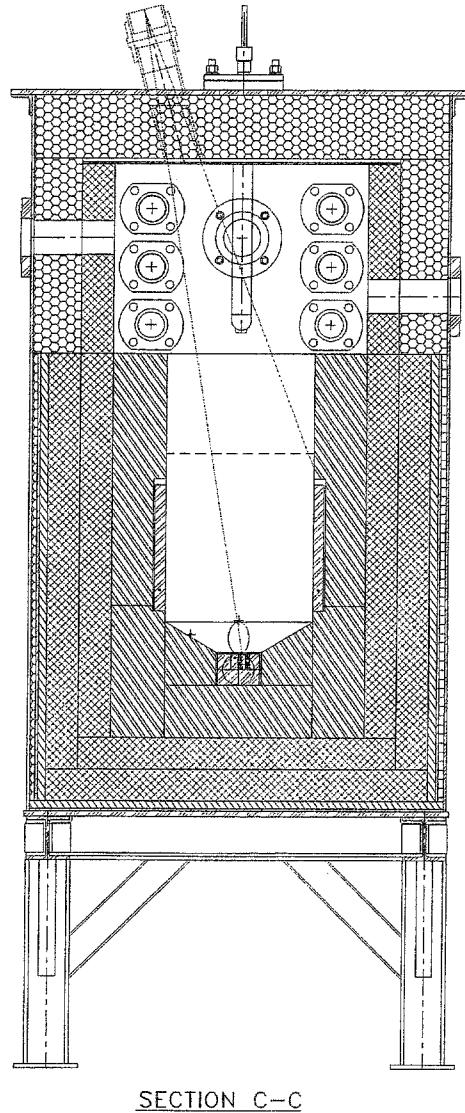


Figure 1.2(c). Cross-section through the DM100-WV melter—Section CC.

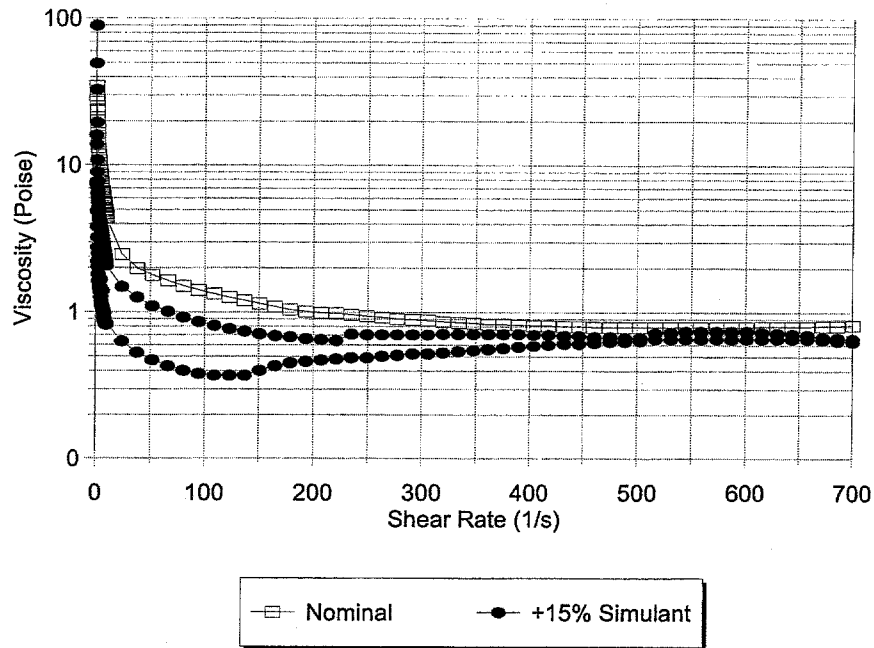


Figure 2.1. Measured viscosity of melter feed samples.

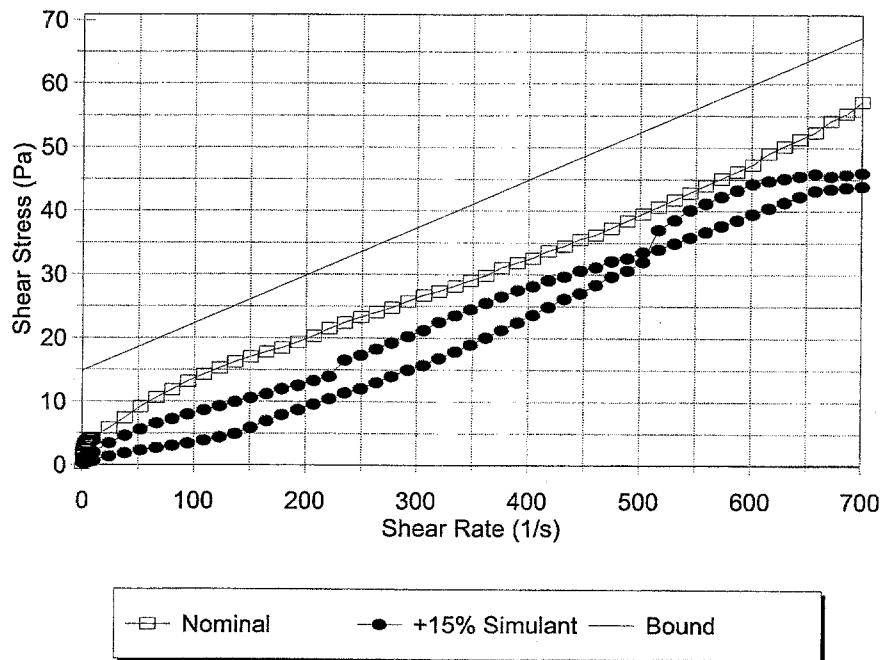


Figure 2.2. Comparison of measured feed rheology with proposed WTP bounds (WTP-RPT-075, Rev. 0, Feb. 2003).

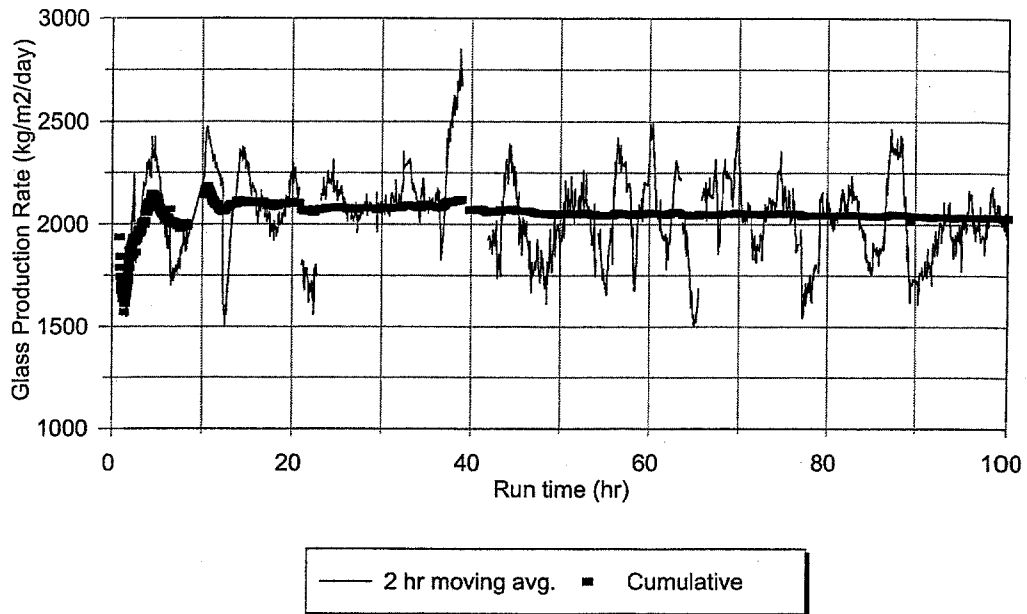


Figure 3.1. Glass production rates for Test 1 (nominal).

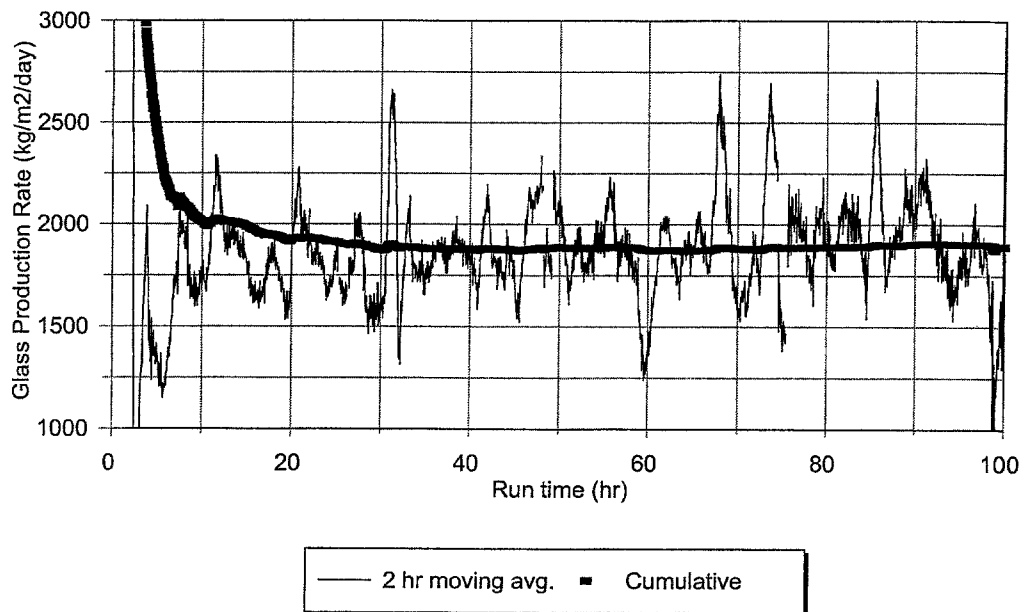


Figure 3.2. Glass production rates for Test 2 (+15% simulant).

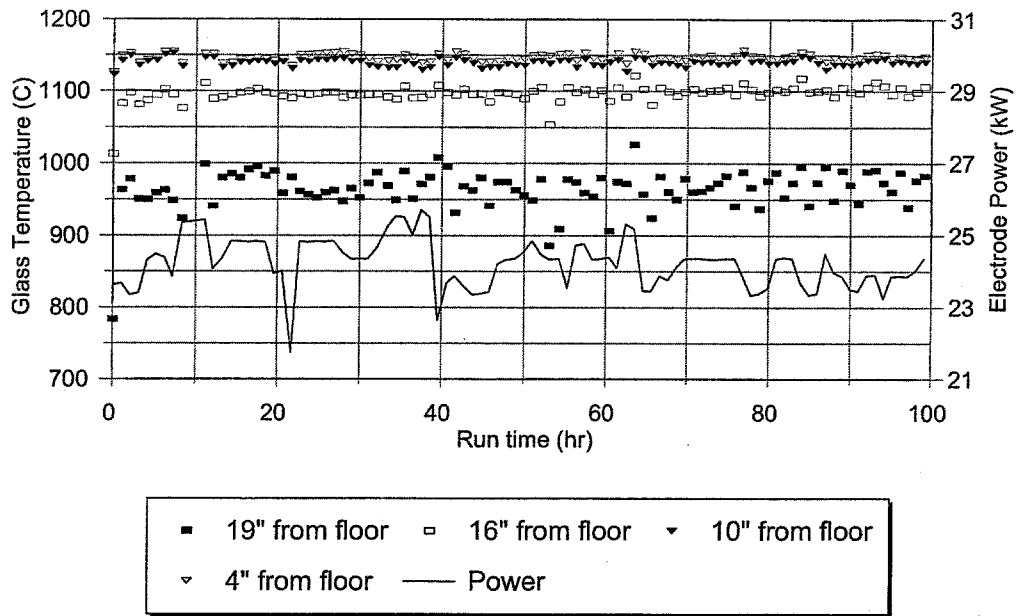


Figure 3.3. Glass temperatures and electrode power for Test 1 (nominal).

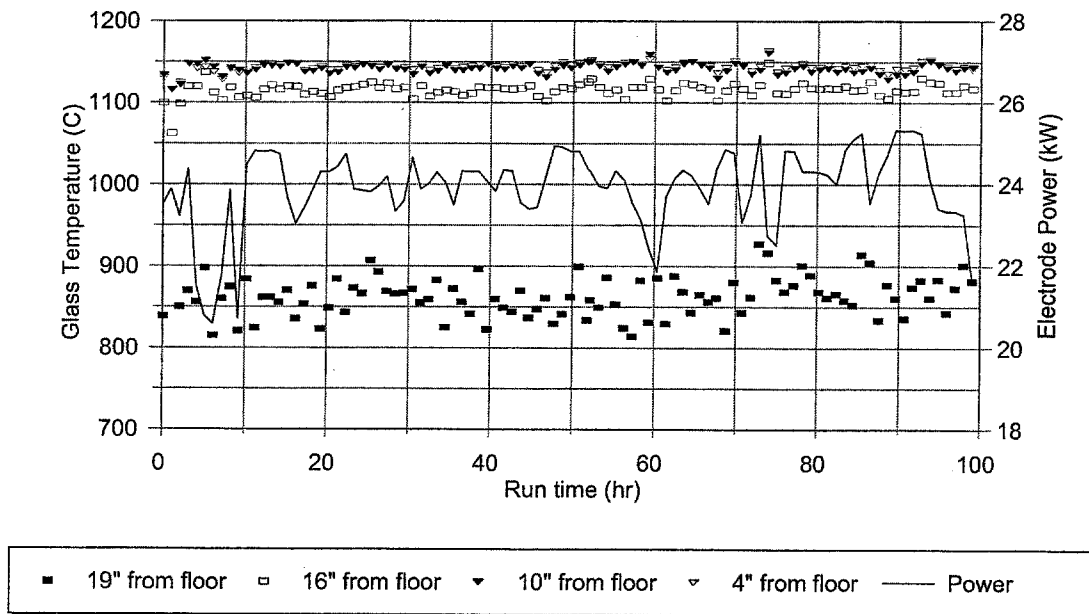


Figure 3.4. Glass temperatures and electrode power for Test 2 (+15% simulant).

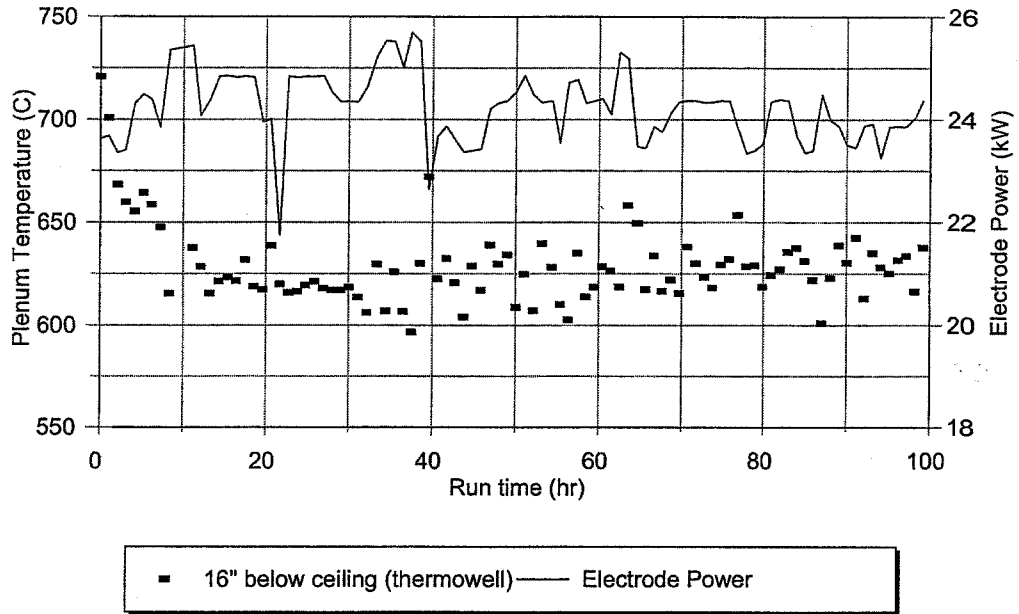


Figure 3.5. Plenum temperatures and electrode power for Test 1 (nominal).

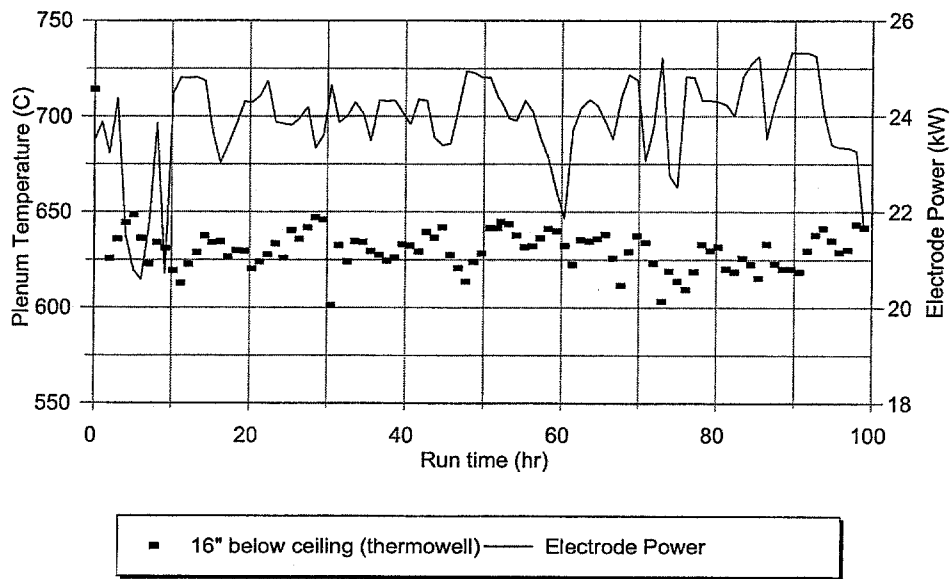


Figure 3.6. Plenum temperatures and electrode power for Test 2 (+15% simulant).

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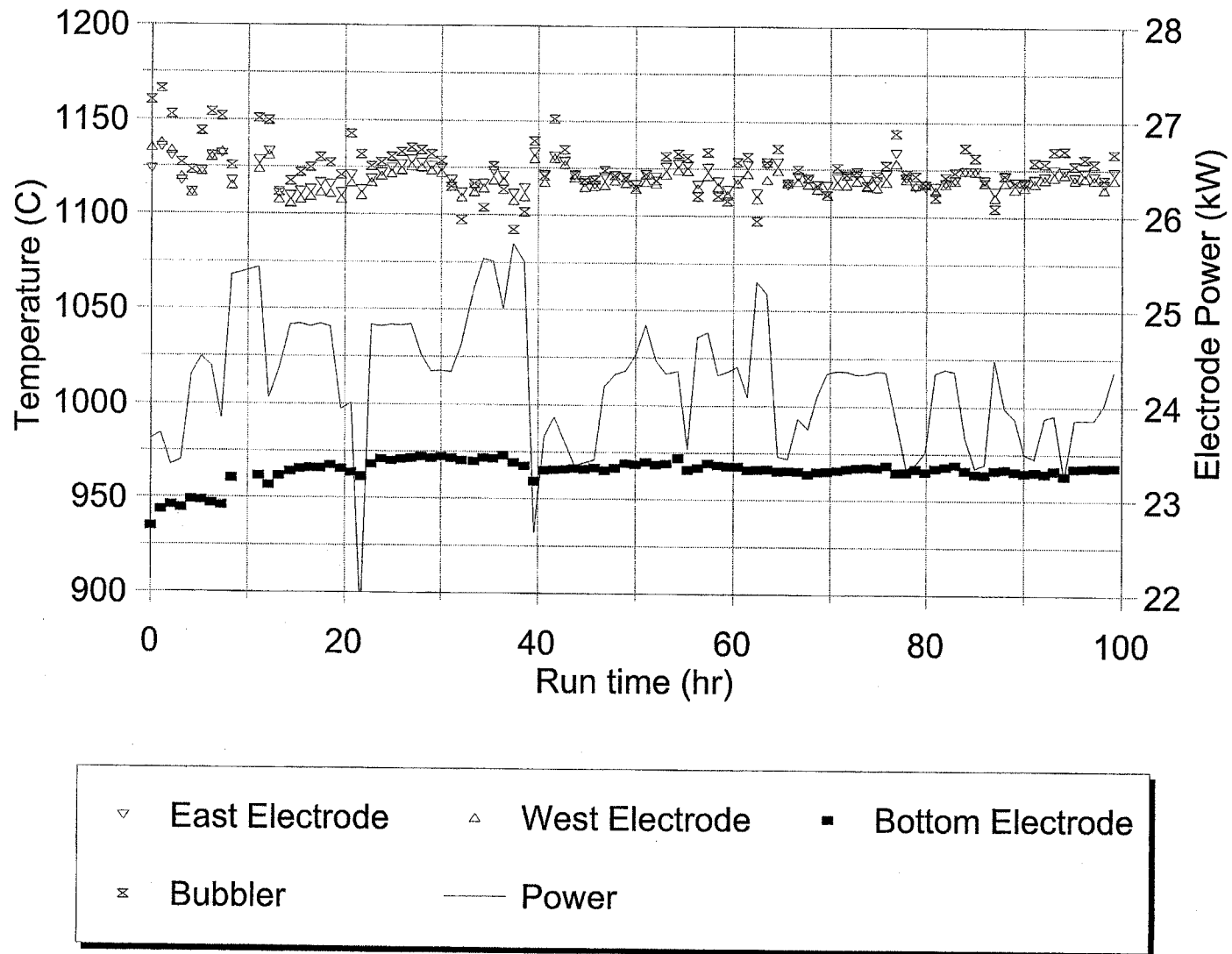


Figure 3.7. Electrode temperature and power plus bubbler temperature for Test 1 (nominal).

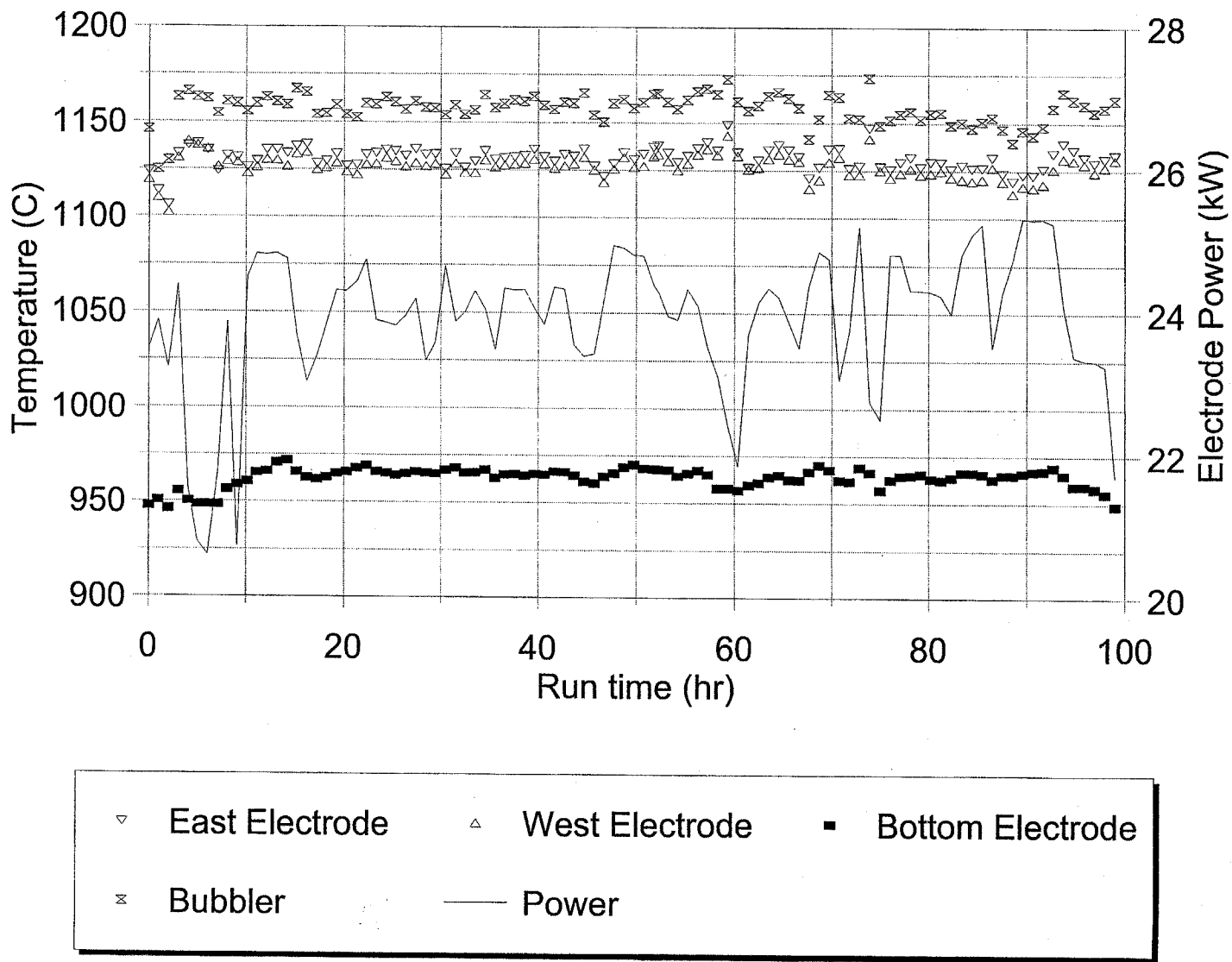


Figure 3.8. Electrode temperature and power plus bubbler temperature for Test 2 (15% simulant).

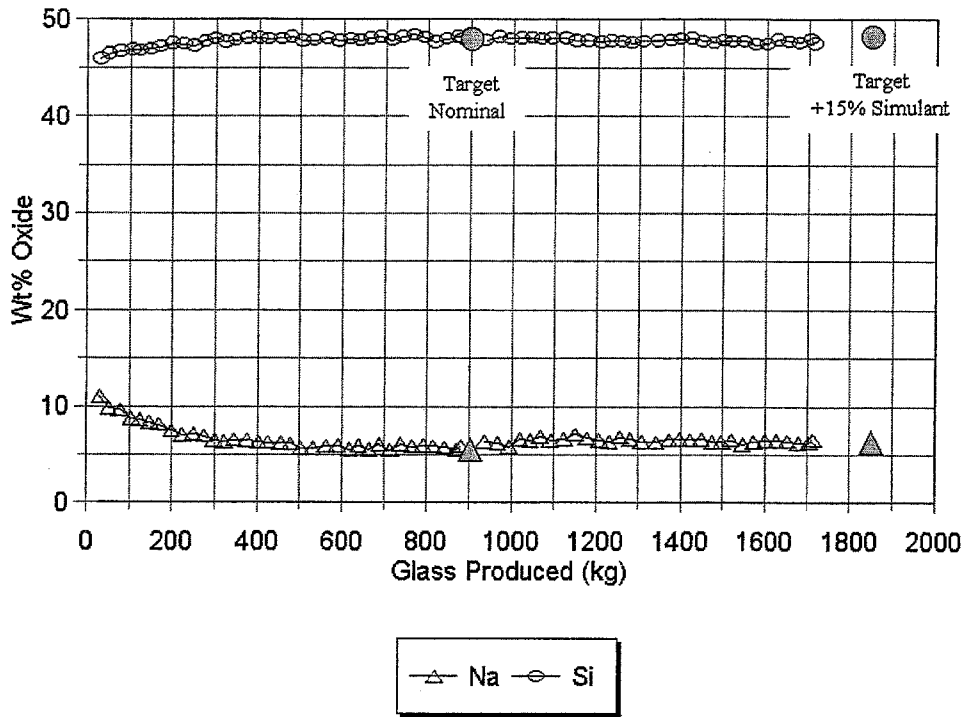


Figure 4.1. XRF analysis of Na₂O and SiO₂ in melter glasses.

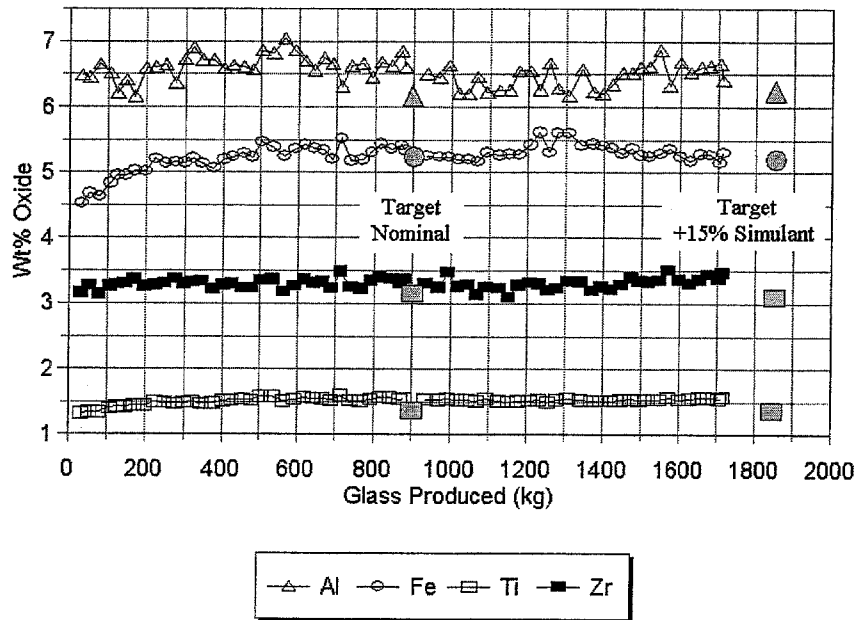


Figure 4.2. XRF analysis of select major oxides in product glasses.

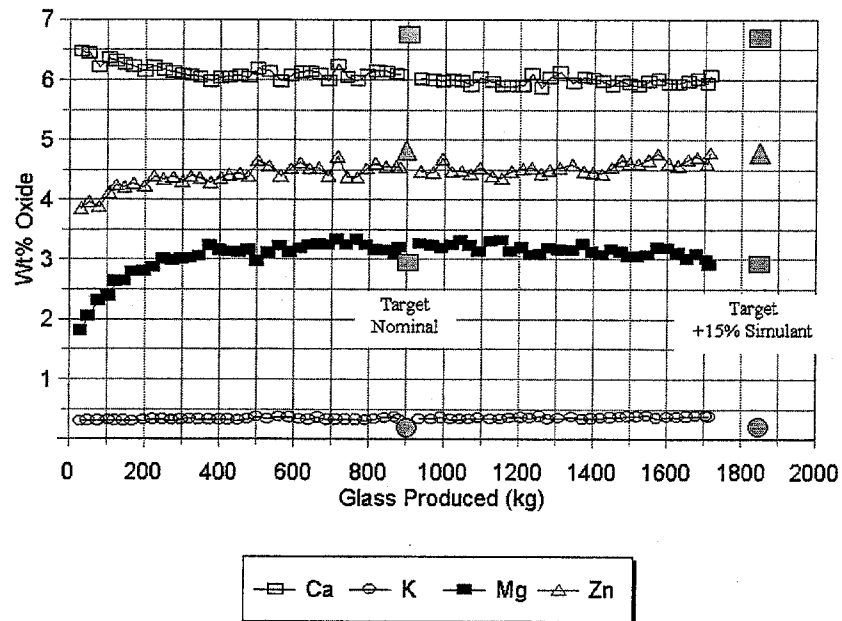


Figure 4.3. XRF analysis of select oxides in product glasses.

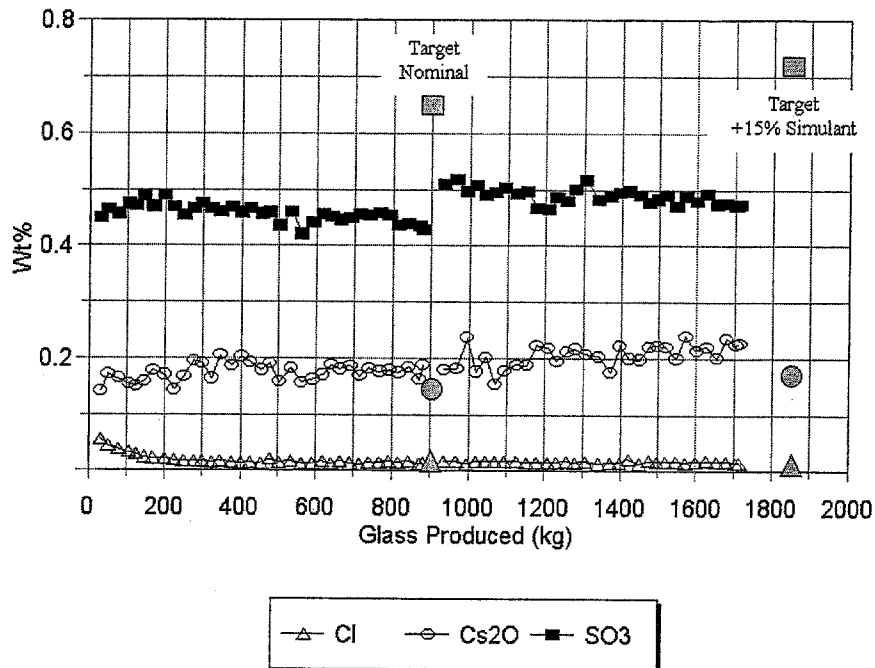


Figure 4.4. XRF analysis of volatile constituents in melter glasses.

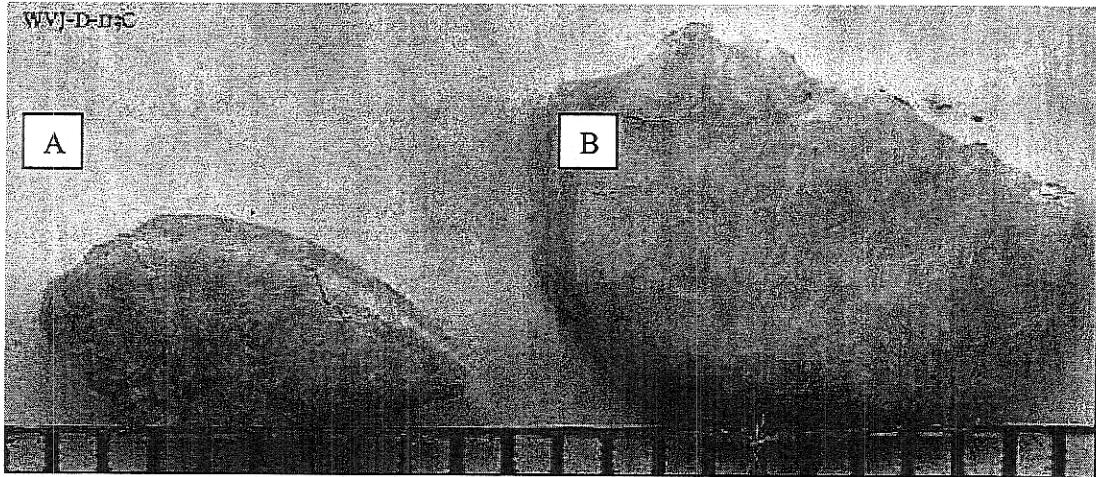


Figure 4.5. Nodules from dip sample taken after about three days of idling (scale divisions in mm).

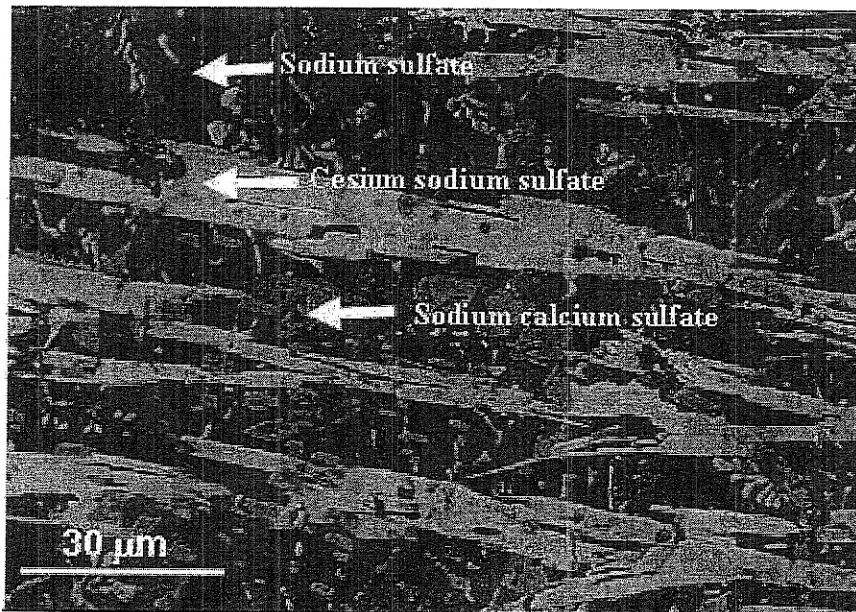


Figure 4.6. Back-scattered electron image of a typical microstructure of nodules from dip samples shown in Figure 4.5.

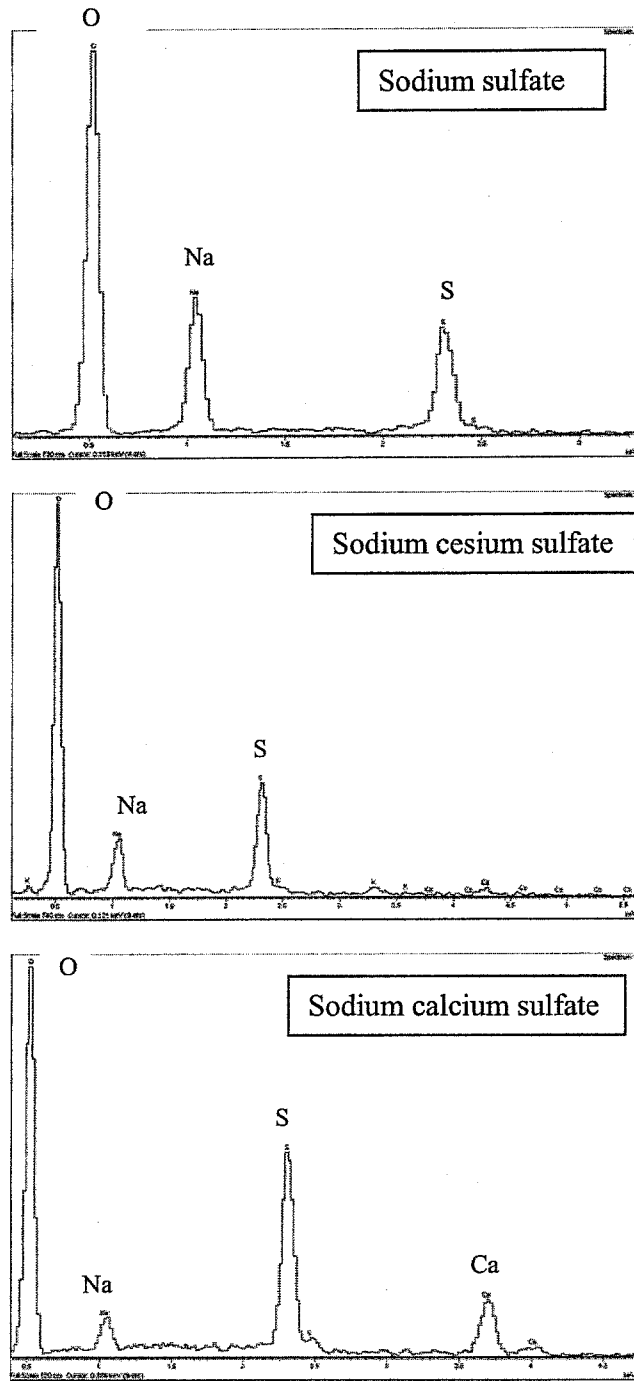


Figure 4.7. EDS spectra for various phases in dip-sample nodules shown in Figure 4.5.

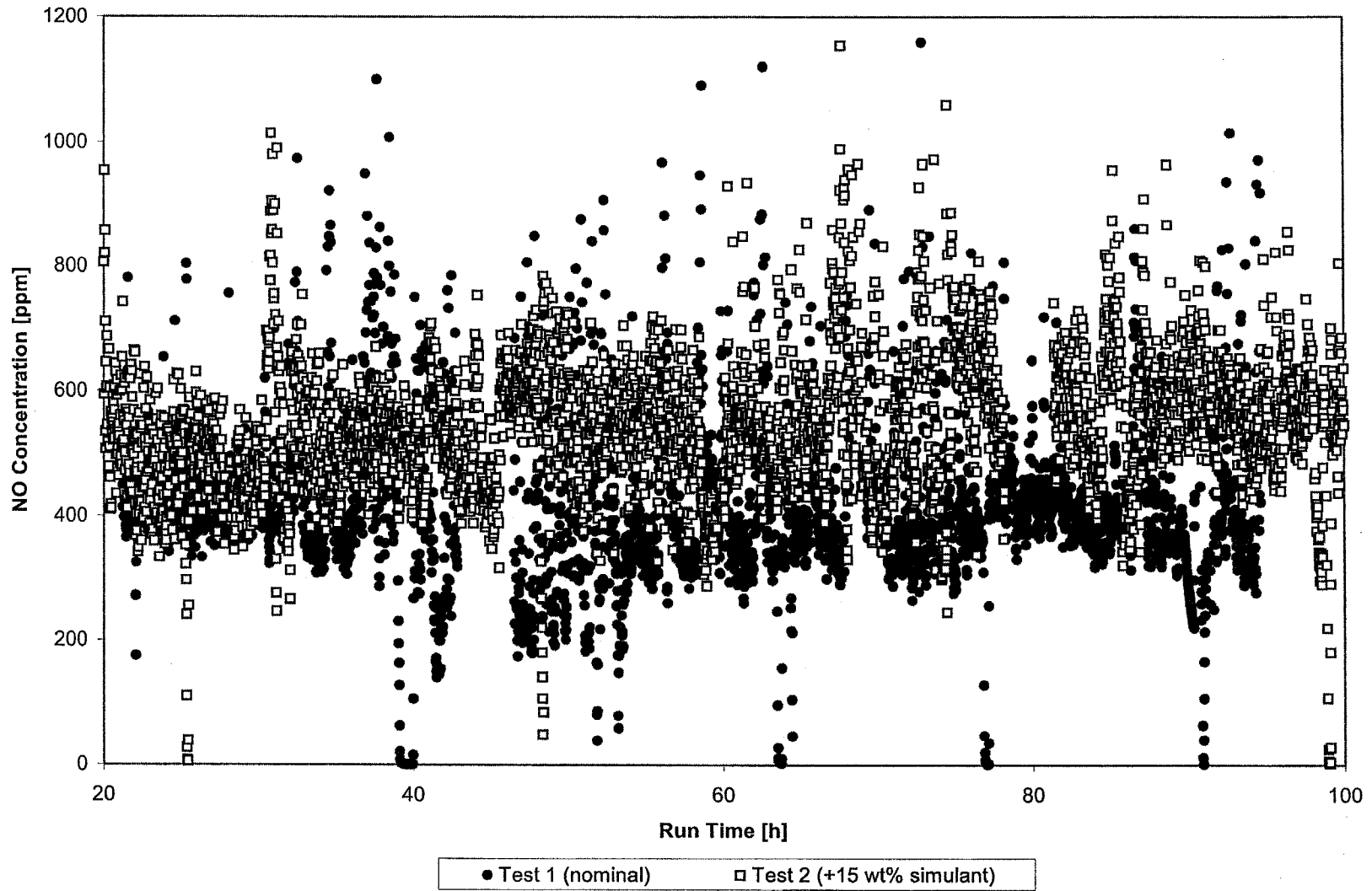


Figure 5.1. NO concentration in off-gas from FTIR.

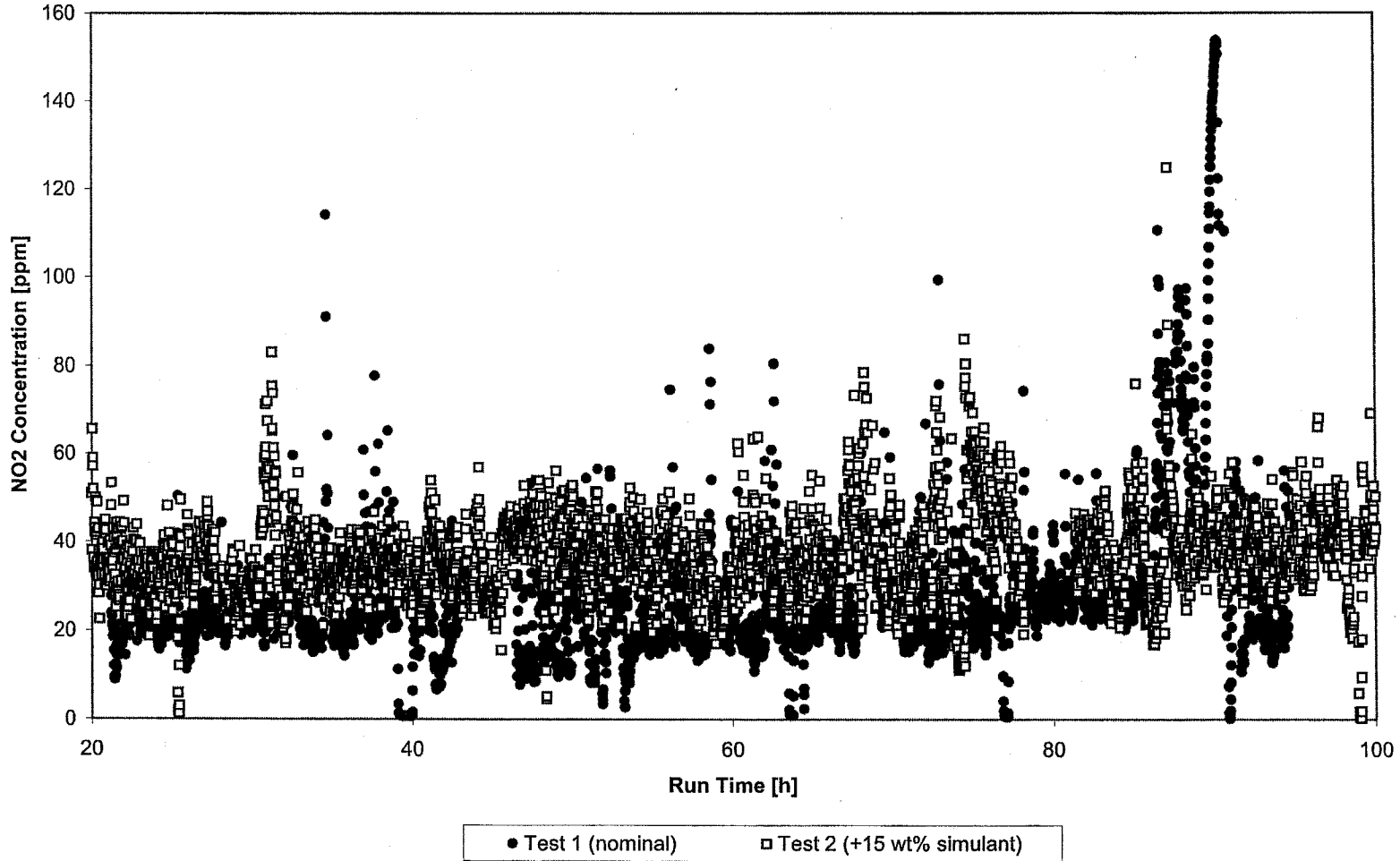


Figure 5.2. NO₂ concentration in off-gas from FTIR.

60

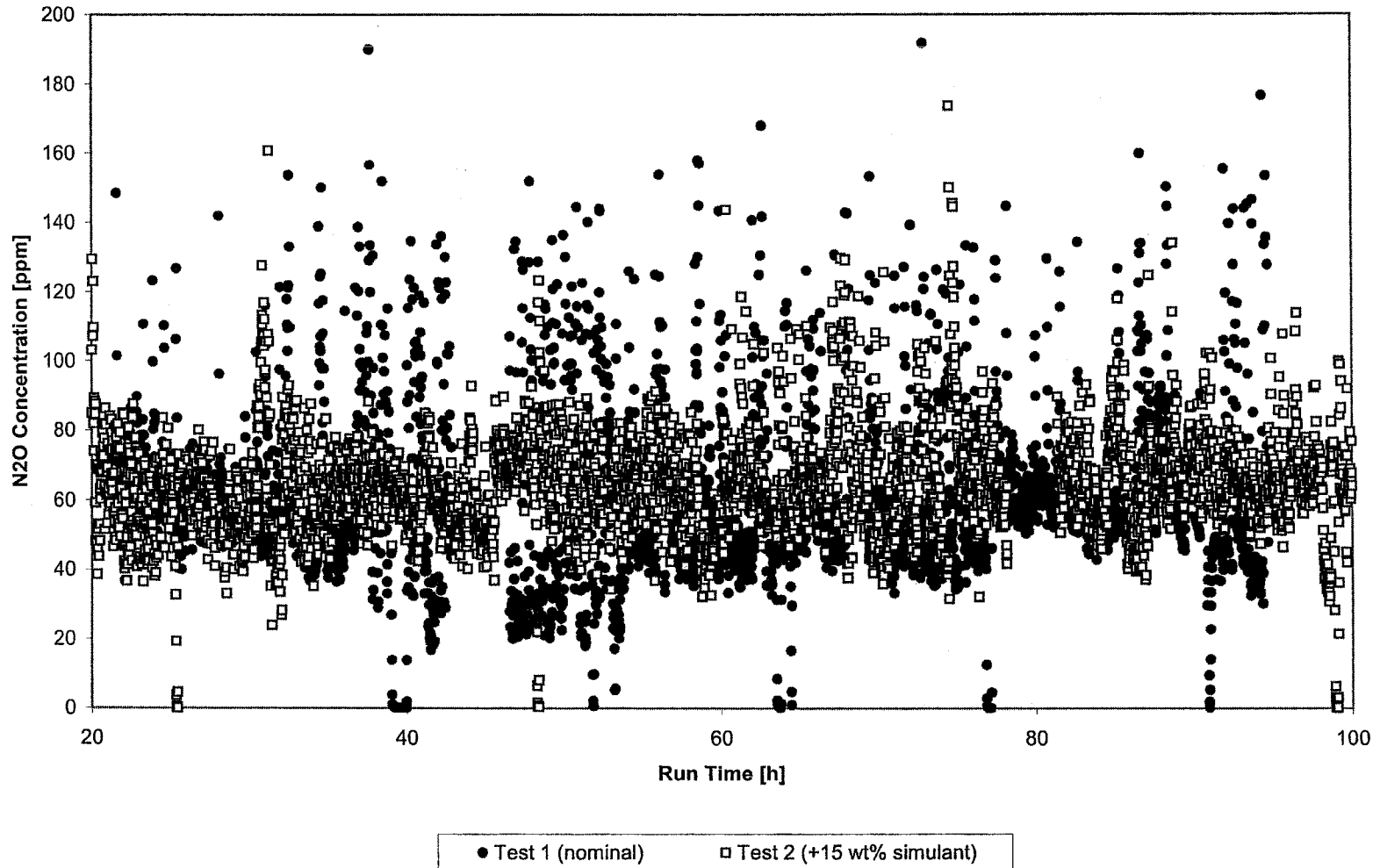


Figure 5.3. N₂O concentration in off-gas from FTIR.

601

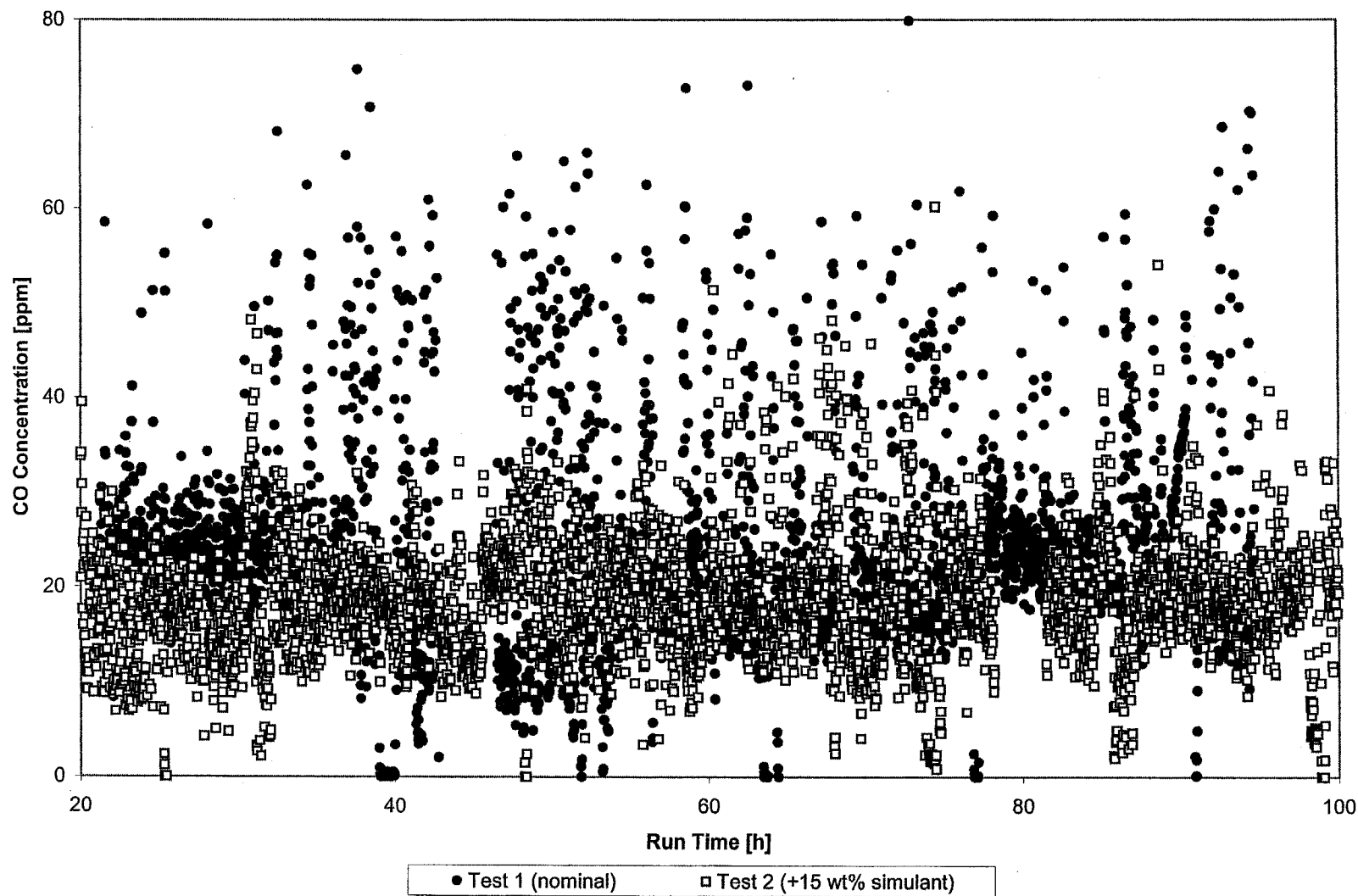


Figure 5.4. CO concentration in off-gas from FTIR.

62

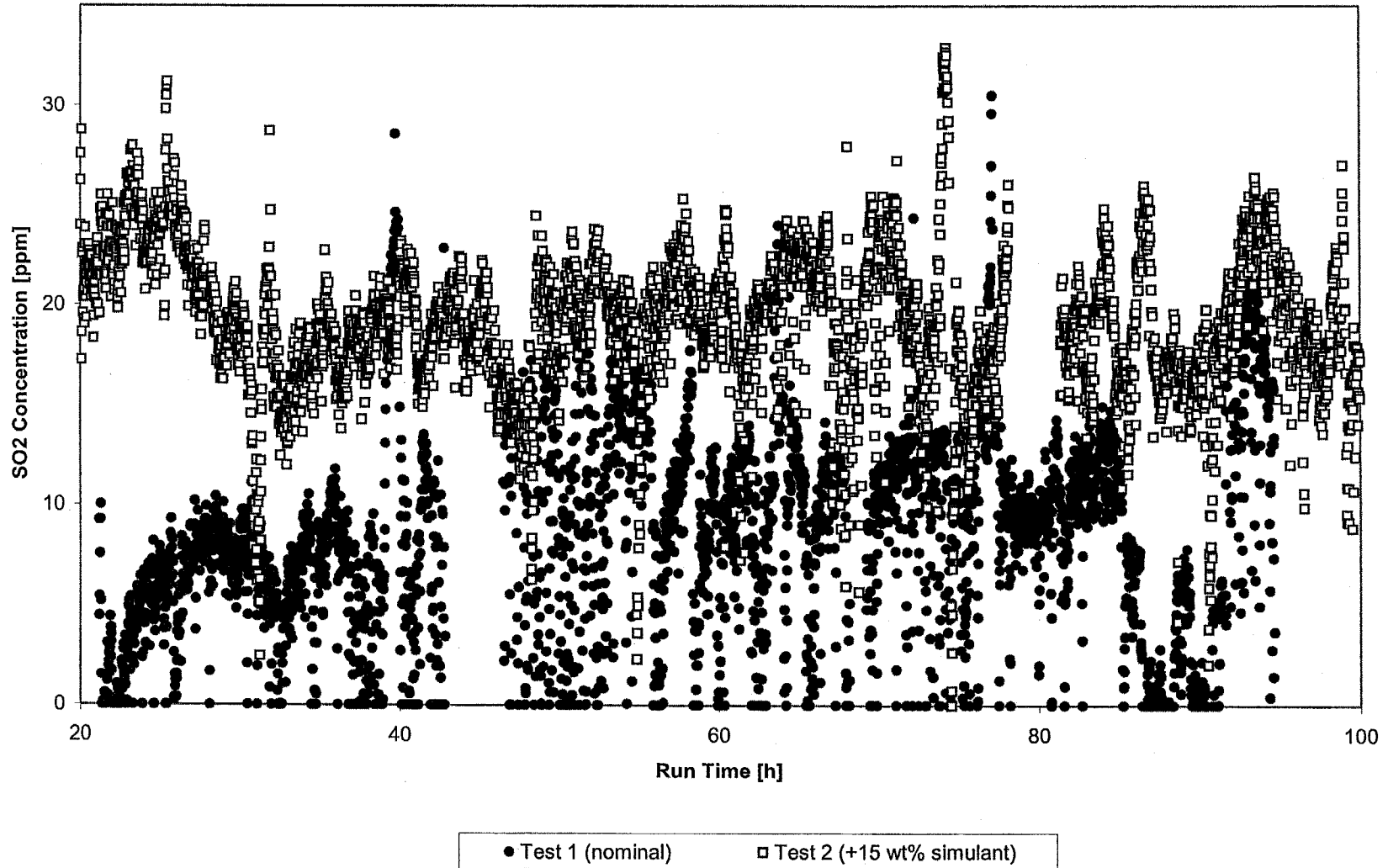


Figure 5.5. SO₂ concentration in off-gas from FTIR.

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Duratek

Duratek, Inc.
River Protection Project
 345 Hills Street
 Richland, Washington 99352
 (509) 376-7055 - Phone
 (509) 372-3830 - Fax

June 17, 2003
 L-12144

Bechtel National, Inc.
 WTP PDC, Correspondence
 2435 Stevens Center Place
 MSIN H4-02/MS11-B
 Richland, WA 99352

Attn: Mr. L. Scot Jenkins H4-02 (MS14-3A)

SUBCONTRACT NO. 24590-101-TSA-W000-0009
DURATEK FEDERAL SERVICES, INC. RESEARCH AND TECHNOLOGY SUPPORT,
TRANSMITTAL OF FINAL REPORT, APPROVED BY BNI R&T MANAGER FOR USE.

Dear Mr. Jenkins:

Please find attached the following approved Final Report:

- Final Report – “Compositional Variation Tests on DuraMelter 100 with LAW Sub-Envelope B1 Feed in Support of the LAW Pilot Melter”
 VSL-02R62N0-5, Rev. 0, dated May 8, 2003

Should you have any questions and/or concerns, please contact the undersigned on 376-9942.

Sincerely,

P. K. Brockman
 Duratek Federal Services, Inc.
 Vice President / RPP Project Manager

Attachments

cc:	Steve Barnes w/o att	H4-02 (MS1-B)	Jeannette Doyle w/o att	H4-02 (MS1-B)
	Karen Hornbuckle w/o att	H4-02 (MS1-B)	Karen Petro w/o att	Columbia
	Joe Perez w/o att	H4-02 (MS1-B)	Scot Jenkins w/o att	H4-02 (MS14-3A)
	Chris Musick w/o att	H4-02 (MS1-B)		
	Brad Bowan w/o att	Columbia		
	Glenn Diener w/o att	Columbia		
	Ron Garretsen w/o att	H4-02 (MS14-3A)		
	Chris Chapman w/o att	H1-11		
	Document Control file w/o att	Columbia		
	P. K. Brockman LB			

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DOCUMENT REVIEW RECORD

Sheet 1 of 2

Return to: Eugene Morrey 371-8447; MS1-B

Comments Due: 11/15/02

Document Title: Final Report - Compositional Variation Tests on DuraMelter 100 with LAW Sub-Envelope B1 Feed in Support of the LAW Pilot Melter		Document No. VSL-02R62N0-5		Revision: 0	Date: 11/01/02
Reviewer: Eugene Morrey	Date: 11/15/02	Response by:	Date:	Comments Resolved: Eugene Morrey	Date: 11/31/02

Item No.	Section/ Paragraph	Comment	Response	Significance ^a	Resolution	Incorporated?
1	Section 1.2	Add a sentence that says there were no departures from the test plan or QAPP.	We are concerned that this statement is too all encompassing and subjective; e.g the plenum temperature is outside the limit for two minutes? test exceptions are not covered by this statement; Project request or direction not in the Test Plan, etc. We suggest the following statement "Also documented in this report are material departures from the Test Plan or QAPP, if any."			
2	Figures 3.7, 3.8, 5.1-5.5	Improve legibility of Figures (difficult to discriminate between data series). For Figures 5.1-5.5, consider plotting average line with error bars for each data series.	Agreed. We will consider alternatives but for these figures we believe that the real scatter from process variations that is displayed is an important aspect of the information content.			
3	Section 2.4.2	Rheology data should be compared to lab-scale simulant data from the same simulant composition as available. The DM100 rheology data should also be compared to the Project operating bounds for melter feed. I will get a copy and send to you so you can overlay the rheology data on top.	Agreed. Agreed; however, to our knowledge there are no approved WTP operating bounds. What we have seen circulated are draft recommendations from a sub-contractor report that has not yet been approved.			
4	General	Include table of melter DFs for volatile components or incorporate melter DFs in	Melter DFs are already included in Table 5.1.			

Morrey, Eugene

From: Morrey, Eugene
Sent: Thursday, May 29, 2003 10:36 AM
To: Saucedo, Ermelinda; Papp, Ivan; Smith, Gary L
Subject: No Comments on B1 Variation DM100 Report

WTP E&NS, Ivan Papp, Gary Smith;

Comments have not been received on, test report, "Final Report - Compositional Variation Tests on DuraMelter 100 with LAW Sub-Envelope B1 Feed in Support of the LAW Pilot melter," VSL-02R62N0-5, by the due date. Issue of the document will proceed without your comments. If there are comments, they will be addressed / resolved / incorporated in the next revision of the document.

If you do not have comments, please respond as such to this message.

Thanks, Eugene

-----Original Message-----

From: Morrey, Eugene
Sent: Friday, November 01, 2002 10:25 AM
To: Barnes, Steven M; Block, Oliver U; Papp, Ivan; Carl, Daniel; WTP ES&H; Jenkins, L. S (Scot); WTP QA; Khianey, Ken; Smith, Gary L
Cc: Perez, Jameilyn M; Perez, Joseph; Musick, Chris A; Kelly, Sam
Subject: Test Report for Review and Comment - B1 Variation DM100 (Due November 15)

All

Duratek has submitted test report, "Final Report - Compositional Variation Tests on DuraMelter 100 with LAW Sub-Envelope B1 Feed in Support of the LAW Pilot melter," VSL-02R62N0-5, rev. A, for project review, comment, and acceptance. This report documents Sub-Envelope B1 compositional variation testing in the DM100 melter to test impacts of typical process errors in the WTP and to support LAW Pilot melter operations.

The Document Review Request and Document Review Record are attached.



Document Review
Request VSL-02...



Document Review
Record VSL-02R...

The report and the controlling test plan/test exception have been posted to the R&T share drive that everyone has access to. The folder address is: //W\tps0027\R&t\Vitrification/LAW Reports for Review/B1 Variation DM100

The test plan is titled: "Tests on DuraMelter 100 with LAW Sub-Envelope B1 Feed in Support of the LAW Pilot Melter," VSL-02T62N0-2, Rev. 0.

One test exception was written against the test plan as follows: "Test Exception #1 to Test Plan VSL-02T62N0-2 - Delete Sub-Envelope B1 15% Low Waste Loading Variation Test in DM100," 24590-WTP-TEF-02-RT-039, Rev. 0.

Comments are due to be submitted by me Friday, November 15, 2002.

Please call if you have questions (371-5191).

Thanks, Eugene

Morrey, Eugene

From: Reynolds, Jacob
Sent: Monday, November 18, 2002 10:16 AM
To: Morrey, Eugene
Subject: FW: Test Report for Review and Comment - B1 Variation DM100 (Due November 15)

I have no comments on this report

-----Original Message-----

From: Block, Oliver U
Sent: Thursday, November 14, 2002 6:12 AM
To: Reynolds, Jacob; Gimpel, Rod
Cc: Berrios, Edgardo
Subject: FW: Test Report for Review and Comment - B1 Variation DM100 (Due November 15)

-----Original Message-----

From: Morrey, Eugene
Sent: Friday, November 01, 2002 10:25 AM
To: Barnes, Steven M; Block, Oliver U; Papp, Ivan; Carl, Daniel; WTP ES&H; Jenkins, L. S (Scot); WTP QA; Khianey, Ken; Smith, Gary L
Cc: Perez, Jameilyn M; Perez, Joseph; Musick, Chris A; Kelly, Sam
Subject: Test Report for Review and Comment - B1 Variation DM100 (Due November 15)

All

Duratek has submitted test report, "Final Report - Compositional Variation Tests on DuraMelter 100 with LAW Sub-Envelope B1 Feed in Support of the LAW Pilot melter," VSL-02R62N0-5, rev. A, for project review, comment, and acceptance. This report documents Sub-Envelope B1 compositional variation testing in the DM100 melter to test impacts of typical process errors in the WTP and to support LAW Pilot melter operations.

The Document Review Request and Document Review Record are attached.



Document Review
Request VSL-02...



Document Review
Record VSL-02R...

The report and the controlling test plan/test exception have been posted to the R&T share drive that everyone has access to. The folder address is: //Wtps0027/R&t/Vitrification/LAW Reports for Review/B1 Variation DM100

The test plan is titled: "Tests on DuraMelter 100 with LAW Sub-Envelope B1 Feed in Support of the LAW Pilot Melter," VSL-02T62N0-2, Rev. 0.

One test exception was written against the test plan as follows: "Test Exception #1 to Test Plan VSL-02T62N0-2 - Delete Sub-Envelope B1 15% Low Waste Loading Variation Test in DM100," 24590-WTP-TEF-02-RT-039, Rev. 0.

Comments are due to be submitted by me Friday, November 15, 2002.

Please call if you have questions (371-5191).

Thanks, Eugene

Morrey, Eugene

From: Reed, Ronald D
Sent: Monday, March 24, 2003 4:30 PM
To: Morrey, Eugene
Cc: WTP QA
Subject: RE: Log#7430, VSL-02R62N0-5 R0, Final Report - Compositional Variation Tests on DuraMelter 10 with LAW Sub-Envelope B1 Feed in Support of the LAW Melter; Comment Responses - B1 Variation DM100 Test Report

Eugene -

Based on the information you have provided, my comments provided under the older WTP Project document review procedure, Internal Review and Approval of Documents, are resolved.

Ronald D. Reed/QA

-----Original Message-----

From: Morrey, Eugene
Sent: Friday, March 21, 2003 1:46 PM
To: Reed, Ronald D
Subject: RE: Log#7430, VSL-02R62N0-5 R0, Final Report - Compositional Variation Tests on DuraMelter 10 with LAW Sub-Envelope B1 Feed in Support of the LAW Melter; Comment Responses - B1 Variation DM100 Test Report

Ron,

Per our discussion, VSL revised the wording in their test plan to respond to your followup comment shown below. A revised Document Review Record is attached for your review and approval. The changed text is in blue. Please let me know if the attached comment resolutions are acceptable as soon as possible.

Thanks, Eugene

<< File: VSL-02R62N0-5 QA Comments.doc >>

-----Original Message-----

From: Reed, Ronald D
Sent: Tuesday, February 04, 2003 9:00 AM
To: Morrey, Eugene
Subject: RE: Log#7430, VSL-02R62N0-5 R0, Final Report - Compositional Variation Tests on DuraMelter 10 with LAW Sub-Envelope B1 Feed in Support of the LAW Melter; Comment Responses - B1 Variation DM100 Test Report

Eugene -

Comment resolutions are Not Accepted.

- Subcontractor failed to commit to providing sufficient historical background on the transition of QA requirements in the report so that an understanding would be communicated as to how the results can be accepted per NQA-1, when the original driving requirements probably were DOE 0 414.1 and 10CFR830.

-----Original Message-----

From: Morrey, Eugene
Sent: Friday, January 31, 2003 2:18 PM
To: Reed, Ronald D
Subject: Comment Responses - B1 Variation DM100 Test Report

Ron,

Attached are Duratek/VSL's responses to your comments on test report, VSL-02R62N0-5, *Compositional Variation Tests on DuraMelter 100 with LAW Sub-Envelope B1 Feed in Support of the LAW Pilot Melter*. Please review the proposed comment resolutions and let me know if they are acceptable.

Thanks, Eugene

Morrey, Eugene

From: Khianey, Ken
Sent: Friday, November 22, 2002 2:53 PM
To: Morrey, Eugene; Davis, Cynthia A
Subject: RE: Test Report for Review and Comment - B1 Variation DM100 (Due November 15)

Eugene/Cyn
I have no comments
Ken

-----Original Message-----

From: Morrey, Eugene
Sent: Friday, November 01, 2002 10:25 AM
To: Barnes, Steven M; Block, Oliver U; Papp, Ivan; Carl, Daniel; WTP ES&H; Jenkins, L. S (Scot); WTP QA; Khianey, Ken; Smith, Gary L
Cc: Perez, Jameilyn M; Perez, Joseph; Musick, Chris A; Kelly, Sam
Subject: Test Report for Review and Comment - B1 Variation DM100 (Due November 15)

All

Duratek has submitted test report, "Final Report - Compositional Variation Tests on DuraMelter 100 with LAW Sub-Envelope B1 Feed in Support of the LAW Pilot melter," VSL-02R62N0-5, rev. A, for project review, comment, and acceptance. This report documents Sub-Envelope B1 compositional variation testing in the DM100 melter to test impacts of typical process errors in the WTP and to support LAW Pilot melter operations.

The Document Review Request and Document Review Record are attached.

<< File: Document Review Request VSL-02R62N0-5.doc >> << File: Document Review Record VSL-02R62N0-5.doc >>

The report and the controlling test plan/test exception have been posted to the R&T share drive that everyone has access to. The folder address is: //Wtps0027/R&t/Vitrification/LAW Reports for Review/B1 Variation DM100

The test plan is titled: "Tests on DuraMelter 100 with LAW Sub-Envelope B1 Feed in Support of the LAW Pilot Melter," VSL-02T62N0-2, Rev. 0.

One test exception was written against the test plan as follows: "Test Exception #1 to Test Plan VSL-02T62N0-2 - Delete Sub-Envelope B1 15% Low Waste Loading Variation Test in DM100," 24590-WTP-TEF-02-RT-039, Rev. 0.

Comments are due to be submitted by me Friday, November 15, 2002.

Please call if you have questions (371-5191).

Thanks, Eugene

Morrey, Eugene

From: Carol_A_Babel@RL.gov
Sent: Friday, November 15, 2002 4:07 PM
To: Morrey, Eugene
Subject: RE: Test Report for Review - DM-100 Melter B1 Variation (Due November 15)

Eugene,

I have finished my review of the test report, "DM-100 Melter B1 Variation" and have no comments. Thank you for the opportunity to review this report.

Carol Babel
DOE/ORP
373-9281

-----Original Message-----

From: Morrey, Eugene [mailto:evmorrey@bechtel.com]
Sent: Friday, November 01, 2002 10:44 AM
To: 'Carol Babel (E-mail)'
Cc: Damerow, Frederick W; Doyle, Jeanette
Subject: Test Report for Review - DM-100 Melter B1 Variation (Due November 15)

Carol,

Steve Barnes directed me to forward the draft test report, VSL-02R62N0-5, Rev. A, "Compositional Variation Tests on DuraMelter 100 with LAW Sub-Envelope B1 Feed in Support of the LAW Pilot Melter," for ORP review. This report documents DM-100 melter testing with Subenvelope B1 (AZ-101) composition variations in support of variation testing in the LAW Pilot Melter. A Document Review Record (DRR) is provided for your convenience.

Please provide any comments directly to Eugene Morrey at (evmorrey@bechtel.com) by COB Friday, November 15, 2002.

Please call if you have questions (371-8447).

Thanks, Eugene

<<LAW DM100 B1 Final text.pdf>> <<LAW DM100 B1 Figures.pdf>> <<LAW DM100 B1 Tables.pdf>> <<Document Review Record VSL-02R62N0-5.doc>>



Research and Technology Completion Form

R&T Scoping Statement(s): VL-4

Test Specification Number/Title: TSP-W375-00-00015/LAW DM10 and DM100 Melter Tests

Test Plan Number/Title: VSL-02T62N0-2, Rev. 0/Test Plan - Tests on DuraMelter 100 with LAW Envelope B1 Feed in Support of the LAW Pilot Melter

Test Report Number/Title: VSL-02R62N0-5, Rev. 0/Compositional Variation Tests on DuraMelter 100 with LAW Sub-Envelope B1 Feed in Support of the LAW Pilot Melter

Prepared by: Eugene Morrey Date: 5/13/03

List Test Objectives:	State how objectives were met:
Perform tests on the DM100-WV system using the nominal and 15% surplus simulant Sub-Envelope B1 feeds to ascertain the sensitivity of the vitrification process to variations in simulant-additive ratio.	The Sub-Envelope B1 melter feed formulation proved to be robust to compositional variations. Nominal operating conditions were maintained and full test durations were completed without problems for the nominal and 15% surplus simulant compositions. (Section 3.0)
Demonstrate sustained processability and product quality (composition, absence of secondary sulfate phase) for glass generated from nominal and 15% surplus simulant Sub-Envelope B1 feeds.	Target feed rates, glass temperatures, and plenum temperatures were maintained and the full test duration was completed for both of the compositional variations (nominal and +15% waste loading) (Table 3.1 and Figures 3.1 - 3.4). Both of the compositional variation feeds processed without a sulfate layer. (Table 3.1) Glass compositions as measured by XRF on the discharged glass analysis were within 10% of target for all major elements except calcium and titanium, which deviated by up to 11.5% (Table 4.2). Boron not analyzed.
Collect and analyze discharge glass to determine sulfur retention in the glass.	Sulfate retention was measured in the glass to be 69% and 67% for the nominal and +15% waste loading feeds respectively. Target feed rates, glass temperatures, and plenum temperatures were achieved and maintained for both compositional variation feeds. (Table 3.1 and Figures 3.1 - 3.4)
Characterize the properties of the melter feed (rheological properties, composition, etc.)	<p>Rheological and selected physical property data were collected on samples of melter feed taken once a day during processing. The rheological data from each sample were within the operational bounds^(a) established for LAW melter feed.</p> <p>^(a) Test Report, <i>Interim Report: Development of LAW and HLW Vitrification Physical Property Bounding Conditions and Simulant Verification Criteria</i>, WTP-RPT-075 Rev. 0 (draft).</p> <p>Melter feed compositions as measured by XRF analysis were within 10% of target for all major elements except titanium, which deviated by up to 13.6% in one sample (Table 2.5). Boron not analyzed.</p>



Research and Technology Completion Form

R&T Scoping Statement(s): VL-4

Test Specification Number/Title: TSP-W375-00-00015/LAW DM10 and DM100 Melter Tests

Test Plan Number/Title: VSL-02T62N0-2, Rev. 0/Test Plan - Tests on DuraMelter 100 with LAW Envelope B1 Feed in Support of the LAW Pilot Melter

Test Report Number/Title: VSL-02R62N0-5, Rev. 0/Compositional Variation Tests on DuraMelter 100 with LAW Sub-Envelope B1 Feed in Support of the LAW Pilot Melter

List Test Objectives:	State how objectives were met:
Collect melter emissions data to determine the effect of composition on melter emissions.	Melter emissions were sampled and analyzed during both tests. Total particulate emissions from the melter 0.11 wt% and DFs were determined for each element in the feed. (Section 5.1 and Table 5.1)
Provide supporting data necessary to ensure the success of the larger-scale Pilot Melter tests.	Each of the compositional variation feeds were successfully tested in the DM100 melter without processing problems and without formation of a separate sulfate layer. As a result, this formulation and accompanying waste loading variations were accepted for testing in the LAW Pilot Melter.
List any Test Exceptions:	Did exceptions impact the objective? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No (Explain)
1) 24590-WTP-TEF-02-RT-039, <i>Test Exception #1 to Test Plan VSL-02T62N0-2 - Delete Sub-Envelope B1 15% Low Waste Loading Variation Test in DM100</i>	Due to scheduling conflicts in the DM100, the 15% low waste loading test could not be run prior to the scheduled 15% low waste loading test in the LAW Pilot melter. Nominal composition tests in the LAW Pilot, which processed without a sulfate layer, provided the necessary confidence to proceed without the DM100 15% low waste loading test.
List Success Criteria	Did the test meet the criteria? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No (Explain)
1. Determination that the processing characteristics of the Sub-Envelope B1 formulation are satisfactory and stated variations in the ratio of glass formers to waste do not affect key process characteristics, including production rate, secondary phase formation, cold cap and melting characteristics. This will be evidenced by stable operation for a sufficient period of time (defined here as a minimum of 8 hours) to determine and document the nominal processing rate and melting characteristics.	Stable operation for periods of 90 hrs was achieved for each of the compositional variation tests (See Figures 3.1-3.4). Production rates for each of the tests were acceptable, no secondary phases were observed in the quenched glass product, no separate sulfate layers were observed in the melter, and cold cap and melter characteristics were acceptable (i.e., no operational problems).



Research and Technology Completion Form

R&T Scoping Statement(s): VL-4

Test Specification Number/Title: TSP-W375-00-00015/LAW DM10 and DM100 Melter Tests

Test Plan Number/Title: VSL-02T62N0-2, Rev. 0/Test Plan - Tests on DuraMelter 100 with LAW Envelope B1 Feed in Support of the LAW Pilot Melter

Test Report Number/Title: VSL-02R62RN0-5, Rev. 0/Compositional Variation Tests on DuraMelter 100 with LAW Sub-Envelope B1 Feed in Support of the LAW Pilot Melter

<p>2. Collection of supporting off-gas characterization data. Samples of the off-gas particulate, semi-volatile, and condensable emissions will be collected during steady-state operation. Data on feed and process flows (flow rate, humidity, etc.) that are necessary to relate the off-gas sample data to the process operations will also be collected.</p>	<p>Samples of offgas particulate, semi-volatile, and condensable emissions were collected under steady-state conditions for each test and analyzed (see Tables 5.1 through 5.4). Supporting data such as flow rates and humidity were also collected.</p>
<p>3. Collection and analysis of glass samples to determine sulfur retention in the glass.</p>	<p>Sulfur retention is included in Table 3.1</p>
<p>List QA Requirements:</p>	<p>Did the subcontractor meet the requirements? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No (Explain)</p>
<p>1) Per the test plan, work is to be conducted according to NQA-1 (1994).</p>	<p>Work was conducted in accordance with a VSL Project Quality Assurance Project Plan (QAPP), which complies with NQA-1 (1989).</p>
<p>2) Per the test plan, software development is to be conducted in accordance with NQA-2a (1990) Part 2.7.</p>	<p>Software quality assurance was conducted in accordance with a VSL Project Quality Assurance Project Plan (QAPP) which complies with NQA-2a (1990) Part 2.7.</p>
<p>3) Verification of test conditions and properties determination.</p>	<p>Independent review of methods and results by VSL.</p>
<p>List R&T Test Conditions:</p>	<p>Were test conditions followed? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No (Explain)</p>
<p>1) nominal and +15% waste loading variation in simulant to additive ratios around the nominal with nominal sugar.</p>	<p>Glass compositions as measured by XRF on the discharged glass analysis were within 10% of target for all major elements except calcium and titanium, which deviated by up to 11.5% (Table 4.2). Boron not analyzed.</p>
<p>2) Bubbling Rate: fixed during each test at a rate selected to maintain a complete cold cap while maintaining the target feed rate.</p>	<p>Bubbler rates of 17 lpm for nominal composition simulant and 14 lpm for +15% simulant variation were adequate to achieve target glass production rates. The targeted glass production rate was 2.0 MT/m²/day based on glass conversion ratios of a nominal feed. (Table 3.1)</p>
<p>3) Glass Temperature: 1150°C</p>	<p>Bulk glass temperatures were maintained between 1140°C – 1147°C very near the target of 1150°C. (Section 3.0, Figures 3.3-3.4)</p>



Research and Technology Completion Form

R&T Scoping Statement(s): VL-4

Test Specification Number/Title: TSP-W375-00-00015/LAW DM10 and DM100 Melter Tests

Test Plan Number/Title: VSL-02T62N0-2, Rev. 0/Test Plan - Tests on DuraMelter 100 with LAW Envelope B1 Feed in Support of the LAW Pilot Melter

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4) Plenum Gas Temperature: 550±100°C	Plenum temperatures typically ranged between 600-650°C (Section 3.0)
5) Target Glass Production Rate: 2.0 MT/m ² /day assuming nominal glass conversion ratios. The 15% deviations in feed composition also affect the glass conversion ratios so the actual glass production rates may vary accordingly.	Target glass production rates were achieved for all tests. The nominal and +15% waste loading glass production rates were 2.03 MT glass /m ² /day and 1.90 MT glass /m ² /day, respectively, which when adjusted for glass yield are very close to the feed rate equivalent to 2.0 MT glass/m ² /day for a nominal feed.
Was testing performed with simulants? If yes, discuss how results compare to radioactive tests. <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	
Relevant rheological and vitrification data is currently being generated on actual waste from AZ-101 (draft report expected June 25, 2003. Simulant data will be compared to actual waste data when it becomes available, and the results of the comparison will be included in a separate simulant verification report.	
Are all discrepancies resolved? If no, explain. <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	
Are all subcontractor signoffs completed? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	
This work is acceptable to complete the indicated: If Other, please explain what the report completes.	<input type="checkbox"/> Test Specification(s) <input type="checkbox"/> Scoping Statement(s) <input checked="" type="checkbox"/> Test Plan(s) <input type="checkbox"/> Other
Does the Testing or Report suggest any follow-on work? If yes, describe the suggested activity and, if appropriate, attach a Request for Technology Development (RTD). <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	
None	
Additional comments:	
None	
Approved by R&T Manager or Designee: 	Date: 6/15/2003



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Sheet 1 of 1

Document Number	Rev
VSL-02R62N0-5, Compositional Variation Tests on DuraMelter 100 with LAW Sub-Envelope B1 Feed in Support of the LAW Pilot Melter	0

Name	MSIN	Controlled	Uncontrolled	Size					Comments	
				8 1/2 x 11 (A)	11 x 17 (B)	Drawings				As Is
						C	D	E		
Eugene Morrey	MS1-B								Info	
Joe Perez	MS1-B								Info	
Paul Rutland	MS1-C								Info	
Scott Saunders	MS1-C								Info	
Greg Pace	MS1-C								Info	
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Sean Sunday	MS14-4B								Info	
Scot Jenkins	MS14-3A								Info	
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Approver Jeanette Doyle *Jeanette Doyle* 6/26/03
Print Name Signature Date