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VSL-01R0100-2, Rev. 0, 1/20/03

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

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Start-Up and Commissioning Tests on the DuraMelter 1200 HLW Pilot Melter System Using AZ-101 HLW Simulants

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SECTION 1.0
INTRODUCTION

This document provides the final report on data and results obtained from commissioning tests performed on the one-third scale DuraMelter™ 1200 (DM1200) HLW Pilot Melter system that has been installed at VSL with an integrated prototypical off-gas treatment system. That system has replaced the DM1000 system that was used for HLW throughput testing during Part B1 [1]. Both melters have similar melt surface areas (1.2 m^2) but the DM1200 is prototypical of the present RPP-WTP HLW melter design whereas the DM1000 was not. These tests were performed under a corresponding RPP-WTP Test Specification [2] and associated Test Plan [3]. This report is a follow-up to the previously issued Preliminary Data Summary Report [4].

The DM1200 system will be used for testing and confirmation of basic design, operability, flow sheet, and process control assumptions as well as for support of waste form qualification and permitting. This will include data on processing rates, off-gas treatment system performance, recycle stream compositions, as well as process operability and reliability. Consequently, this system is a key component of the overall HLW vitrification development strategy. The results presented in this report are from the initial series of short-duration tests that were conducted to support the start-up and commissioning of this system prior to conducting the main body of development tests that have been planned for this system [5, 6]. These tests were directed primarily at system "debugging," operator training, and procedure refinement. The AZ-101 waste simulant and glass composition that was used for previous testing [1, 7-9] was selected for these tests.

1.1 Test Objectives

The principal objectives of this work were to:

- Bring the DM1200 system to full routine operating status by performing tests to diagnose and correct any remaining system issues.
- Refine operating procedures as needed in response to commissioning test findings.
- Complete operator training.
- Conduct final confirmation of instrumentation, control, and data acquisition systems.
- Determine routine operating parameter ranges for system components.

- Collect emissions data for local regulatory purposes.

Secondary objectives included:

- Obtain data on the effects of key operating parameters (feed water content and glass bubbling) on glass production rates and melter emissions.
- Identify possible processing problems such as foaming, secondary phase formation, and poor cold cap characteristics, particularly in comparison to previous small-scale and DM1000 melter tests.
- Evaluate off-gas system component efficiency by sampling exhaust at various points in the off-gas system as well as sump solutions from the various components.
- Collect data on product glass composition and product quality.
- Collect data on mass balance across the melter.
- Collect operating data with a simulated air-displacement slurry (ADS) pump melter feed system (i.e., intermittent, pulsed flow of feed to the melter), particularly with respect to off-gas transients.

1.2 Test Overview

The DM1200 system and the test matrix are described in the Test Plan [3]. A detailed description of the off-gas treatment system has also been provided [8]. In addition, the results of extensive off-line testing of the submerged-bed scrubber (SBS), which was performed prior to the present tests, have also been reported [11].The commissioning tests were composed of four test segments, during which, a total of 10,500 kg of glass was produced:

- **Turnover** – during which the glass inventory (about 1700 kg) was turned over from the start-up frit composition to the AZ-101 glass composition. About 5000 kg of glass was produced during this period.
- **Test 1** – High-solids feed, very low bubbling (4 scfh); 120 hours, 1587 kg glass produced.

- **Test 2** – High-solids feed, with bubbling (120 scfh); 50 hours, 1948 kg glass produced.

- **Test 3** – Low-solids feed, with bubbling (120 scfh); 50 hours, 1922 kg glass produced.

All of the tests were performed with the same waste simulant and glass composition [3], a nominal glass pool temperature of 1150°C, essentially complete cold cap coverage, and a nominal plenum temperature between 400-600°C. Side-to-side electrode firing was used (the bottom electrode was not powered) and one of the two installed feed tubes was used in order to more closely reflect the number of feed tubes per unit area planned for the full-scale HLW melter. Bubbling was from the bottom electrode bubblers. The high- and low-solids melter feeds had nominal glass yields of 570 and 350 g/l, respectively. Table 1.1 provides a summary of the test conditions and production rate data for each test.

1.3 Melter System Description

1.3.1 Feed System

The feed material for these tests was prepared by a chemical supplier, as detailed in Section 2. Each batch of feed slurry was shipped to VSL in lined 55-gallon drums (approximately 16 per shipment) and staged for unloading into the mix tank. Both the mix tank and the feed tank are 750-gallon polyethylene tanks with conical bottoms that are fitted with mechanical agitators. Five calibrated load cells directly mounted on the legs of the feed tank were used to measure additions to and removal from the feed tank and were electronically monitored to determine the feed rate to the melter. The requisite amount of feed is pumped to the feed tank from the mix tank; measured amounts of water were combined with the feed at this point for the high-water feed tests. The material in the feed tank is constantly recirculated from the feed tank discharge outlet, at the tank bottom, to the tank inlet at the top, which provides additional mixing.

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 two parallel Teflon-lined feed lines and water-cooled feed tubes. Three computer-operated pinch valves, one on each of the feed lines and one on the recirculation loop, are activated in a timed sequenced 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 each of the feed lines and can be used to automatically clear the feed lines (feed and "chase air") into the melter after each pulse.

1.3.2 Melter System

The DuraMelter™ 1200 is a Joule-heated melter with Inconel 690 electrodes and thus has an upper operating temperature of about 1200°C. The melter shell is water-cooled and incorporates a jack-bolt thermal expansion system. The footprint of the melter is approximately 8 ft. by 6.5 ft. with a 4 ft. by 2.3 ft. air-lift discharge chamber appended to one end; the melter shell is almost 8 ft. tall. The melter surface area and the melt pool height are approximately 32 percent and 57 percent, respectively, of the corresponding values for the full-scale HLW melter. The discharge riser and trough are full-scale to verify pouring adequacy. Other aspects of the discharge system are also prototypical such as the chamber ventilation scheme. The glass contact refractory is Monofrax™ K-3 while the plenum area walls are constructed of Monofrax™ H refractory. The surface of the glass pool is 34" by 54" with a glass depth of nominally 25". The resultant melt volume is approximately 45,000 cubic inches (735 liters), which represents a glass tank capacity of more than 1.7 metric tons of glass. As compared to the two parallel pairs of flat plate electrodes in the former DuraMelter™ 1000, the DuraMelter™ 1200 is fitted with one pair of electrodes placed high on opposite walls of the melter as well as one bottom electrode. The side electrodes are 11" by 34" giving an electrode area for the pair of about 750 sq. in. Depending on the glass level, the plenum space extends about 33" to 36" above the melt surface resulting in a plenum volume ranging from about 43 to 46 ft^3. Cross-sectional diagrams of the melter illustrating the discharge chamber and electrode configuration are provided in Figures 1 and 2.

The single-phase power supply to the melter electrodes (250 kW designed power) is derived from the DuraMelter™ 1000 transformers by wiring them in parallel and using a single large silicon controlled rectifier (SCR). Current can be passed either from the side electrodes to the bottom electrode or between the two side electrodes only, by rearranging jumpers. Programmable process controllers are installed and can be used to control temperature or power. It is convenient to control the melt temperature by configuring the process controller to maintain constant power and adjusting the power set-point as needed to maintain the desired operating temperature. Alarms can be set to detect out-of-range temperatures or power in the melter. Backup process controllers are installed to be used in case of failure of the main controllers.

The DuraMelter™ 1200 has several others features worth noting. The lid refractory is prototypic and also includes a two-piece construction, which simulates the seam that was part of the full-scale LAW lid, which was to have been fabricated in three pieces; however, that design element of the LAW lid has since been revised. Nozzles are provided for the off-gas film cooler, a standby off-gas port, discharge airlift, along with 11 ports available for top-entering bubblers, start-up heaters and other components as needed. In addition, a bubbler arrangement is installed in the bottom electrode with the objective of developing permanent bubblers for possible use on future melters. Another innovation is a fiber optic distributed temperature monitor that is cast into the Narcon^{TM} 60A castable on the discharge chamber side of the DM1200 that is intended to demonstrate the use of a distributed temperature sensor for refractory corrosion monitoring.

1.3.3 Off-Gas System

The DM-1200 off-gas system was designed to be prototypic of the off-gas treatment system planned for use with the HLW melters in the RPP-WTP facility. In addition, the system can be reconfigured to represent the LAW off-gas treatment train for testing with LAW feeds. A detailed description of the design and installation of the DM-1200 off-gas system was provided earlier [10]. A schematic process flow diagram showing the components of the system is provided in Figure 1.3.

1.3.3.1 Functional description

The melter and the entire off-gas treatment system are maintained under slight negative pressure by external induced draft blowers. This negative pressure is necessary to minimize escape of gases from the system into the working spaces surrounding the melter and is prototypical of the full-scale system. The off-gas treatment system, shown schematically in Figure 1.3, consists of a submerged bed scrubber (SBS); a wet electrostatic precipitator (WESP); a high-efficiency mist eliminator (HEME); a high-efficiency particulate arrestor (HEPA); a packed-column caustic scrubber (PBS); a second HEME; a thermal catalytic oxidation unit (TCO); and a second HEPA as the primary treatment units. Differences between the DM1200 off-gas system and the RPP-WTP baseline design include the addition of intermediate blowers and a second High Efficiency Mist Eliminator (HEME) after the caustic scrubber in the pilot system. The second HEME can be bypassed if necessary but the VSL design team judged this a necessary addition in order to prevent undesirable salt carryover into the TCO unit. Several changes have been made to the RPP-WTP baseline design since the deployment of the DM1200 system, including the replacement of the packed-bed scrubber by a silver mordenite column for iodine removal located after the TCO. The Project is evaluating the addition of a silver mordenite column to the DM1200 system; for the present test, however, the packed bed scrubber was not operated.

The system can be functionally subdivided into four subsystems:

<u>Particulate Removal</u>: Components from the submerged bed scrubber (SBS) to HEPA #1 serve to remove essentially all of the particulate from the gas stream with an estimated removal efficiency of greater than 99.9999% for particles greater than 0.3 μm in size. In the RPP-WTP facility, this

provision serves to segregate the radioactive from the non-radioactive components in the system for maintenance and handling purposes.

Acid Gas/VOC Control: The caustic scrubber and HEME #2 provide acid gas scrubbing to protect the thermal catalytic oxidation (TCO) unit, which is designed to oxidize any hazardous organics that are present in the off-gas stream. However, as noted above, the caustic scrubber was by-passed for these tests. In addition, no catalyst was installed in the TCO for the present tests.

Stack System: Components from HEPA #2 to the stack outlet, including the emergency/bypass exhaust system, provide final filtration of the gas and serve to exhaust the treated gas stream to the atmosphere.

Liquid Processing: Components including the water spray lines, liquid sampling and water storage tanks, as well as the effluent evaporator, function to sample and process the system liquids for recycle or discharge.

Initial quenching of the gas stream from the melter takes place in the film cooler. Gas exits the film cooler at a temperature of 250 to 350 ^{o}C flowing at a rate of typically 100 - 250 scfm, of which 5 - 50 scfm is water vapor, depending on the operating conditions. The off-gas is then rapidly quenched by direct liquid water contact in the Submerged Bed Scrubber (SBS), which also effects removal of most of the larger particulates. High superficial gas velocity in the piping between the film cooler and SBS minimizes particulate deposition. Gas leaves the SBS at a relatively low temperature (typically between 35 and 50 ^{o}C). Further mist and particulate removal continues in the WESP, HEPAs, and HEMEs. Water deluge nozzles are installed in WESP and HEMEs to wash down deposits into their respective collection sumps. The system components are fabricated from corrosion resistant materials including AL6XN in the SBS and 316L stainless steel and various plastics in other locations. There are extensive provisions for sampling both the gas and liquid streams throughout the system in order to collect mass balance information and removal efficiency data for each treatment stage.

1.3.3.2.1 SBS Modifications

Several modifications were made to the SBS as a result of data collected during initial stand-alone testing using Landa evaporator as an off-gas/steam source simulator [11] and subsequent testing by feeding the DM1200 melter with water; these are briefly summarized here for background. Significant among the issues were:

- Excessive fluctuations in melter pressure attributed to oscillations on the large gas bubble that forms underneath of the SBS diffuser plate at the exit of the downcomer pipe.

- Rapid disintegration of the ceramic saddle packing media that was originally specified by the RPP-WTP Project.

- A need for supplemental cooling to handle the increased steam flow into the SBS at the higher processing rates that are realized when the glass pool is agitated by bubbling.

Several modifications were tested, including extension of the center inlet downcomer below the diffuser plate and alternative packing media. A perforated downcomer extension tube extending 12 inches below the diffuser plate was installed with holes along the tube wall with the intent of breaking up the gas bubble forming below the diffuser plate. This change reduced the amplitude of the pressure pulsations to an acceptable level. Several other changes were also investigated, such as plugging weir tubes, plugging the standby gas nozzle, and constraining the inlet source of gas. However, the perforated downcomer extension appeared to have the most effect in mitigating the pressure fluctuations. In the downcomer extension used during the commissioning tests there were 32 half-inch diameter holes distributed along the tube in four rows of eight, 1½ inch apart.

Various packing media, including ½ inch stainless steel saddles, metal balls, and ceramic balls were tested in place of the original ceramic Intallox saddle packing medium. Based on these tests, ceramic balls, approximately an inch in diameter, packed all the way up to the top retaining screen were used during the commission testing. However, the original Intallox saddles were retained in the spaces between the liquid weirs that protruded through the diffuser plate to prevent jamming of the ceramic balls in crevices. A metal screen was laid on top of the weirs to eliminate intermixing of packing media.

During "water runs" that were performed prior to the commissioning tests, the performance of the integrated DM1200 off-gas system was evaluated by feeding water to the melter at rates as high as 2.5 liters per minute, both continuously and in a pulsed manner to mimic the ADS feed pump. Initially, water feed rates in excess of one liter per minute resulted in substantial moisture condensation downstream of the SBS. Even with the cooling jacket of the SBS working at full capacity, the sump operated at a temperature of about 60°C to 70°C. While this would not be a problem with the lower feed processing rates achieved without bubbling, the heat load to the SBS would be excessive with the higher processing rates anticipated during test runs with bubbling of the glass melt pool. To temporarily alleviate the problem, an external heat exchanger was added to decrease the operating temperature of the SBS and minimize down-stream moisture condensation.

This was accomplished by re-circulating the SBS sump liquid through a plate heat exchanger and returning it to the SBS via the jet stirring lances, which were operated continuously[1]. With the added plate heat exchanger cooling, it was possible to maintain the dew point of the gas leaving the SBS in a range of 23 to 29 °C, resulting in stack exhaust gas of 2-3% relative humidity at 90-95°C. During steady-state operation, the gas flow from the SBS varied between 180 and 220 scfm with the film cooler injection flow set at 70 scfm. Following addition of the plate heat exchanger, no unwanted condensation of moisture was observed anywhere along the off-gas train.

1.3.3.2 Data Acquisition

During the commissioning test runs, off-gas data from most measurement points were logged at two-minute intervals by a PC-based data acquisition system using LabVIEW2 software. The following is a list of off-gas system data electronically logged during these tests:

Melter

- Melter plenum pressure relative to room ("gauge" pressure, in W.C.)

SBS

- Inlet gas pressure relative to room ("gauge" pressure, in W.C.)
- Outlet gas pressure relative to room ("gauge" pressure, in W.C.)
- Differential pressure (in W.C.) across the SBS
- Temperature (°C) of the chilled cooling water supplied to the SBS external cooling jacket and to the plate heat exchanger
- Outlet temperature (°C) of cooling water from the SBS external cooling jacket
- Flow rate (gpm) of cooling water through the SBS external cooling jacket
- Outlet temperature (°C) of cooling water from the SBS plate heat exchanger
- Flow rate (in gpm) of cooling water through the SBS plate heat exchanger
- Liquid temperature (°C) inside of SBS at four depths (48, 60, 72 and 78 inches) below

[1] A permanent, internal cooling coil utilizing chilled process water replaced this temporary modification prior to the next sequence of tests. Such a coil is included in the RPP-WTP baseline SBS design but was deleted from the DM1200 SBS in Part B1 as a cost saving measure.

[2] National Instruments Corporation, Austin Texas.

the overflow level

WESP

- Differential pressure (in W.C.) across the WESP
- Inlet gas temperature (°C)
- Outlet gas temperature (°C)

HEPA #1

- Differential pressure (in W.C.) across HEPA #1
- Outlet gas temperature (°C)

Caustic Scrubber

- Inlet gas temperature (°C)

Neutralization tank

- pH of liquids in neutralization tank

TCO

- Outlet gas temperature (°C)

1.4 Quality Assurance

This work was conducted under an NQA-1 (1994) based quality assurance program that is in place at VSL. This program was supplemented by a Quality Assurance Project Plan for RPP-WTP work [12] that is conducted at VSL, which includes the correlation of the VSL QA program with the contractually imposed 10-CFR-830.120. This work is not subject to DOE/RW-0333P. The special requirements of EPA Guidance for Quality Assurance Project Plan (EPA QA/G-5) do not apply to this work. Since the completion of this work, the RPP-WTP Project has directed the implementation of an NQA-1 (1989) and NQA-2a (1990) subpart 2.7, in place of NQA-1 (1994) and the VSL program and Quality Assurance Project Plan for RPP-WTP work that is conducted at VSL has been revised accordingly [13]. The program is supported by VSL standard operating procedures that were used for this work [14].

SECTION 2.0
WASTE SIMULANT AND GLASS FORMULATIONS

2.1 Waste Simulants

The AZ-101 HLW simulant that was used for these tests is based on waste compositions provided in the Tank Waste Remediation System Operation and Utilization Plan (TWRS-OUP) [15]. The TWRS-OUP provides inventory information on 24 major waste components, which is, for the most part identical to that found in the Best Basis Inventory (BBI) database [16]; the exceptions are mercury, which is omitted in the TWRS-OUP, and strontium, for which the higher of the two values was assumed in this work. The TWRS-OUP, in addition to total inventories, provides the information on the partitioning of those inventories into solid and supernatant fractions that is needed to define waste simulants. The chemical wash factors that are provided in the TWRS-OUP were applied to the solid fractions in defining the AZ-101 simulant. For waste components that are not tracked in the TWRS-OUP or the BBI, data from the HLW Feed Staging Plan [17] based on the recommended number of in-tank sludge washings were used. No radionuclides or noble metals were included and all constituents present at less than 0.05 wt% (waste oxide basis) were omitted. In addition, all of the TOC was assumed to be oxalate and the small amounts of boron, lithium, and zinc were omitted since much greater amounts are present in the glass forming additives. While it was recognized that more recent information was available (e.g., in the Tank Farm Contractor Operation and Utilization Plan [18]) the compositional changes for AZ-101 are not great. Furthermore, it was judged more important to keep exactly the same simulant and melter feed composition for these tests as those used previously [1, 7-9] in order to be able to directly compare the test results.

A total of 32 chemical components are present in the resulting simulant for the washed AZ-101 HLW (Table 2.1). This HLW material must then be blended with the projected products from LAW pretreatment to complete the waste simulant formulation. These pretreatment processes (Cs and Tc removal by ion exchange and Sr/TRU removal by Sr/permanganate precipitation) lead to increases in the amounts of cesium, technetium, sodium, nitrate, strontium, and manganese in the HLW material. The pretreatment products from technetium removal, which contribute technetium, sodium, and nitrate, were neglected in the simulant since the impact on nitrate is relatively small (75 liters of Tc concentrate vs. 3,811 liters of Cs concentrate [19]) and sodium is used as a glass forming additive. The quantities of pretreatment products to be combined with the AZ-101 HLW material were calculated based on References [19] and [20]. In particular, 7.71% of the total Sr/TRU precipitate from pretreatment of Envelope C waste is to be added to AZ-101 waste, which is equivalent to (78 MT × 0.0771) = 6.01 MT of strontium and (38 MT × 0.0771) = 2.93 MT of manganese. The strontium precipitate will probably consist of a combination of carbonate and hydroxide. We have assumed that the carbonate is predominant and have included 3 g of carbonate per 100 g of oxides in the simulant (no carbonate is present in the washed HLW material as a consequence of the assumed 100% wash factor for carbonate [15]). The composition of the resulting AZ-101 simulant mixed with pretreatment products is summarized in Table 2.1. Subsequent to the Turnover and prior to Test 1, potassium iodide (at the expense of potassium nitrate) was added to the feed to achieve a target glass composition of 0.1 weight percent iodine if all of the iodine were retained.

2.2 Glass and Melter Feed Formulations

Glass formulations have been developed for the AZ-101 simulant that accommodate the replacement of iron by manganese for Sr/TRU removal and meet the processing and product quality requirements. The glass composition selected for these tests, HLW98-31, is presented in Table 2.1. On an oxide basis, this glass incorporates 27.0 wt% of Envelope D waste and 3.5 wt% of pretreatment products; the resulting content of MnO is 3.03 wt%. Crucible, DM10, DM100, and DM1000 tests have been conducted to determine that this glass meets all processing and performance requirements [1, 7-9]. The measured viscosity and conductivity at 1150°C are 43 P and 0.41 S/cm, respectively. Heat treatment of HLW98-31 at 950°C for 70 hours resulted in 0.26 vol% of spinel while the glass was completely homogeneous after 66 hours at 1050°C. The glass also shows good TCLP performance: the Cd concentration in the TCLP leachate is 0.067 mg/l, compared to the Universal Treatment Standard (UTS) level of 0.11 mg/l, while all other constituents are below their respective UTS levels by much wider margins.

The additional constituents required to form HLW98-31 glass from the AZ-101 simulant are boron, lithium, sodium, silicon, and zinc. The corresponding chemical additives that are the sources for these elements were selected based upon cost and compatibility with the vitrification process. The theoretical glass yield of the resulting feed is 0.39 kg of glass per kg of feed, which is equivalent to 0.55 kg of glass per liter of feed based on a density of the feed of 1.40 g/ml.

2.3 Preparation of Melter Feed

Early in B1 VSL solicited bids from vendors to collaborate in simulant and feed development and to supply material for the large-scale melter tests, which resulted in the selection of NOAH Technologies Corporation. NOAH Technologies' Quality Assurance program has been reviewed and approved by VSL. NOAH Technologies has produced the simulant and feed samples used in development and screening tests conducted to date at VSL as well as larger-scale tests on the DM100 and DM1000 melter systems.

Table 2.2 lists the starting materials and amounts required to generate the target AZ-101 simulant and feed. A total of about 26 MT of feed was used, which resulted in about 10 MT of glass. NOAH Technologies prepared the feed in batches based on their production capacity of about 4,000 kg per batch. The formulation was specified by VSL based on chemical assays of the raw materials provided by NOAH, or as necessary, assay samples of those materials performed by VSL. NOAH Technologies provided signed certificates of addition to VSL for each batch.

2.4 Analysis of Feed Samples

2.4.1 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. Sample names, sampling dates, sampling location, tank mass during sampling and measured properties are provided in Table 2.3. At the end of Test 3, the residual feed was processed to determine if segregation occurs as the feed level falls well below the bottom mixer blades (last four samples in Table 2.3). Samples were simultaneously taken from the feed line and from the feed tank. Water was added to the AZ-101 feed for Test 3 to produce the low-solids feed, resulting in the observed lower densities and glass yields. The target glass yields of 570 g/l for the first two tests and 350 g/l for Test 3 were closely approximated for most of the testing periods. Exceptions occurred in the period after Test 3 when the feed level was below the mixer blade and the sample taken from the tank at the end of Test 2. Aside from those exceptions, the measured parameters for these tests fall into relatively narrow ranges: water percent (51.6-53.8 for Test 1 and 2, 65.1-67.4 for Test 3), density (1.39-1.45 g/ml for Test 1 and 2; 1.26-1.29 g/ml for Test 3) and glass yield (534-573 g glass/l feed for Test 1 and 2; and 324-367 g/liter Test 3). Given this similarity, the average values of 0.380 and 0.275 kg of glass per kg feed were used in calculating production rates for Tests 1 and 2 and for Test 3, respectively. Although analyses of samples taken from the feed line and the feed tank were very similar for most sample pairs, the feed line was selected as the standard sampling location for future tests. Furthermore, minimum amount of feed in the tank will be sufficient to ensure that good mixing is maintained (greater than about 1000 kg, depending on feed density).

2.4.2 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 [15]. 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. It should be noted that this approach is somewhat different than the "flow curve" approach that is often used 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 arbitrarily selected ramp rate. In contrast, the present measurements are equilibrium values of the shear stress at each measured shear 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. All of the measurements in this work were made at 25°C; previous work [15], 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 are compared in Table 2.4. As expected, the samples group into two distinct populations based on the solids content of the feed. The observed and expected reduction in viscosity with increased water contents has been observed in previous analysis of simulated HLW melter feeds [9, 21]. It is worth noting the small difference in viscosities between samples taken during Test 3 at the tank weight extremes suggesting limited feed segregation, even when the feed level is far below the bottom blade (probably a result of the effectiveness of the recirculation line flow in mixing the tank contents).

2.4.3 Chemical Composition

The chemical compositions of the feed samples were determined by first making a glass from the feed samples via crucible melt. The glass was subsequently crushed and either dissolved in an HF/HNO_3 acid mixture with the aid of a microwave oven to produce a solution for DCP analysis or analyzed directly by XRF. Boron and lithium oxide concentrations derived from the DCP procedure were used for normalizing the XRF data since those elements were not determined by XRF. The digested glass sample solutions were also analyzed for cesium using flame atomic absorption. Data from both methods are compared to each other and to the target composition 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. The measured lithium concentrations tended to be low but the results for an NIST standard glass (SRM 1412, 4.5 Wt. % Li_2O) that is dissolved and analyzed with each set of glasses consistently yielded values within 7 percent of the standard value. The lithium results for several of the feed samples were rejected; these samples would normally have been reanalyzed but in view of the large number of comparable samples, all of which were derived from the same NOAH production batch, and the preliminary nature of these tests, these results were simply replaced by the average values for comparable samples, as indicated in Table 2.5. Values for zirconia generated by DCP were within 10% of target for all samples, however, as observed previously, the XRF results for zirconia are biased high as a result of limited relevant standards available for XRF. Some of the minor oxides which were targeted at less than 0.5 wt%, such as CaO and K_2O, were consistently above target sometimes by as much as a factor of two, which may be a result of their presence as impurities in the raw materials. Volatile minor elements such as selenium, cesium, and chlorine are below target due to loss during crucible melting. The sum of analyzed oxides for DCP is below 100% because not all elements are determined and there are minor losses during glass dissolution. Typically, sample recoveries for this procedure are about 95%, however several of feed samples had lower values. In these instances, comparison with XRF results indicates the deficiency is mainly in silicon or iron. Good agreement between the two procedures exists for the majority of the other analytes. The total for the XRF results is always slightly greater than 100% due to post normalization correction to standard reference materials. Further comparison of XRF and DCP results for the products glass samples is provided in Section 5.1.

The large number of feed samples taken at various tank weights and two sampling locations provides data to evaluate the possibility of any chemical segregation in the feed tank. The concentrations of select soluble and insoluble oxides are plotted against feed tank mass in Figure 2.2. Notice the lack of correlation between concentrations and feed tank mass, except perhaps for the lowest tank reading. Also apparent is the agreement in analyzed sample chemistry between samples taken at the two different locations (i.e., tank and melter feed line). These data provide strong evidence that the melter feed was homogeneous throughout these tests.

SECTION 3.0
MELTER OPERATIONS

Three melter tests were conducted on the DM1200 with the AZ-101 simulant between 5/7/01 and 5/24/01, producing over 5400 kg of glass. Glass bubbling rate and feed water content were varied, as shown in the test summary in Table 1.1. Prior to beginning the tests, over 5000 kg of glass was produced during the turnover of the melt pool composition. The turnover was performed in a series of runs between 4/17/01 and 5/4/01 during which operators were trained, procedures were refined, and emissions data were collected for local regulators.

The measured glass production rates are depicted in Figures 3.1 - 3.3 as cumulative and five-hour moving averages. Note that only manually logged, instead of electronic, rate data were available for the first eight hours of Test 2. Typically, by the end of each test, the cumulative production rate approximates the five-hour average rate, indicating that steady-state rates have been approached. This was not the case in the test without bubbling because of the high rate achieved over the first day and half, even though steady-state was maintained for the last three days of the test. Overall, the test variable with the greatest effect on production rate was bubbling. Bubbling, by supplying air through the bottom electrode, resulted in an approximate five-fold increase in steady-state production rate from 155 $kg/m^2/day$ to 750 $kg/m^2/day$. As expected, the production rate decreased with increasing feed water content, albeit modestly, from 750 $kg/m^2/day$ to 700 $kg/m^2/day$. The low production rate in Test 1 is about half that achieved for the comparable test on the DM1000 [1] and about a third of that achieved on the DM100 [9]. The DM1000 test featured only 50 hours of slurry feeding and results in these and subsequent tests have indicated that often longer periods of time are required to reach steady state when bubbling is not used. The DM100 tests were of sufficient duration, however, normalized production rates are typically higher on smaller melters due to wall effects.

A variety of operational measurements were recorded during these melter tests including temperatures throughout the melter system, as given in Table 3.1. The target glass temperature of 1150°C was successfully maintained for at least one portion of glass pool during each of the tests, as illustrated in Figures 3.4 - 3.6. The coldest regions were between 27" and 30" from the floor due to the thermocouples being in or near the cold cap. The saw tooth pattern exhibited for these thermocouples is in response to the level changes associated with the pouring of glass over the course of each test. In tests with bubbling, the 1150° C target temperature was obtained at more locations throughout the melt pool resulting in more uniform temperature profile. Conversely, temperatures towards the bottom of the melter were generally lower in the test without bubbling (Figure 3.4) reflecting the poorer mixing. Glass temperatures measured in the East thermowell were lower than those measured at corresponding locations in the West thermowell. Plenum temperatures between 400 - 500°C were targeted and achieved for the steady-state portions of the tests. Since plenum temperature is a function of the extent to which the surface of the melt pool is covered by feed, plenum temperatures decrease over the course of each test as the cold cap develops, as shown in Figures 3.7 - 3.9. The discharge chamber temperature was maintained above 900°C. Gas temperatures after film cooler dilution typically averaged between 250 and 300°C, depending on the plenum temperature, the amount of added film cooler air, and the temperature of the added film cooler air.

The amount of power supplied to the electrodes depended on the feed rate, water content of the feed. Tests with higher feed rates (e.g., bubbled tests) required more power; however, when normalized to glass production, they had the lowest power utilization per unit glass produced. Notice in Table 1.1 that tests with bubbling required a half to a third the power per unit mass of glass. As expected, Test 3 required more power than Test 2 per unit mass of glass as a result of the higher feed water content.

SECTION 4.0
OFF-GAS SYSTEM PERFORMANCE

These tests are the first in which this particular off-gas train has been operated with a joule-heated melter. This section presents and discusses data on the off-gas system performance obtained during the three commissioning test run segments following the initial glass turnover run. It should be noted, however, that these were start-up and commissioning tests and, accordingly, a significant amount of hardware and procedure debugging was performed during these tests.

4.1 Off-Gas System Test Results

Data for each system measurement channel logged by LabVIEW were imported into MS Excel files for data manipulation and plotting. Time "0" on the x-axis of each data plot corresponds to the start of feeding of water to the melter at the beginning of each test run. Where indicated in the following discussion, some data were smoothed by time averaging instantaneous measurements logged at two minute intervals over a ten minute periods to reduce data scatter and narrow the width of line plots of the data. Table 4.1 includes the extreme and the average values for all off-gas system measured parameters.

4.1.1 Melter Pressure

Previously described modifications to the SBS reduced melter pressure fluctuations and improved melter pressure control. There was however, as shown in Figure 4.1, a temporary increase in melter plenum pressure following each periodic shot of feed injected by the pulsed feed system[3]. There is a small baseline pressure oscillation of approximately one-second duration and 0.5 in W.C. amplitude. A rapid increase of ~5 in W.C. follows each pulsed injection of feed. These data were collected using a fast (5 ms response time) pressure transducer opened to the melter plenum through a short run of wide-bore tubing. The cold cap was only partially developed at the time these measurements were taken (about 80%). The periodic feed pressure pulses usually diminish as the cold cap coverage increases. Conversely, the pressure peaks are greater when feeding directly onto an exposed, hot glass surface. Thus, the feed start-up procedure used at West Valley has been adopted for the DM1200, wherein water is first fed in continuous stream to begin the formation of a "cold-cap" (about 1-2 hours) before switching over to pulsed feed of slurry.

[3] Pulsed feeding action of ADS feed pumps planned for use in the RPP-WTP was simulated by periodically opening "pinch valves" on lines from the feed re-circulation loop to the two melter feed nozzles. The feed rate was controlled by the frequency at which the pinch valves were opened.

The melter pressure data collected during each of the three tests are displayed as frequency distributions in Figure 4.1a. The distribution is somewhat narrower for the lower-feed-rate unbubbled test (Test 1) than for the bubbled tests, probably due in part to the more complete cold cap closure for the unbubbled test. The larger excursions towards positive pressure are due to the feed pulses, as discussed above. The data in Figure 4.1a indicate that slightly lower average melter pressure is needed to maintain all excursions below ambient.

As shown the plot in Figure 4.2 shows, the computer logged melter pressure values for Test 1 are considerably scattered, likely, randomly depending on when during the feed pulse cycle the pressure was recorded. These data smoothed by averaging over five consecutive measurements are shown in the lower plot in Figure 4.2. The ten-minute time averaged melter pressure data for Test 2 and Test 3 are shown in Figure 4.3.

The water feed rate to the melter was progressively increased from 300 ml/min at the start of Test 1 to 2.8 l/min prior to the start of feeding at 3.15 hours, during which time the Paxton blower (blower #1 in Figure 1.3) speed was progressively increased up to 95% to reduce the melter pressure below -4 in W.C. The melter pressure dropped to about -8 in W.C. following a switch from water feeding to slurry feed at 3.15 hour and was brought back to about -5 in W.C. by reducing the Paxton blower speed. A brief loss (for about 6 min) in off-gas system pressure occurred at 23.4 hours, while performing maintenance on the Paxton blower, as noted in the DM1200 operations logbook.

During the first 4.35 hours of Test 2 there were problems with several channels of the off-gas data logging system were identified and no data were recorded from 3.5 to 4.2 hours, followed by another 6 minute gap in logged data at 4.3 hours. There was a sharp reduction in melter vacuum between 6 to 7 hours into Test 2 attributed to the emergency/bypass off-gas line valve tripping open, during which feeding was stopped. The valve was reset and the melter vacuum sharply increased to about -9 in W.C., followed by a brief reduction to ~-1 in W.C. when feeding was resumed.

The ten-minute time-averaged melter vacuum values were relatively consistent at around –4 in W.C. during most of Test 3 with three exceptions. At approximately 26 hours, the emergency/bypass off-gas valve was again tripped while installing gas-sampling equipment. A loss of power caused the shutdown of all three blowers for about 4 minutes at 48 hours and again at 50 hours when the blowers were briefly off-line while re-setting power to the off-gas scrubber control panel and the TOC heater.

4.1.2 SBS Performance

Modifications made to the SBS prior to the commissioning tests greatly reduced pressure pulsations in the melter plenum. Installation of the plate heat exchanger increased the heat removal capacity of the SBS and prevented condensation of water vapor in downstream components during high-heat-load operations, such as feeding onto a hot glass surface or when processing at high rates with bubbling.

Test 1

The SBS gas temperatures and pressures, for Test 1 are plotted in Figure 4.4. The inlet gas temperature peaked at 533 °C at 0.9 hours. The outlet gas temperature peaked at 53 °C at 3.1 hours, just before the start of AZ-101 surrogate feeding. Later, during the Test 1 steady-state operation period (45 to 123 hours) when the feed rate was 19.7 kg/hr, the average inlet gas temperature was 205°C and the average outlet temperature was at 19 °C. During this same period, the average inlet and outlet pressures were -6.2 in W.C. and -56.7 in W.C. respectively (compare with Table 4.1 listing the overall averages).

The water temperatures in the SBS, the SBS chilled water supply temperature, the cooling jacket outlet temperature, and the water outlet temperature from the plate heat exchanger recorded during Test 1 are all shown in the top plots of Figure 4.5. These data are time-averaged over 10 minutes (5 measurements) to reduce the scatter. There was very little difference in water temperatures measured at four depths (48, 60, 72 and 78 inches) within the SBS, and notably, even at the start of the test when feeding water to the hot melter plenum transferred steam heat to the SBS at the greatest rate. During this initial period of water feeding (increasing from 0.6 l/min at 0 hours to 2.8 l/min at 2.65 hours), the water in the SBS was heated to a maximum temperature of ~55 °C. Feed was switched from water to AZ-101 surrogate feed at 3.15 hours. During the first 30 hours after the start of AZ-101 surrogate feeding, the feed rate averaged 70.6 kg/hr and the SBS water temperature dropped to a steady-state value of ~25 °C. After about 40 hours, the feeding rate was reduced to an average rate of 19.7 kg/hr for the remainder of Test 1. The steady-state SBS water temperature during this later period averaged 17.7 °C.

The amount of heat removed by the SBS jacket cooling water and the plate heat exchanger is shown in the lower plots of Figure 4.5 along with the cumulative feed weight. The plotted heat data are calculated based on 10 minute time-averaged cooling water temperature increases (outlet temperature minus supply temperature) across cooling jacket and plate heat exchanger multiplied by the average flow rate through each. The average flow through the jacket was 40.6 gpm and the average cooling water flow through the plate heat exchanger was 47.1 gpm. The heat removed by the plate heat exchanger during Test 1 peaked at 248 kW at 2.7 hours. The heat removed by the jacket peaked at 69 kW at 2.6 hours. From 12 to 32 hours during the steady state, 70.6 kg/hr feeding rate period, the heat removal averaged 73.6 kW for the plate heat exchanger and 16.4 kW for the jacket. During the later part of Test 1 at the steady-state feed rate of 19.7 kg/hr (after 44 hours), heat removal averages were, respectively, 36.7 and 7.5 kW. Throughout Test 1, about 80% of the total heat load to the SBS was removed by the plate heat exchanger and about 20% by the jacket.

During the 19.7 kg/hr average feed rate period, assuming the feed water content to be 52% by weight, ~10.2 kg/hr of steam was introduced into the SBS. Using the VERT thermodynamic properties database [22], the enthalpy change during steam quenching from the 205 °C SBS inlet temperature to the 19 °C SBS outlet temperature is 14.05 kWh/kg-mole. Consequently, ~8.0 kW of the overall 44.2 kW of heat removed by the jacket and plate heat exchanger (or about 18 %) relates to steam condensation.

Test 2

The SBS temperatures and pressures are plotted in Figure 4.6. The SBS temperature data logged during the first 4.4 hours of the test were rejected as a result of system debugging problems. During the steady-state operation (10 to 50 hours), the average inlet and outlet gas temperatures were 259 °C and 28.3 °C, respectively. During this same period, the SBS inlet and outlet pressures averaged -6.6 and -57.6 in W.C.

SBS thermal data for the Test 2 along with cumulative feed weight are shown in Figure 4.7. The average feed rate with the melt pool agitated by bubbling was 100 kg/hr, or about 5 times the steady-state processing rate observed with the same 570 g-oxide/l feed with no bubbling during Test 1. For the 10 to 50 hour period, the SBS water temperature averaged about 28 °C with little difference between the four thermocouples located at the 48 to 78 inch levels. The average heat removed by the plate heat exchanger during this period was 90 kW, versus 21.5 kW removed by the cooling jacket during the same period. Again, ~80 % of the total heat load was removed through the plate heat exchanger.

For the average 100 kg/hr of feed containing 52% water, the steam input to the SBS was ~52 kg/hr. From the VERT database, the enthalpy change between the 259 °C SBS inlet temperature and the 28 °C SBS outlet temperature was 14.4 kWh/kg-mole. Thus, ~41.6 kW of the total 111.5 kW of heat exchanged (or about 37 %) can be attributed to the condensation of steam.

Test 3

The experimental data for this test are shown in Figures 4.8 and 4.9 in a manner similar to the two preceding cases. Inlet and outlet gas temperatures reached their respective peaks at 518 °C (at 0.7 hours) and at 55 °C (at 1.9 hours), just before the AZ-101 surrogate feeding was initiated. During the steady-state period (10 to 50 hours), the inlet and outlet gas temperatures were 275 °C and 33.7 °C on average. During this same period, the respective inlet and outlet average pressures were -6.3 and -58.1 in W.C. During the initial water-feeding period (increasing from 1.5 to 3.0 l/min over 1.5 hours), the liquid temperature within the SBS rose to a maximum of 57 °C at 1.9 hours into the operation.

As expected, the greatest steady-state heat loads to the SBS occurred during Test 3. Within the 10 to 50 hour steady-state period, the average SBS water temperature was 33.7 °C with little deviation between the thermocouples located at different levels. The average amount of heat removed by the plate heat exchanger during this period was 122 kW, versus 33.7 kW removed by the jacket cooling during the same period (~80 % through the plate heat exchanger).

In this test ~86 kg/hr of steam (average ~128 kg/hr of feed containing 67 % water) entered the SBS. Since the enthalpy of quenching steam from the 275 °C SBS inlet temperature to the 33.7 °C SBS outlet temperature is 14.44 kWh/kg-mole, ~69 kW of the 155.7 kW of the total heat exchanged in the SBS (or about 44 %) is due to steam condensation.

Post-Test SBS Inspection

After completion of these tests, the SBS sump materials were left undisturbed for about three days. The contents (~500 gal) were then drained without difficulty using a side drain pipe/suction wand combination. The deposits accumulated in the SBS bottom and a view up from the bottom towards the diffuser plate showing the down-comer extension and weir tubes, are shown in Figure 4.10. The sump material appeared to be very well suspended and had not appreciably clarified over that period of time. Removal of the bottom dish of the SBS revealed a thin layer of deposits (~2 inches at the center), centrally arranged in a square pattern, which is the typical pattern formed when the mixing jets are operated continuously. The deposited material was collected weighed, assayed for water content, and analyzed. The total mass of (wet) material was 6.39 kg and the water content was 35.1 wt% (by drying to a constant weight at 105°C). The material was soft and re-suspended easily. The upper internals of the SBS appeared clean and smooth with no visible deposits other than a thin coating of dust.

Post-test inspection also revealed no significant deposits in the transition line downstream of the film cooler. The pipe walls remained clean and smooth. Any crevices, however, along the transition line (such as between gasketed flange lips or within expansion joint corrugations) were tightly packed with a fine, powdery material making the surface flush with the pipe walls. This, in effect, rendered the entire transition line a smooth channel.

4.1.3 WESP Performance

The data recorded by the computerized data acquisition system for the WESP were differential pressure across WESP along with inlet and outlet gas temperatures.

Test 1

The WESP inlet and outlet gas temperatures and the differential pressure across the WESP during Test 1 are plotted in Figure 4.11. During the steady-state period while feeding at 19.7 kg/hr (44 to 123 hours), the respective WESP average inlet and outlet gas temperatures were 23.3 and 30.9 °C, indicating a 7.6 °C temperature increase across the WESP during this period. The pressure differential across the WESP measured a steady 1.61±0.14 in W.C.

Test 2

The WESP inlet and outlet gas temperatures and the differential pressure across the WESP during Test 2 are plotted in Figure 4.12. During the steady-state period while feeding at 100 kg/hr (10 to 50 hours), the respective WESP average inlet and outlet gas temperatures were 29.8 and 36.5 °C, indicating a 6.7 °C temperature increase across the WESP during this period. The pressure differential across the WESP measured a steady 1.72±0.17 in W.C.

Test 3

The WESP inlet and outlet gas temperatures and the differential pressure across the WESP during Test 3 are plotted in Figure 4.13. During the steady-state period while feeding at 128 kg/hr (10 to 50 hours), the respective WESP average inlet and outlet gas temperatures were 33.9 and 39.1 °C, indicating a 5.2 °C temperature increase across the WESP during this period. The pressure differential across the WESP measured a steady 1.61±0.25 in W.C. Notably, the differential pressure across WESP increased (see Figure 4.13) for ~2 hours starting at 25.5 hours, during which time the Paxton blower power was increased to 95 %, then to 97%, while off-gas sampling equipment was being installed.

The WESP inlet temperature data appear to correlate with the SBS outlet temperature data if a warm ambient temperature (e.g. ~35 °C) is assumed around the line between the two units. During the Test 1 steady-state period, gas leaving the SBS at ~19 °C warmed up by ~4.3 °C while flowing from the SBS to the WESP. During Test 2 this temperature increase was smaller, only ~1.5 °C from 28.3 °C at the SBS outlet. It was smaller yet during the Test 3 – only 0.2 °C.

WESP Electrical Data

Current-voltage (I-V) data at various flow rates shown in Table 4.2 were obtained for the baseline WESP operation. Data for gas moisture contents of up to 23% (dew point of 61°C) showed no abnormalities. The WESP design cut-off current of 20 mA was reached between 26 and 29 kV suggesting no dielectric breakdown beyond corona discharge. At high dew-points (50°C and above) condensation was observed. However, no appreciable condensation was observed at low dew points (25 to 30°C).

During processing of the AZ-101 feed, the WESP current was maintained at 17±1 mA at 22 to 26 kV. Accumulation of liquid in the WESP sump was very slow: about 14 gallons over 10,500 kg of glass, most of which accumulated during the first 700 kg of glass when the SBS sump was operated at higher temperature.

The gas temperature rise while flowing through WESP can be clearly attributed to resistance heating. For example, considering that ~0.41 kW of power is being dissipated within WESP operating at 24 kV and 17 mA and that the heat capacity of moist air saturated at 30 °C and flowing at rate of 200 cfm equals to ~0.12 kW/K, a temperature rise of 3.4 °C may be expected, in reasonable agreement with actual observations.

Post-Test WESP Inspection

The inside of the WESP was examined twice during these tests. The first inspection occurred after about 2100 kg of feed was processed (about 700 kg of glass made). No significant accumulation of materials was then observed on the anode except for a strongly adhered reddish coloration extending less than 1 foot towards the downstream section of the 5-foot long collector assembly. The WESP was examined a second time at the conclusion of all three tests (after 10,500 kg of glass was produced). The second visual inspection revealed substantial deposits extending upwards along the entire length of collectors (both the cathode and the anode) with varying thickness of $^{1}/_{8}$ to $^{1}/_{2}$ inch. A 40-gallon water deluge was effective in washing down these deposits. Figure 4.14 shows the WESP internals before and after the wash, as well as washed-down deposits in the sump.

4.1.4 HEME and HEPA Filters

The gas exiting the WESP flows through a Paxton blower (Blower #1) followed by a high efficiency mist eliminator (HEME #1), an in-line heater, and the first HEPA filter (HEPA #1). The purpose of the HEME is to trap any mist entrained in saturated gas leaving WESP. The purpose of the heater is to protect the HEPA from condensation. The outlet temperature and the pressure differential across HEPA #1 were the only two parameters monitored by the off-gas data acquisition system between the WESP and the Packed Bed Scrubber (PBS). Data recorded during Tests 1, 2 and 3 are plotted in Figures 4.15, 4.16 and 4.17. The outlet temperature at HEPA #1 averaged 122.6 °C during all three tests with very little variation. The differential pressure was steady at 0.21±0.01 in W.C. These results indicate that no significant particulate loading or moisture blinding of HEPA #1 occurred.

4.1.5 Packed Bed Scrubber (PBS)

Following HEPA #1 is, in order: a second blower, a control damper, and a PBS intended to remove soluble acidic gases such as HF, HCl and SO_x from the off-gas stream. The scrubber includes a pH-controlled caustic addition system and appropriate effluent management plumbing. However, the system was not active for the duration of the commissioning tests and only the gas inlet temperature was logged by the data acquisition system. These data are plotted in Figures 4.18, 4.19 and 4.20. These figures also show the pH values measured in the neutralization tank, discussed below.

4.1.6 Effluent Liquid Treatment System

Effluent liquids from the SBS, WESP, HEME #1, PBS, and HEME #2 (downstream of the PBS) are all transferred to a series of separate sampling tanks that discharge into three 500-gallon tanks for neutralization, mixing, and storage. The largest effluent volume is generated by the overflow from the SBS, which is initially pumped to one of the two SBS sampling tanks. Caustic solution (25-30% NaOH) from the same caustic container that supplies the PBS can also be added to the 500-gallon tank that receives acidic effluents from the sampling tanks. Effluents collected in the storage tank can be periodically transferred to the integral Landa Evaporator for concentration and either recycle or disposal. The Landa evaporator is periodically opened for removal of salt residues from evaporation.

The various effluent liquid sampling and storage tanks are visually monitored during periodic rounds and effluent liquid transfers are made as needed. The only parameter of the effluent liquid treatment system monitored by the computerized data acquisition system during the commissioning tests was the pH of the neutralization tank. As shown in Figure 4.18, a caustic addition was made to the neutralization tank early in Test 1, just before melter feeding was started at 2.5 hours, increasing the pH of the tank contents from ~7.2 to greater than 10. At that time, there was a limitation in the data acquisition system that precluded recording of pH values above 10. After 26 hours, a sufficient amount of acidic effluent had been transferred to the neutralization tank to bring the pH below 10, after which, actual pH data were recorded. Step changes and spikes in the plotted pH data generally correspond to effluent liquid transfers and caustic additions to the neutralization tank.

4.1.7 Thermal Catalytic Oxidation Unit

HEME#2 and the Thermal Catalytic Oxidation (TCO) unit follow the PBS in the off-gas treatment system. The HEME removes any aerosols that may be carried over from the scrubber. The TCO unit is equipped with an 80 kW heater at the front end to appropriately condition the incoming gas. No catalyst was installed in the TCO, which was therefore not active during commissioning tests. However, the TCO heater was utilized to prevent condensation within the building stack.

The gas temperature exiting the TCO was logged by the data acquisition computer and is plotted for all three test runs in Figure 4.21. The TCO outlet temperature averaged about 73 °C during all tests. The TCO heater was turned on shortly after the start of Test 3, as is evident in the TCO outlet temperature data plotted in Figure 4.21. A momentary power loss at hour 48 of Test 3 caused the TCO heater to trip. Power to the heater was reset after two hours and the TCO outlet gas temperature returned to its normal operating value of ~77 °C.

4.2 Effluent Fluids

4.2.1 SBS Fluids

One-liter aliquots were taken from the SBS and WESP each time liquids were blown down from the main reservoir and at the end of each test. Samples were subjected to total dissolved solids (TDS) and total suspended solids (TSS) determinations by gravimetric analysis of filtered material and the evaporated filtrate. Additional sample was filtered to generate solids and filtrate for complete chemical analysis, which included pH determination, direct current plasma emission spectroscopy (DCP) analysis for metals, atomic absorption (AA) for cesium, and ion chromatography for anions; the dried filtered solids underwent microwave assisted acid dissolution prior to chemical analysis. The acids (HF and HNO_3) required to dissolve the filtered solids prevented analysis of all anions except sulfate and iodide.

All of the SBS and WESP sump samples that were taken throughout the DM1200 commissioning tests are listed in Table 4.3; the middle letter in the sample name is "S" for the SBS samples and "W" for the WESP samples. Table 4.3 shows the TSS, TDS, and pH values for each sample, as well as the amount of glass that had been produced at the time the sample was taken. Also shown in Table 4.3 is the blow-down volume from which each SBS sample was taken and the cumulative SBS blow-down volume; the WESP was not blown down during these tests. The volume of the SBS sump is about 500 gallons. At the end of Test 2, a 55-gallon drum of the SBS sump liquid was collected and shipped to SRTC for use in recycle stream mixing tests and pretreatment testing.

The TSS, TDS, and pH values for the SBS liquids are plotted in Figure 4.22. The average values for the SBS liquid TSS and TDS values were 450 mg/l and 1550 mg/l, respectively, and the values over the course of these tests do not vary widely from these averages (Figure 4.22). Conversely, the pH values were stable at around pH 3 until the last test (high water), during which the pH quickly rose to an average of about pH 3.6 over the course of that test. The pH rise is probably a dilution effect due to the increased feed water content (67 vs 52 wt. %) used in the last test.

Figure 4.23 compares the amount of water fed to the total volumetric accumulations in the SBS over the course of the post-turnover tests. The close agreement between these quantities indicates that nearly all of the feed water is condensed in the SBS as a result of its low operating temperature. Water was fed to the melter at the beginning of each test to create a cold cap and thereby minimize subsequent off-gas surges due to pulsed feeding onto bare glass (this is the same feed start-up protocol used at West Valley.) Consequently, the accumulation in the SBS is slightly greater than the amount of water that was introduced as part of the slurry feed.

Chemical analysis results for the SBS samples are provided in Table 4.4. Figure 4.24 compares the SBS dissolved and suspended fractions (sample 12D-S-116A) with the composition of the feed. As might be expected, the dissolved solids consist mainly of species such as alkali metals, halogens, boron, nitrate, and sulfate, as well as significant amount of selenium. These constituents are also relatively volatile. The suspended solids consist primarily of iron and silicon with significant amounts of selenium, tellurium, nickel, lead, chromium, and zirconium. Other metals such as aluminum, calcium, magnesium, cadmium, manganese, and zinc are present in comparable amounts in both the suspended and dissolved fractions of the SBS samples[4]. Iodide was not present in the feed during the turnover segment but was present for all three post-turnover tests. Accordingly, there is a significant increase in the iodide concentration with the first sample from Test 1 (12D-S-115A, see Table 4.4), all of which is present in the dissolved fraction.

[4] It should be noted that the filter pore size mandated by the standard methods that were used is 1.5 micron and therefore any particles less than this size could have contributed to the "dissolved" fraction instead of the suspended fraction.

A thermodynamic database and geochemical speciation code (EQ3/6, [23]) was used to calculate the pH of the SBS solution from the chemical analysis and to determine the speciation of the constituents in the solution. The pH agreed well with the measured value; a summary of the calculated speciation results is presented in Table 4.5. The code also calculates mineral phase saturation indices, which can be compared with the dissolved solids fraction.

The accumulations of elements in the SBS solutions over the course of the tests are depicted in Figures 4.25-28. The elemental accumulations coincide with the accumulation of water (Figure 4.23), as expected given the relative consistency of total suspended and dissolved solids over the course of the tests (Figure 4.22). Over two kilograms of both selenium and sulfate accumulated over the course of the tests as well as tens of grams of metals such as cadmium, nickel, lead, and arsenic. Significant accumulations of cesium and iodide in the SBS effluents were also apparent.

4.2.2 WESP Fluids

Results from the analysis of WESP samples are provided in Table 4.6 and indicate that the majority of the coarser, less-soluble species were removed by the SBS leaving only highly soluble species. Notice that the concentrations of dissolved species in the WESP typically exceed the corresponding values in the SBS by greater than an order of magnitude. Conversely, the suspended solid concentration is substantially lower than that in the SBS. The WESP solutions are high in alkali metals, halides, boron, selenium, and sulfate and show significant enrichment over the SBS in arsenic, cadmium, and chromium, as depicted in Figure 4.29. These observations are generally consistent with the enhanced capture by the WESP of smaller particulates formed by the more volatile species, as is intended in the off-gas system design. However, the small volume of solution in the WESP at the end of the commissioning tests (a total of 14 gallons and no blow down) results in the WESP not being a significant factor with respect to elemental mass balances. In addition, as a consequence of the WESP not being blown down during or between tests, most elemental concentrations increased over the course of these tests.

SECTION 5.0
GLASS PRODUCT

Over 10,000 kg of glass product was discharged from the melter using an airlift system into 55-gallon drums. The discharged product glass was sampled at the end of each test by removing sufficient glass from the top of the drums for total inorganic analysis and TCLP testing. Product glass masses, discharge date, and the analyses performed for discharges during Tests 1 through 3 are listed in Table 5.1.

5.1 Compositional Analysis

Glass samples were crushed and either dissolved in HF/HNO_3 acid mixtures with the aid of a microwave oven to produce a solution for DCP analysis or analyzed directly by XRF. Boron and lithium oxide concentrations derived from the DCP procedure were used for normalizing the XRF data since those elements were not determined by XRF. Digested glass samples were also analyzed for cesium using flame atomic absorption. Analyzed glass compositions are provided in Table 5.2 for discharged samples, using both methods. Compositional trends over the course of the tests are plotted for selected elements in Figures 5.1 - 5.4. The results are similar to those for the feed samples given in Table 2.5. Generally, there was good agreement with the target composition for the major oxides except for Li_2O (about 15% below target) and XRF analysis of ZrO_2 (about 25% above target). Some of the minor oxides, targeted at less than 0.5 wt%, such as CaO and K_2O, were consistently above target, sometimes by as much as a factor of two. This is probably due to impurities in the raw materials. Unlike the feed samples that were vitrified via crucible melting, more of the volatile minor elements were retained in the glass product from the melter tests. As expected, selenium glass concentrations are well below target due to volatilization ranging from 7 to 50 percent (see Section 6). Results from the different methods of analyses agree well for the vast majority of elements, as was the case for feed sample analysis. Silicon analyses using XRF are always higher and closer to target than the DCP analysis, presumably as a consequence of the dissolution step used for DCP analysis.

5.2 Chemical Durability

A sample of the glass product was subjected to the EPA TCLP leach test (SW-846 Method 1311). In that procedure, a leachate solution is extracted from crushed glass with a sodium acetate buffer solution for 18 hours at 22°C with constant end-over-end agitation. The leachate concentrations were then measured by direct current plasma atomic emission spectroscopy (DCP-

AES). The test results and the Universal Treatment Standard (UTS) limits are given in Table 5.3. The measured leachate concentrations were all lower than the regulatory limits and, for many analytes, one to two orders of magnitude lower than the limits. Cadmium values, although below the UTS limit, came closest to the limit. Although the value for barium is still more than 35 times less than the UTS limit, the value of 0.58 ppm is appears to be high given the low concentration of 0.04 wt% targeted in the glass product and in comparison to the earlier results.

SECTION 6.0
MONITORED OFF-GAS EMISSIONS

6.1 Particulate and Gaseous Emissions

Eleven exhaust samples were taken from the melter and various off-gas system components according to 40-CFR-60 Methods 3, 5, and 29 to examine particulate and certain gaseous fluxes. The majority of the off-gas analyte concentrations were derived from laboratory data on solutions extracted from air samples (filters and various solutions) together with measurements of the volume of air sampled. The volume of air sampled and the rate at which it can be sampled are defined in 40-CFR-60 and SW-846. 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), was used. Typically, a sample size of 30 dscf is taken at a rate of between 0.5 and 0.75 dscfm. Total particulate loading was determined by gravimetric analysis of the standard particle filter and of probe-rinse solutions. Down stream of the particulate filter in the sampling train are iced impingers with acidic (5% concentrated nitric acid plus 10% hydrogen peroxide) and basic (0.1 N sodium hydroxide) solutions. The analysis of these solutions permits the determination of total gaseous emissions of several elements, notably halides and sulfur.

Results from exhaust sampling and analysis are compared to feed fluxes in Tables 6.1-6.4, which also list the calculated decontamination factors (DFs) across the melter and the SBS. Solids carry-over from the melter was minimal during these tests, never exceeding 0.27 % of feed solids. As expected, the particulate emissions, both as flux and percent of feed, are far lower in Test 1 than in Tests 2 and 3 due to the lack of bubbling in Test 1; DFs across the melter for total solids were around 400 with bubbling and around 2000 without bubbling. The composition of the particles is similar to that observed in previous studies [1, 9]: high in volatile species such as boron, selenium, sulfur, and alkali, with lower concentrations of all other feed constituents. Impinger solutions were analyzed for the all of the elements in the feed but only the halides, sulfur, selenium, and boron were detected, with the exception of the Test 3 melter exhaust sample. The prescience of these elements in the gas fraction is consistent with observations from previous studies [1, 9]. The small amount of chlorine in the feed (0.01 wt. % in the target glass) and the ubiquity of chloride as a trace level contaminant in water and the raw materials used for the feed explain the occurrences of gaseous chlorine emissions exceeding the recipe feed fluxes. The impinger solution, probe rinse, and filter chemical analysis for the Test 3 melter exhaust sample were very similar indicating a filter breach. Since a distinction could not reasonably be made between the particle and gaseous species in this sample, composite values for each element are provided in Table 6.4.

DFs across the SBS for total particulate ranged from about 2 to 77 and were higher for the bubbled tests, for which the particulate flux from the melter was higher. Elemental DFs across the SBS tended to be lower for the more volatile feed constituents, which would be expected to form the majority of the finer particulate matter.

Iodine was detected in significant quantities in samples taken at all three locations. Iodine was only detected in the impinger solution downstream of the particle filter, indicating that it was exclusively gaseous. Furthermore, greater than 90% of all the iodine detected was measured in the basic impinger (0.1 N NaOH) down stream of the two acidic impingers (5% nitric acid and 10% hydrogen peroxide). Although this may not clearly indicate which gaseous form the iodine takes, it does indicate that acidic scrubbing solutions in the off-gas system will not remove significant amounts of iodine. This is corroborated by the large iodine fluxes detected in samples taken down stream of the WESP (100-200 mg/min or up to 77 % of feed iodine) and that only 11.1% of feed iodine accumulated in the SBS (Table 6.5). Iodine emissions were highly variable ranging from 17 to 95 % with no clear trend with respect to melter operating conditions or sampling location. This variability coupled with the lack of iodine detected in the glass product result in variable mass balance closure with respect to feed iodine.

6.2 Particle Size Distribution

Samples were also taken using a University of Washington cascade impactor, which separates particles into particle size ranges enabling the determination of particle size distributions. The melter, SBS, and WESP exhaust streams were sampled during each test. Data for the particle size distributions are provided in Tables 6.6 and 6.7. The chemical compositions of each particle size fraction emitted from the melter are provided in Table 6.8 and 6.9. Enough material was collected on filters from the melter and SBS exhaust to determine size distributions; however, sufficient material for chemical analysis was only collected on melter exhaust samples from Tests 2 and 3. The particulate concentration in the WESP exhaust was insufficient for accurately determining particle size distributions and therefore no results are reported here. However, the results from these initial tests were used as the basis for optimization of off-gas sample collection durations for subsequent tests, from which particle size distributions for the WESP outlet stream have been successfully determined [6].

Particle emissions from the SBS were mainly sub-micron in size, whereas melter emissions were more evenly distributed across the size spectrum. This is consistent with the design intent of the SBS, which is primarily to remove the larger particulate, leaving removal of the finer particulate to the WESP, which is much better suited to that function. The composition of the particles emitted from the melter varied with size as shown in Tables 6.8 and 6.9. Notice the increases in mass percent for Cd, Cs, K, S, and Te with decreasing particle size whereas elemental mass percentages of Al, B, Mn, Si, Sr, Zn and Zr decrease with decreasing particle size. Sodium and selenium are common in all size fractions and show some tendency towards the smaller fractions. Comparison of SBS and WESP sump analysis (Tables 4.4 and 4.5) with the chemical analysis by particle size is consistent with the expectation of smaller water-soluble particles accumulating in the WESP, whereas coarser insoluble species tend to accumulate in the SBS.

6.3 FTIR Analysis

Off-gas analysis by Fourier Transform Infra-Red (FTIR) spectroscopy was performed using an On-Line Technologies Inc. Model 2010 Multi-Gas™ Analyzer. Data were recorded at 71 s intervals, corresponding to an average of 128 scans at 0.5 cm^{-1} spectral resolution. The melter off-gas supplied to the FTIR spectrometer was extracted using a sampling and transfer loop, which removed a gas sample stream from the off-gas system at 5 liters per minute. The sampling and transfer loop was maintained at 150 °C throughout in order to prevent analyte loss due to condensation.

Melter off-gas emissions were monitored by FTIR spectroscopy during each test for a set of selected species over discrete time intervals at specified off-gas system locations. Table 6.10 displays a summary of the average analyte concentrations measured over the course of each test. Real-time concentration run data are presented in Figures 6.1-6.3 for most of the nitrogen-bearing species monitored over the three tests. As expected, NO and NO_2 were observed at the highest concentrations among the nitrogen-bearing analytes. In general throughout Tests 1 - 3, NO was detected at concentrations five to fifteen times higher than those of NO_2 and significantly higher than those of the other nitrogen-bearing analytes. The observation of increased concentrations of NO_X analytes in Tests 2 and 3 compared to Test 1, by approximately a factor of two, is consistent with the increased feed rates used in the later tests. Other than the NO_X analytes, H_2O and CO_2, the remaining analytes were detected at rather low concentrations, typically less than 1 ppm. HF, HCl, and SO_2 were observed at slightly higher concentrations in Tests 2 and 3, presumably due to the increased feed rates, at the melter outlet port but were effectively removed from the off-gas emissions by the SBS unit. Nitrogen mass balances over Tests 1 - 3 are shown in Table 6.11 and Figures 6.4-6 for the predominant NO_X species (NO and NO_2) compared to feed nitrogen. Although feed nitrogen can only account for ~ 60% of combined NO and NO_2 emissions, this observation is likely related to the low feed concentrations and the influence that low levels of contamination would therefore exert.

SECTION 7.0
SUMMARY AND CONCLUSIONS

A series of tests was successfully completed on the DM1200 HLW pilot melter system configured with an integrated prototypical off-gas treatment system. To our knowledge, these tests are the first in which a joule-heated waste glass melter has been operated with this particular sequence of off-gas treatment components. The general objectives of these tests related to the start-up and commissioning of this new system prior to its use in subsequent vitrification development testing. It is expected that the DM1200 system will be used for testing and confirmation of basic design, operability, flow sheet, and process control assumptions as well as for support of waste form qualification and permitting. This will include data on processing rates, off-gas treatment system performance, recycle stream compositions, as well as process operability and reliability. Consequently, this system is a key component of the overall HLW vitrification development strategy. Conversely, the results presented in this report are from the initial series of short-duration tests that were conducted to support the start-up and commissioning of this system prior to conducting the main body of development tests that have been planned for this system. Accordingly, these tests were directed primarily at system "debugging," operator training, and procedure refinement.

The commissioning tests were composed of four test segments, during which, a total of 10,500 kg of glass was produced:

- **Turnover** – during which the glass inventory (about 1700 kg) was turned over from the start-up frit composition to the AZ-101 glass composition. About 5000 kg of glass was produced during this period.
- **Test 1** – High-solids feed, very low bubbling (4 scfh); 120 hours, 1587 kg glass produced.
- **Test 2** – High-solids feed, with bubbling (120 scfh); 50 hours, 1948 kg glass produced.
- **Test 3** – Low-solids feed, with bubbling (120 scfh); 50 hours, 1922 kg glass produced.

All of the tests were performed with the same AZ-101 waste simulant and glass composition , a nominal glass pool temperature of 1150°C, essentially complete cold cap coverage, and a nominal plenum temperature between 400-600°C. Side-to-side electrode firing was used (the bottom electrode was not powered) and one of the two installed feed tubes was used in order to more closely reflect the number of feed tubes per unit area planned for the full-scale HLW melter. Bubbling was from the bottom electrode bubblers. The high- and low-solids melter feeds had nominal glass yields of 570 and 350 g/l, respectively. These tests evaluated a relatively wide range of feed water contents and processing rates in order to fully exercise the off-gas treatment system.

Although several system refinements were identified and implemented during these tests, such as the need for additional SBS cooling capacity to support the higher processing rate bubbled tests and the condensation of water downstream of the SBS at the higher SBS sump temperatures, the general operating characteristics of the system were in line with the system design intent. The SBS effectively quenched the off-gas stream and removed the majority of the larger particulate, while the WESP was effective in removing the remaining finer particulate. As a result, there was no indication of increased pressure drops across either the HEMEs or the HEPAs during these tests. Other system design issues, such as the degradation of the SBS packing and the amplitude of pressure fluctuations caused by the SBS, were shown to have been effectively remedied by the approaches that were identified during the prior off-line testing of the system [11]. Although not the primary intent of these tests, the processing rates were generally consistent with earlier tests that were performed on the DM1000 system [1] with the same AZ-101 simulant and glass composition.

SECTION 8.0
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Table 1.1. Test Summary for DuraMelter 1200 AZ-101 Commissioning Tests.

Test #		1	2	3
Time	Feed Start	5/7/01 10:00	5/14/01 09:29	5/21/01 08:51
	Feed End	5/12/01 13:10	5/16/01 13:39	5/23/01 13:28
	Interval	123.2 hr	52.2 hr	52.7 hr
Water Feeding for Cold Cap		3.2 hr	2.6 hr	2.5 hr
Slurry Feeding		120.0 hr	49.6 hr	50.2 hr
Cold cap burn off		10.0 hr	1.2 hr	1.6 hr
Total		133.2 hr	53.4 hr	53.2 hr
Bubbling Rate		< 8 scfh	120 scfh	120 scfh
Feed	Characteristics	Nominal	Nominal	High Water
	Used	4178 kg	4948 kg	6423 kg
	Glass yield#	570 g/l	570 g/l	350 g/l
		0.380 kg/kg	0.380 kg/kg	0.275 kg/kg
	Average Feed Rate	34.8 kg/hr	99.8 kg/hr	127.9 kg/hr
Glass Produced	Poured	1587 kg	1948 kg	1922 kg
	Average Rate$	265 $kg/m^2/day$	785 $kg/m^2/day$	766 $kg/m^2/day$
	Average Rate*	265 $kg/m^2/day$	759 $kg/m^2/day$	705 $kg/m^2/day$
	Steady State Rate*	155 $kg/m^2/day$	750 $kg/m^2/day$	700 $kg/m^2/day$
	Average Power Use	9.8 kW.hr/kg glass	3.6 kW.hr/kg glass	4.5 kW.hr/kg glass

- Target values.
$ - Rates calculates from amount of glass poured.
*- Rates calculated from amount of feed consumed and conversion ratio.
Note: Rates do not take into account the time for water feeding and cold-cap burn-off.

Table 2.1. Composition Summary of AZ-101 Waste, LAW Pretreatment Products, AZ-101 Simulant Plus Pretreatment Products, Glass Additives, and HLW98-31 Glass.

	AZ-101 Envelope D Waste	Pretreatment Products (as wt% of total AZ-101 oxides)	AZ-101 Simulant (Envelope D + Pretreatment Products)	Additives (as wt% of glass)	HLW98-31 Glass Composition
Al_2O_3	27.41%		24.27%		7.40%
As_2O_3	0.15%		0.13%		0.04%
B_2O_3				10.00%	10.00%
BaO	0.16%		0.14%		0.04%
CIO	0.91%		0.81%		0.25%
CdO	1.38%		1.22%		0.37%
CeO_2	0.31%		0.27%		0.08%
Cl	0.03%		0.02%		0.01%
Cr_2O_3	0.16%		0.14%		0.04%
Cs_2O	0.01%	0.3%	0.27%		0.08%
CuO	0.10%		0.09%		0.03%
F	0.14%		0.12%		0.04%
Fe_2O_3	38.49%		34.08%		10.39%
K_2O	0.63%		0.55%		0.17%
La_2O_3	1.20%		1.06%		0.32%
Li_2O				6.00%	6.00%
MgO	0.24%		0.21%		0.06%
MnO	7.76%	3.5%	9.94%		3.03%
Na_2O	1.46%	0.8%	1.96%	6.00%	6.59%
NiO	1.99%		1.76%		0.54%
P_2O_5	0.47%		0.42%		0.13%
PbO	0.56%		0.50%		0.15%
SO_3	0.93%		0.82%		0.25%
Sb_2O_5	0.78%		0.69%		0.21%
SeO_2	0.55%		0.49%		0.15%
SiO_2	0.08%		0.07%	45.51%	45.53%
SrO	0.16%	8.6%	7.60%		2.32%
TeO_2	0.53%		0.47%		0.14%
TiO_2	0.23%		0.21%		0.06%
ZnO				2.00%	2.00%
ZrO_2	13.19%		11.68%		3.56%
TOTAL	100%	13.16%	100%	69.61%	100%
Total Oxides (kg)	82,997	10,920	93,917	214,108	308,025
Volatiles, g/100 g oxides					
CO_3		4.96*	3.00		
NO_2			1.39		
NO_3		1.63	1.67		
TOC			1.3		

- If all Sr in pretreatment is precipitated as $SrCO_3$

Table 2.2. Composition of Melter Feed Simulant to Produce 10 Metric Tons of HLW98-31 Glass from AZ-101 Waste Plus Pretreatment Products.

AZ-101+ Pretreatment Products		Glass-Forming Additives	
Starting Materials	**Target Weight, kg**	**Starting Materials**	**Target Weight, kg**
$Al(OH)_3$	1131.6		
Na_2HAsO_4	7.5		
$Ba(OH)_2$*$8H_2O$	8.7		
$CaCO_3$	44.1		
CdO	37.2		
$Ce(OH)_4$	10.1		
Cr_2O_3*$1.5H_2O$	5.2		
CsOH (50% Solution)	17.5		
$CuSO_4$*$5H_2O$	8.8		
NaF	8.4		
$Fe(OH)_3$ Slurry	10553.5		
KNO_3	36.3		
$La(OH)_3$*$3H_2O$	48.5		
Li_2CO_3		Li_2CO_3	1484.1
$(MgCO_3)4(Mg(OH)_2$*$5H_2O)$	15.1		
MnO_2	371.5		
NaOH (50% Solution)	12.8		
		$Na_2B_4O_7$*$10H_2O$	2738.7
$Ni(NO_3)_2$*$6H_2O$			
$Ni(OH)_2$	66.7		
$FePO_4$ (80%)	33.8		
$PbCO_3$*$Pb(OH)_2$	17.3		
Na_2SO_4	39.4		
Sb_2O_5	21.1		
SeO_2	14.9		
SiO_2	2.2	SiO_2	4551.8
$Sr(NO_3)_2$	57.3		
$Sr(OH)_2$*$8H_2O$	522.2		
TeO_2	14.2		
TiO_2	6.3		
ZnO		ZnO	200.0
$ZrOOH(CO_3)_{0.5}$ (50%)	570.9		
$Zr(OH)_4$ (50%)	330.8		
KCl	1.5		
Na_2CO_3		Na_2CO_3	264.3
$NaNO_2$	63.6		
$NaNO_3$			
$C_2H_2O_4$*$2H_2O$	208.1		
H_2O	1897.6		
TOTAL	16,184.8	TOTAL	9,431.9
		FEED TOTAL	25,616.7

Table 2.3. Measured Properties of Feed Samples from DM1200 Commissioning Tests.

Sampling Date		Sample Name	Sampling Location	Feed Tank Weight (kg)	Wt. % Water	Density (g/ml)	Glass Yield (kg/kg)	Glass Yield (g/l)	pH
NOAHF9 (Target, Li_2CO_3)					51.57	1.51	0.392	592	9.95
	5/7/01	12D-F-98A	Tank	3649	53.8	1.40	0.393	550	9.9
1	5/12/01	12E-F-49A	Tank	1620	52.7	1.42	0.383	544	9.9
	5/14/01	12E-F-61A	Tank	3817	52.5	1.42	0.389	552	10.0
	5/14/01	12E-F-78A	Tank	3250	52.5	1.43	0.392	561	9.8
	5/15/01	12E-F-98A	Tank	2881	ND	1.39	0.393	534	9.9
	5/16/01	12E-F-99A	Tank	2323	52.3	1.41	0.391	551	9.9
	5/16/01	12E-F-107A	Tank	1823	52.1	1.40	0.396	554	9.9
	5/16/01	12E-F-110A	Tank	1325	52.7	1.40	0.393	550	9.8
	5/16/01	12E-F-112A	Tank	975	56.3	1.32	0.368	486	9.9
2	5/16/01	12E-F-112B	Line	975	51.6	1.45	0.395	573	9.9
	5/21/01	12E-F-130A	Tank	4014	65.6	1.28	0.287	367	9.8
	5/21/01	12E-F-130B	Line	4014	65.7	1.29	0.280	361	9.8
	5/22/01	12E-F-149B	Tank	1130	65.5	1.28	0.287	367	9.8
	5/22/01	12F-F-10A	Line	1130	65.7	1.29	0.283	365	9.8
	5/22/01	12F-F-11A	Tank	3655	67.1	1.29	0.276	356	9.8
	5/22/01	12F-F-11B	Line	3655	67.4	1.29	0.273	352	9.8
	5/22/01	12F-F-16A	Tank	1975	ND	1.26	0.257	324	9.9
	5/22/01	12F-F-16B	Line	1975	66.7	1.28	0.268	343	10.0
	5/22/01	12F-F-17A	Tank	3590	65.1	1.28	0.273	349	10.0
	5/22/01	12F-F-17B	Line	3590	67.2	1.27	0.273	347	10.0
	5/23/01	12F-F-36A	Tank	1210	67.4	1.29	0.261	337	9.8
3	5/23/01	12F-F-36B	Line	1210	66.5	1.26	0.271	345	9.9
3 *	5/24/01	12F-F-55A	Tank	700	68.4	1.27	0.255	324	9.9
	5/24/01	12F-F-56A	Line	700	68.0	1.27	0.233	296	9.9
	5/24/01	12F-F-58A	Line	178	70.6	1.24	0.220	273	9.9
	5/24/01	12F-F-58B	Tank	178	70.4	1.25	0.242	303	9.9

ND – No Data; * = Samples taken at end of Test 3 when tank level fell below mixer blades.

Table 2.4. Rheological Properties of Feed Samples from DM1200 Commissioning Tests.

Test #	Sampling Date	Sample Name	Sample Location	Feed Tank Weight (kg)	Glass Yield (g/l)	Viscosity (P)		
						@ 1/s	@ 10/s	@ 100/s
1	5/12/01	12E-F-49A	Tank	1620	383	37.8	4.1	0.62
2	5/14/01	12E-F-61A	Tank	3817	389	36.3	4.6	0.72
	5/14/01	12E-F-78A	Tank	3250	392	28.5	4.8	0.76
	5/16/01	12E-F-112B	Line	975	395	30.0	7.4	1.13
3	5/21/01	12E-F-130A	Tank	4014	287	5.23	0.59	0.12
	5/24/01	12F-F-58B	Tank	178	242	3.12	0.37	0.09

Table 2.5. Chemical Compositions of Feed Samples for DM1200 AZ-101 Tests (wt%).

Test #		1					2							
Oxide	Target	12D-F-98A			12E-F-49A		12E-F-61A		12E-F-78A		12E-F-98A		12E-F-99A	
		XRF	DCP		XRF	DCP	XRF	DCP	XRF	DCP	XRF	DCP	XRF	DCP
Al_2O_3	7.40	7.85	7.55	7.55	7.54	6.98	7.52	7.08	7.47	7.25	8.02	7.53	7.64	7.52
As_2O_3	0.04	0.04	0.04	0.01	0.03	0.02	0.04	0.03	0.04	0.03	0.04	0.05	0.04	0.01
B_2O_3	10.00	10.42	10.42	10.54	10.51	10.51	10.43	10.43	10.74	10.74	11.03	11.03	11.00	11.00
BaO	0.04	ND	0.06	0.06	ND	0.06	ND	0.06	ND	0.06	ND	0.06	ND	0.06
CaO	0.25	0.37	0.39	0.37	0.38	0.39	0.36	0.40	0.39	0.39	0.38	0.40	0.39	0.40
CdO	0.37	0.40	0.33	0.33	0.37	0.31	0.42	0.34	0.45	0.37	0.36	0.31	0.40	0.31
CeO_2	0.08	0.08	NA	NA	0.08	NA	0.09	NA	0.07	NA	0.06	NA	0.07	NA
Cl	0.01	ND	NA	NA	0.01	NA	ND	NA	ND	NA	ND	NA	ND	NA
Cr_2O_3	0.04	0.03	0.02	0.03	0.01	0.01	ND	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Cs_2O	0.08	0.08	NA	NA	0.09	NA	0.09	NA	0.09	NA	0.08	NA	0.09	NA
CuO	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.03
F	0.04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fe_2O_3	10.39	10.47	10.11	10.08	10.26	8.88	10.46	9.04	10.67	8.96	10.07	8.93	10.31	8.82
K_2O	0.17	0.30	0.25	0.23	0.25	0.21	0.23	0.20	0.25	0.20	0.25	0.21	0.23	0.19
La_2O_3	0.32	0.18	NA	NA	0.19	NA	0.18	NA	0.18	NA	0.18	NA	0.17	NA
Li_2O	6.00	5.04	5.04	5.01	4.84	4.84	4.98	4.98	5.36	5.36	5.01	5.01	5.14	5.14
MgO	0.06	NA	0.10	0.09	NA	0.10	NA	0.10	NA	0.09	NA	0.10	NA	0.10
MnO	3.03	3.20	2.86	2.89	3.23	2.84	3.22	2.78	3.29	2.78	3.08	2.80	3.13	2.82
Na_2O	6.59	7.07	6.31	6.36	7.41	6.24	7.43	6.30	6.62	6.47	7.38	6.47	7.73	6.62
NiO	0.54	0.52	0.52	0.50	0.52	0.52	0.53	0.52	0.53	0.51	0.49	0.51	0.51	0.50
P_2O_5	0.13	0.15	0.22	0.21	0.14	0.20	0.15	0.22	0.15	0.17	0.16	0.19	0.15	0.22
PbO	0.15	0.14	0.20	0.19	0.14	0.20	0.13	0.20	0.14	0.20	0.13	0.20	0.13	0.19
Sb_2O_3	0.21	0.18	0.22	0.31	0.18	0.33	0.20	0.27	0.19	0.31	0.19	0.22	0.21	0.21
SeO_2	0.15	0.03	0.03	0.02	0.04	0.03	0.05	0.03	0.06	0.03	0.04	0.04	0.03	0.05
SiO_2	45.53	45.42	41.63	42.00	46.08	41.87	45.81	42.29	45.27	41.74	45.93	41.96	45.28	41.38
SO_3	0.25	0.54	NA	NA	0.18	NA	0.18	NA	0.24	NA	0.18	NA	0.16	NA
SrO	2.32	2.16	2.06	2.22	2.12	1.98	2.14	1.96	2.22	2.00	2.00	2.04	2.08	2.06
TeO_2	0.14	0.10	0.13	0.13	0.11	0.15	0.12	0.13	0.13	0.13	0.11	0.12	0.11	0.12
TiO_2	0.06	0.07	0.10	0.09	0.07	0.10	0.06	0.10	0.07	0.10	0.07	0.10	0.07	0.10
ZnO	2.00	1.91	1.92	1.94	1.94	1.97	1.95	1.95	2.01	1.91	1.85	1.95	1.90	1.97
ZrO_2	3.56	4.13	3.92	3.92	4.10	3.80	4.07	3.67	4.21	3.71	3.80	3.79	4.01	3.84
Sum	100.00	100.90	94.47	95.06	100.82	92.54	100.87	93.12	100.92	93.56	100.92	94.03	101.02	93.69

NA: Not analyzed; ND: Not detected.

Table 2.5. Chemical Compositions of Feed Samples for DM1200 AZ-101 Tests (wt%) (continued).

Test #	2								3				
Oxide	12E-F-107A		12E-F-110A		12E-F-112A		12E-F-112B		12E-F-130A		12E-F-130B	12E-F-149B	
Method	XRF	DCP	XRF	DCP	XRF	DCP	XRF	DCP	XRF	DCP	XRF	XRF	DCP
Al_2O_3	7.64	7.55	7.89	7.33	7.91	7.57	7.57	7.50	7.83	7.66	8.23	7.85	7.60
As_2O_3	0.04	0.01	0.04	0.01	0.04	0.05	0.04	0.04	0.04	0.03	0.04	0.04	0.04
B_2O_3	10.87	10.87	10.44	10.44	10.24	10.24	11.47	11.47	10.50	10.50	9.57	10.57	10.57
BaO	ND	0.05	ND	0.06	ND	0.06	ND	0.06	ND	0.06	ND	ND	0.06
CaO	0.38	0.36	0.40	0.42	0.39	0.40	0.36	0.36	0.40	0.39	0.39	0.40	0.40
CdO	0.37	0.30	0.38	0.29	0.31	0.31	0.29	0.29	0.41	0.32	0.42	0.37	0.33
CeO_2	0.07	NA	0.07	NA	0.06	NA	0.07	NA	0.08	NA	0.07	0.07	NA
Cl	ND	NA	0.01	NA	0.01	NA	ND	NA	ND	NA	ND	0.01	NA
Cr_2O_3	0.01	0.01	ND	0.01	0.01	0.01	ND	0.01	0.03	0.03	0.03	0.03	0.03
Cs_2O	0.08	NA	0.09	NA	0.07	NA	0.06	NA	0.11	NA	0.10	0.08	NA
CuO	0.04	0.05	0.04	0.03	0.04	0.03	0.03	0.03	0.04	0.03	0.04	0.04	0.04
F	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fe_2O_3	10.75	8.76	10.74	9.30	10.97	9.70	10.15	9.09	10.43	8.68	10.36	10.27	9.14
K_2O	0.25	0.19	0.26	0.23	0.28	0.25	0.25	0.19	0.25	0.20	0.26	0.27	0.22
La_2O_3	0.19	NA	0.18	NA	0.19	NA	0.18	NA	0.18	NA	0.24	0.19	NA
Li_2O	5.09	5.09	5.10*	5.10*	5.10*	5.10*	5.49	5.49	5.10*	5.10*	5.10*	5.10*	5.10*
MgO	NA	0.09	NA	0.10	NA	0.09	NA	0.08	NA	0.10	NA	NA	0.10
MnO	3.29	2.81	3.25	2.70	3.17	2.70	3.17	2.98	3.35	2.91	3.33	3.28	2.77
Na_2O	7.06	6.52	6.98	6.28	7.43	6.46	7.39	6.96	6.74	6.27	6.63	6.95	6.35
NiO	0.54	0.49	0.54	0.54	0.54	0.54	0.50	0.50	0.55	0.51	0.55	0.55	0.52
P_2O_5	0.16	0.23	0.16	0.19	0.16	0.27	0.17	0.18	0.18	0.24	0.17	0.17	0.26
PbO	0.14	0.19	0.14	0.20	0.14	0.18	0.13	0.19	0.15	0.20	0.14	0.14	0.18
Sb_2O_3	0.18	0.23	0.20	0.34	0.16	0.19	0.15	0.19	0.20	0.26	0.20	0.17	0.20
SeO_2	0.04	0.06	0.03	0.04	0.04	0.05	0.03	0.00	0.04	0.03	0.02	0.04	0.04
SiO_2	45.08	41.80	45.98	43.49	46.40	44.64	45.32	43.47	46.35	42.23	47.35	46.29	44.45
SO_3	0.17	NA	0.20	NA	0.27	NA	0.16	NA	0.24	NA	0.18	0.24	NA
SrO	2.20	2.05	2.19	1.96	2.19	2.06	2.06	2.09	2.28	2.12	2.23	2.22	2.09
TeO_2	0.09	0.11	0.11	0.12	0.09	0.13	0.08	0.09	0.12	0.14	0.11	0.12	0.14
TiO_2	0.07	0.10	0.07	0.11	0.07	0.10	0.07	0.09	0.07	0.10	0.09	0.07	0.10
ZnO	2.01	1.94	2.01	1.95	2.01	2.01	1.88	1.85	2.03	2.03	2.01	2.00	1.96
ZrO_2	4.10	3.79	4.18	3.60	4.11	3.80	3.85	3.82	4.33	4.01	4.23	4.17	3.80
Sum	100.90	93.67	100.88	94.06	100.80	95.31	100.89	97.03	100.83	93.00	100.72	100.90	95.69

NA: Not analyzed; ND: not detected; * = Average of values obtained for same feed batch.

Table 2.5. Chemical Compositions of Feed Samples for DM1200 AZ-101 Tests (wt%) (continued).

Test #	3												
Oxide	12F-F-10A		12F-F-11A		12F-F-11B		12F-F-16A		12F-F-16B		12F-F-17A		12F-F-17B
Method	XRF	DCP	XRF	DCP	XRF	DCP	XRF	DCP	XRF	DCP	XRF	DCP	XRF
Al_2O_3	7.90	7.74	7.88	7.55	7.90	8.20	8.03	7.47	7.85	7.46	8.16	7.45	8.19
As_2O_3	0.04	0.03	0.04	0.05	0.05	0.05	0.04	0.03	0.04	0.10	0.04	0.06	0.05
B_2O_3	10.77	10.77	10.04	10.04	10.55	10.55	9.84	9.84	10.03	10.03	9.74	9.74	9.86
BaO	ND	0.06	ND	0.06	ND	0.06	ND	0.06	ND	0.06	ND	0.06	ND
CaO	0.39	0.41	0.41	0.42	0.41	0.44	0.41	0.42	0.40	0.40	0.40	0.41	0.40
CdO	0.37	0.32	0.42	0.34	0.37	0.36	0.40	0.33	0.42	0.33	0.37	0.34	0.38
CeO_2	0.08	NA	0.07	NA	0.08	NA	0.09	NA	0.08	NA	0.07	NA	0.08
Cl	ND	NA	ND	NA	ND	NA	ND	NA	0.01	NA	ND	NA	ND
Cr_2O_3	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.04	0.04
Cs_2O	0.08	NA	0.09	NA	0.07	NA	0.08	NA	0.10	NA	0.08	NA	0.08
CuO	0.04	0.03	0.04	0.04	0.04	0.03	0.04	0.04	0.08	0.04	0.04	0.03	0.04
F	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fe_2O_3	10.28	9.14	10.72	9.19	10.60	10.16	10.45	9.35	9.89	9.53	9.85	9.01	9.89
K_2O	0.26	0.22	0.27	0.23	0.28	0.24	0.27	0.22	0.25	0.20	0.26	0.22	0.27
La_2O_3	0.18	NA	0.19	NA	0.18	NA	0.18	NA	0.18	NA	0.17	NA	0.18
Li_2O	5.10*	5.10*	5.10*	5.10*	5.10*	5.10*	5.10*	5.10*	5.10*	5.10*	5.10*	5.10*	5.10*
MgO	NA	0.10	NA	0.10	NA	0.11	NA	0.10	NA	0.10	NA	0.10	NA
MnO	3.26	3.40	3.42	2.74	3.39	2.95	3.36	2.68	3.30	2.71	3.30	2.72	3.28
Na_2O	7.15	6.53	6.82	6.09	6.54	6.49	6.65	5.97	6.84	5.99	7.19	6.04	6.92
NiO	0.54	0.53	0.58	0.55	0.58	0.58	0.56	0.55	0.53	0.55	0.54	0.54	0.54
P_2O_5	0.17	0.27	0.17	0.22	0.17	0.26	0.17	0.21	0.17	0.26	0.18	0.22	0.18
PbO	0.14	0.18	0.15	0.19	0.15	0.20	0.15	0.19	0.14	0.19	0.14	0.19	0.14
Sb_2O_3	0.18	0.21	0.20	0.20	0.17	0.22	0.20	0.21	0.20	0.18	0.18	0.19	0.18
SeO_2	0.03	0.05	0.03	0.00	0.02	0.06	0.03	0.03	0.02	0.07	0.03	0.13	0.02
SiO_2	45.87	43.58	46.02	44.65	46.16	51.14	46.82	44.14	45.61	45.73	47.42	42.57	47.63
SO_3	0.16	NA	0.24	NA	0.22	NA	0.22	NA	0.20	NA	0.23	NA	0.22
SrO	2.24	2.15	2.40	2.09	2.35	2.28	2.35	2.07	2.23	2.08	2.20	2.05	2.19
TeO_2	0.09	0.10	0.13	0.10	0.11	0.13	0.11	0.10	0.12	0.08	0.12	0.14	0.12
TiO_2	0.07	0.10	0.07	0.10	0.07	0.11	0.08	0.10	0.08	0.10	0.07	0.10	0.07
ZnO	1.98	2.02	2.12	2.03	2.10	2.14	2.08	2.02	1.96	2.02	1.96	2.01	1.96
ZrO_2	4.24	3.76	4.51	3.68	4.36	3.94	4.45	3.76	4.25	3.81	4.12	3.73	4.16
Sum	100.86	96.05	100.87	94.52	100.80	104.61	100.79	93.65	99.14	96.21	100.78	91.96	100.76

NA: Not analyzed; ND: not detected; * = Average of values obtained for same feed batch.

Table 2.5. Chemical Compositions of Feed Samples for DM1200 AZ-101 Tests (wt%) (continued).

Test #	3											
Oxide	12F-F-36A		12F-F-36B		12F-F-55A		12F-F-56A	12F-F-58A		12F-F-58B		Target
Method	XRF	DCP	XRF	DCP	XRF	DCP	XRF	XRF	DCP	XRF	DCP	
Al_2O_3	7.55	7.44	7.88	7.54	8.14	8.00	8.13	8.94	8.56	8.80	8.70	7.40
As_2O_3	0.04	0.06	0.04	0.04	0.04	0.03	0.04	0.05	0.03	0.05	0.05	0.04
B_2O_3	10.33	10.33	10.26	10.26	10.27	10.27	9.97	10.79	10.79	11.72	11.72	10.00
BaO	ND	0.06	ND	0.06	ND	0.06	ND	ND	0.06	ND	0.06	0.04
CaO	0.41	0.51	0.41	0.40	0.41	0.42	0.41	0.46	0.44	0.43	0.45	0.25
CdO	0.38	0.33	0.39	0.34	0.33	0.32	0.38	0.42	0.33	0.40	0.34	0.37
CeO_2	0.09	NA	0.08	NA	0.08	NA	0.08	0.07	NA	0.06	NA	0.08
Cl	ND	NA	ND	NA	ND	NA	ND	ND	NA	0.01	NA	0.01
Cr_2O_3	0.04	0.04	0.04	0.04	0.05	0.04	0.04	0.05	0.05	0.05	0.05	0.04
Cs_2O	0.07	NA	0.08	NA	0.07	NA	0.09	0.10	NA	0.10	NA	0.08
CuO	0.04	0.04	0.04	0.04	0.04	0.05	0.04	0.06	0.04	0.04	0.04	0.03
F	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.04
Fe_2O_3	10.18	9.03	10.09	9.49	10.60	9.14	10.32	11.91	10.17	11.59	10.27	10.39
K_2O	0.25	0.20	0.25	0.23	0.28	0.22	0.26	0.28	0.23	0.28	0.32	0.17
La_2O_3	0.18	NA	0.18	NA	0.19	NA	0.19	0.20	NA	0.19	NA	0.32
Li_2O	5.10*	5.10*	5.10*	5.10*	5.10*	5.10*	5.10*	5.10*	5.10*	5.10*	5.10*	6.00
MgO	NA	0.10	NA	0.10	NA	0.10	NA	NA	0.11	NA	0.11	0.06
MnO	3.55	2.83	3.47	2.83	2.94	2.41	2.92	1.99	1.65	1.92	1.65	3.03
Na_2O	6.77	6.42	7.07	6.22	7.44	6.65	7.45	7.62	7.08	7.96	7.18	6.59
NiO	0.56	0.51	0.56	0.52	0.59	0.56	0.57	0.67	0.60	0.64	0.60	0.54
P_2O_5	0.18	0.21	0.17	0.20	0.17	0.25	0.18	0.19	0.30	0.19	0.25	0.13
PbO	0.14	0.18	0.14	0.19	0.15	0.19	0.14	0.15	0.18	0.14	0.19	0.15
Sb_2O_3	0.17	0.18	0.18	0.17	0.15	0.18	0.18	0.17	0.15	0.17	0.16	0.21
SeO_2	0.04	0.04	0.03	0.04	0.03	0.06	0.03	0.03	0.06	0.04	0.08	0.15
SiO_2	46.19	43.24	46.25	44.12	45.63	42.94	45.97	42.73	40.20	42.35	40.37	45.53
SO_3	0.19	NA	0.19	NA	0.19	NA	0.19	0.19	NA	0.24	NA	0.25
SrO	2.31	2.10	2.29	2.11	2.33	2.20	2.34	2.55	2.27	2.44	2.31	2.32
TeO_2	0.09	0.11	0.10	0.10	0.08	0.09	0.10	0.11	0.09	0.13	0.10	0.14
TiO_2	0.07	0.09	0.07	0.10	0.07	0.10	0.07	0.08	0.11	0.08	0.11	0.06
ZnO	2.08	1.97	2.02	1.97	2.11	2.05	2.05	2.30	2.17	2.20	2.19	2.00
ZrO_2	4.26	3.71	4.24	3.81	4.32	3.97	4.43	4.85	4.12	4.64	4.20	3.56
Sum	100.79	94.37	100.76	95.16	100.82	94.43	100.80	100.96	93.81	101.05	95.68	100.00

NA: Not analyzed; ND: not detected; * = Average of values obtained for same feed batch.

Table 3.1. Summary of Melter System Measured Parameters.

		Test 1			Test 2			Test 3		
		Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Glass Temperatures (°C)	1" from floor, East	1068	1155	1102	1066	1154	1136	1117	1159	1143
	13" from floor, East	1113	1180	1145	1094	1144	1126	1105	1148	1130
	18" from floor, East	1035	1167	1141	1103	1154	1135	1104	1161	1138
	27" from floor, East	648	1138	929	764	1158	1077	488	1159	1062
	9" from floor, West	1117	1184	1154	1099	1161	1143	1121	1164	1147
	18" from floor, West	1053	1182	1148	1123	1172	1150	1114	1173	1152
	24" from floor, West	926	1165	1070	1110	1183	1156	1105	1178	1157
	30" from floor, West	402	1013	697	385	1127	920	239	1137	940
Electrode	East Temperature (°C)	491	1086	1033	1009	1116	1085	1080	1106	1096
	West Temperature (°C)	1021	1068	1056	1024	1109	1087	1042	1106	1095
	Bottom Temperature (°C)	946	1111	997	982	1069	1049	997	1067	1053
	Voltage (V)	0	126	87	75	138	111	95	131	118
	Current (A)	0	1323	890	759	1496	1204	1064	1492	1333
	Power (kW)	0	130	78	100	181	135	120	186	159
Plenum Temperatures (°C)	8" below ceiling	359	796	451	358	576	478	399	651	479
	17" below ceiling	316	755	411	373	549	441	346	584	448
	Exposed TC	NM	NM	NM	319	637	492	367	628	474
Discharge System Temperatures (°C)	Chamber - TC 1	824	1059	929	821	1038	951	997	1078	1031
	Chamber - TC 2	806	998	915	864	988	922	949	1035	976
	Exhaust Flow Air	115	380	307	226	377	307	143	378	323
Film Cooler	Dilution Air (°C)	101	253	118	109	302	134	110	251	152
	Outlet Air (°C)	151	459	246	235	410	299	192	436	302
	Differential Pressure (" water)	-0.2	2.9	0.9	0.8	4.1	1.3	-0.2	3.8	1.4
Bypass Line HEPA (°C)		35	71	38	31	43	41	33	74	41
Absolute Melter Pressure (" water)		-9.1	1.2	-5.3	-9.5	10.1	-2.5	-8.8	0.9	-4.7
Absolute Melter Pressure (" water)		-8.9	2.9	-4.7	-9.6	1.8	-4.5	-7.0	4.0	-4.0
Transition Line Differential Pressure (" water)		-0.3	2.3	0.5	0.4	3.7	0.9	-0.3	3.1	1.1
Feed Tank Mass (kg)		957	3575	2278	968	3816	2145	1093	3944	2477

Table 4.1. Summary of Electronically Recorded Off-Gas System Parameters.

Parameter		Test 1			Test 2			Test 3		
		Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Submerged Bed Scrubber (SBS)	Differential Pressure (in W.C.)	1.1	55.6	50.1	43.8	57.6	50.2	2.7	57.5	50.5
	Inlet gas Pressure (in W.C.)	-12.1	1.3	-6.4	-12.9	-0.9	-6.8	-10.5	1.2	-6.4
	Outlet gas Pressure (in W.C.)	-67.8	-0.2	-56.9	-65.5	-51.0	-57.6	-63.3	-3.8	-58.1
	Inlet gas Temp. (°C)	143.1	533.3	223.6	209.2	324.5	62.0	171.9	518.1	291.7
	Outlet gas Temp. (°C)	16.9	53.4	21.6	24.7	33.6	28.3	22.9	55.0	34.7
	Chilled Water Inlet Temp (°C)	8.1	21.5	12.6	9.9	33.2	13.8	10.6	18.8	14.9
	Chilled Water Outlet Temp (°C)	9.8	25.6	13.7	11.8	33.1	15.9	13.5	24.4	17.9
	48" Depth Temp. (°C)	15.6	55.2	20.8	24.1	34.7	27.9	23.2	57.0	34.8
	60" Depth Temp. (°C)	15.6	54.6	20.7	24.1	34.7	27.8	22.5	57.0	34.7
	72" Depth Temp. (°C)	16.3	54.6	21.5	24.4	35.3	28.6	23.2	57.0	35.3
	78" Depth Temp. (°C)	15.6	54.6	20.9	24.1	34.7	27.9	22.5	57.0	34.9
	Heat Exch. Outlet Temp. (°C)	13.5	38.2	16.9	17.2	33.1	22.2	17.1	38.8	25.7
	Chilled Water Flow (gal/min)	14.5	42.2	40.7	26.6	42.4	40.6	28.2	42.1	40.5
	Heat Exchanger Flow (gal/min)	38.3	54.3	46.9	38.3	54.3	45.2	10.2	54.2	44.9
WESP	Differential Pressure (in W.C.)	-0.0	2.9	1.6	0.9	3.2	1.8	-0.0	3.8	1.6
	Inlet gas Temp. (°C)	21.7	53.4	25.6	27.5	32.9	30.0	26.2	55.3	35.0
	Outlet gas Temp. (°C)	29.7	53.4	32.7	31.0	38.3	36.1	33.4	54.1	39.8
HEPA#1	Differential Pressure (in W.C.)	-0.1	0.3	0.2	0.2	0.3	0.2	0.0	0.3	0.2
	Outlet gas Temp. (°C)	115.6	124.5	122.6	31.7	123.8	116.3	108.3	124.0	122.6
PBS	Inlet gas Temp. (°C)	69.6	84.2	78.5	31.0	85.1	77.5	63.6	87.9	79.9
TCO	Outlet gas Temp. (°C)	68.2	77.5	73.4	32.0	78.7	73.1	23.4	79.4	72.7

Table 4.2. WESP Current-Voltage Relationships Under Various Conditions.

V, [kV]	F_t= 0 scfm W_v= 1.56 %v/v t= 28.5 °C P_a= 29.46 AHg	F_t= 0 scfm W_v= 1.46 %v/v t= 27.5 °C P_a= 29.62 AHg	F_t= 182.9 scfm W_v= 3.142 %v/v t= 23.0 °C P_a= 26.41 Ahg	F_t= 176.2 scfm W_v= 3.396 %v/v t= 23.9 °C P_a= 27.49 AHg	F_t= 174.4 scfm W_v= 4.025 %v/v t= 26.5 °C P_a= 25.40 AHg	F_t= 173.7 scfm W_v= 6.535 %v/v t= 35.2 °C P_a= 25.70 AHg	F_t= 177.2 scfm W_v= 23.05 %v/v t= 60.9 °C P_a= 26.61 AHg
	$I^{(1)}$, [mA]	$I^{(1)}$, [mA]	$I^{(2)}$, [mA]	$I^{(2)}$, [mA]	$I^{(3)}$, [mA]	$I^{(3)}$, [mA]	$I^{(3)}$, [mA]
0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
2.50	0.01	0.00	0.00	0.00	0.00	0.01	0.02
5.00	0.04	0.00	0.00	0.00	0.00	0.03	0.06
7.50	0.05	0.01	0.00	0.00	0.00	0.04	0.08
10.00	0.08	0.02	0.02	0.03	0.02	0.11	0.18
12.00	0.30	0.20	0.24	0.17	0.26	0.55	0.61
14.00	0.98	0.90	0.95	1.00	1.10	1.58	1.47
16.00	2.13	2.15	2.69	2.82	2.95	3.09	2.62
18.00	3.78	3.95	5.00	5.26	5.33	5.05	4.05
20.00	5.92	6.16	7.82	8.20	8.22	7.73	5.96
21.00	7.13	7.40	9.40	9.82	9.83	9.05	7.10
22.00	8.41	8.78	11.09	11.55	11.64	10.57	8.34
23.00	9.78	10.18	12.90	13.43	13.45	12.31	9.70
24.00	11.22	11.70	14.81	15.46	15.45	14.19	11.13
25.00	12.76	13.32	16.88	17.55	17.56	16.20	12.75
26.00	14.39	15.03	19.04	19.02	19.76	18.25	14.35
27.00	16.12	16.85					16.13
28.00	17.97	17.75					17.88
29.00	19.95						
30.00							
Cut-off @ 20.00 mA, [kV]	29.02	28.61	26.44	26.04	26.13	6.81	28.55

(1) - No flow; Stagnant air at ~ 40% R_H.
(2) - Melter plenum air passed through SBS; No feed.
(3) - Water fed to the melter at 2.0 lpm.

F_t – Total flow through WESP.
W_v – Moisture content.
P_a – Gas pressure (absolute) at flow conditions.
t – Gas temperature at flow conditions.

Table 4.3. Characteristics of SBS Samples from DM1200 Commissioning Tests.

Test #	Sample Name -S- = SBS	TSS (mg/l)	TDS (mg/l)	Filtrate pH	Glass (kg)	Blowdown Volume (gal)	Cumulative Blowdown Volume (gal)
TO	12D-S-109A	320	NA	2.75	5092	12	12
	12D-S-113A	494	2158	2.73	5092	42.6	54.6
	12D-S-114A	420	2156	2.75	5092	24.3	78.9
1	12D-S-115A	500	1980	2.93	5150	3.4	82.3
	12D-S-115B	456	2220	2.90	5175	44.9	127.2
	12D-S-116A	480	2090	2.90	5200	28.8	156
	12D-S-121A	382	2020	2.93	5450	39	195
	12D-S-121B	423	1738	3.04	5500	37.7	232.7
	12D-S-128A	413	1705	3.09	5670	31.6	264.3
	12D-S-129A	363	1208	3.08	5720	14.3	278.6
	12D-S-129B	360	1573	3.04	5770	34.4	313
	12D-S-132A	317	1603	2.95	5870	35	348
	12D-S-137A	312	1250	2.90	6050	31.1	379.1
	12D-S-140A	290	1212	2.87	6153	41.4	420.5
	12D-S-142A	265	1214	2.84	6153	15.7	436.2
	12D-S-151A	290	1206	2.88	6250	29.7	465.9
	12E-S-17A	234	1476	2.87	6300	25.7	491.6
	12E-S-24A	214	1290	2.81	6400	32	523.6
	12E-S-38A	192	1112	2.91	6550	43.6	567.2
	12E-S-49A	270	1216	2.93	6679	55	622.2
	12E-S-69A	301	1148	3.00	6679	33.1	655.3
	12E-S-76A	223	1074	2.97	6720	46.6	701.9
	12E-S-77A	233	838	2.85	6800	31	732.9
	12E-S-78A	312	1296	2.95	7000	21	753.9
	12E-S-80A	323	1326	2.92	7050	28.5	782.4
2	12E-S-81A	340	1406	2.88	7211	35	817.4
	12E-S-86A	405	1542	2.94	7250	36.7	854.1
	12E-S-88A	450	1614	2.98	7300	40.6	894.7
	12E-S-90A	453	1656	2.88	7500	65.4	960.1
	12E-S-95A	458	1766	2.87	7733	48.3	1008.4
	12E-S-97A	499	1905	2.89	7800	26	1034.4
	12E-S-98A	488	1888	2.87	7850	31.7	1066.1

Table 4.3. Characteristics of SBS Samples from DM1200 Commissioning Tests (continued).

Test #	Sample Name -S- = SBS	TSS (mg/l)	TDS (mg/l)	Filtrate pH	Glass (kg)	Blowdown Volume (gal)	Cumulative Blowdown Volume (gal)
2	12E-S-98B	470	1896	2.83	7900	18	1084.1
	12E-S-99A	482	812	2.86	7950	32.3	1116.4
	12E-S-105A	498	1556	2.86	8200	35.5	1151.9
	12E-S-105B	497	1676	2.82	8250	32.4	1184.3
	12E-S-109A	518	1786	2.86	8400	23.3	1207.6
	12E-S-109B	512	1572	2.83	8500	32.4	1240
	12E-S-110A	507	1380	2.84	8550	30	1270
	12E-S-118A	690	2270	2.59	8650	27	1297
	12E-S-130A	402	2062	2.74	8650	60	1357
	12E-S-130C	370	1484	2.77	8650	18.1	1375.1
	12E-S-137A	346	1560	2.79	8700	18.7	1393.8
	12E-S-137B	350	1416	2.82	8700	29.2	1423
3	12E-S-137C	365	1292	2.90	8700	25	1448
	12E-S-138A	412	1340	3.01	8750	27.2	1475.2
	12E-S-138B	390	1480	3.09	8750	34.9	1510.1
	12E-S-139A	512	1536	3.17	8800	27.6	1537.7
	12E-S-141A	518	1616	3.37	8850	37.4	1575.1
	12E-S-141B	555	1596	3.67	8900	30.2	1605.3
	12E-S-142A	547	1700	3.71	8950	30.1	1635.4
	12E-S-142B	555	1400	3.58	9000	47.9	1683.3
	12E-S-147A	558	1404	3.54	9200	34	1717.3
	12E-S-147B	579	1428	3.61	9250	53	1770.3
	12E-S-147C	577	1512	3.60	9300	35	1805.3
	12E-S-149A	580	1636	3.53	9350	31.9	1837.2
	12F-S-10A	503	1532	3.42	9400	31.7	1868.9
	12F-S-11A	512	1512	3.53	9500	35.1	1904
	12F-S-13A	500	1572	3.58	9636	18.2	1922.2
	12F-S-14A	453	1528	3.34	9650	30	1952.2
	12F-S-14B	505	1520	3.31	9700	29.3	1981.5
	12F-S-16A	528	1452	3.46	9750	34.7	2016.2

Table 4.3. Characteristics of SBS Samples from DM1200 Commissioning Tests (continued).

Test #	Sample Name -S- = SBS	TSS (mg/l)	TDS (mg/l)	Filtrate pH	Glass (kg)	Blowdown Volume (gal)	Cumulative Blowdown Volume (gal)
3	12F-S-17A	568	1412	3.47	9800	10.9	2027.1
	12F-S-20A	585	1600	3.77	9850	38.6	2065.7
	12F-S-20B	649	1448	3.99	9900	41.8	2107.5
	12F-S-25A	590	1508	3.75	10000	45.7	2153.2
	12F-S-25B	555	1452	3.64	10050	45.2	2198.4
	12F-S-27A	582	1584	3.68	10150	42.6	2241
	12F-S-28A	560	-	3.84	10200	28.6	2269.6
	12F-S-33A	592	1576	3.83	10300	21	2290.6
	12F-S-33B	573	1640	3.83	10350	20	2310.6
	12F-S-34A	590	1528	3.79	10450	37.4	2348
	12F-S-36A	570	1580	3.60	10549	30.2	2378.2

Table 4.4. Analytical Results for Samples of SBS Blowdown Fluids (mg/l).

	12D-S-109A			12D-S-113A			12D-S-114A			12D-S-115A			12D-S-115B		
Glass (kg)	5092			5092			5092			5150			5175		
pH	2.75			2.73			2.75			2.93			2.90		
	Sus.*	Dis.#	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total
Total	320	NA	320	494	2158	2652	420	2156	2576	500	1980	2480	456	2220	2676
Al	7.3	52.3	59.6	2.4	52.3	54.7	7.3	50.8	58.0	14.4	51.2	65.6	5.4	50.7	56.1
As	0.3	0.9	1.2	0.1	1.1	1.2	0.1	1.1	1.2	0.2	1.1	1.3	0.3	1.1	1.4
B	1.9	217.8	219.7	0.8	214.5	215.4	1.1	211.8	212.9	1.7	215.5	217.2	1.3	215.1	216.4
Ba	0.4	0.3	0.6	0.1	0.2	0.3	0.5	0.2	0.7	0.5	0.2	0.8	0.6	0.2	0.8
Ca	<0.1	8.4	8.4	<0.1	8.9	8.9	2.0	8.8	10.8	2.6	9.0	11.6	2.2	9.0	11.2
Cd	0.7	7.6	8.4	0.3	7.3	7.6	1.1	6.9	7.9	1.4	7.0	8.4	1.5	6.8	8.2
Cr	0.9	0.4	1.4	0.4	0.5	0.8	1.3	0.4	1.7	1.5	0.4	1.8	1.5	0.4	1.9
Cs	<0.1	7.1	7.1	<0.1	6.9	6.9	0.2	6.5	6.7	0.4	6.1	6.5	0.4	6.6	7.0
Cu	0.1	0.4	0.5	0.0	0.3	0.4	0.1	0.3	0.4	0.1	0.4	0.5	0.1	0.4	0.5
Fe	62.5	1.5	64.0	25.7	2.3	27.9	88.7	1.6	90.3	112.4	0.8	113.1	61.2	0.9	62.1
K	0.0	11.0	11.0	<0.1	10.0	10.0	0.2	16.4	16.6	0.2	9.8	10.0	0.2	9.9	10.2
Li	0.5	32.4	32.9	0.2	30.6	30.8	0.7	28.4	29.1	1.1	28.6	29.7	1.1	28.2	29.3
Mg	2.1	1.7	3.7	0.9	1.9	2.8	0.7	2.0	2.6	0.1	2.0	2.1	<0.1	2.0	2.0
Mn	2.0	6.9	8.9	0.8	6.3	7.1	2.3	6.3	8.5	3.8	6.5	10.4	3.7	6.3	10.1
Na	0.8	128.2	129.0	0.3	118.9	119.2	1.3	115.9	117.2	2.4	118.8	121.2	2.3	116.2	118.5
Ni	3.2	1.3	4.6	1.3	1.3	2.6	4.0	1.3	5.3	5.4	1.3	6.7	5.8	1.3	7.1
P	0.6	0.9	1.5	0.1	0.9	1.0	0.5	0.9	1.4	0.7	0.9	1.6	0.6	1.0	1.6
Pb	1.4	0.6	2.0	0.6	0.6	1.1	2.1	0.5	2.6	2.6	0.5	3.1	2.6	0.5	3.2
Sb	0.5	0.3	0.7	0.1	0.3	0.3	0.7	0.3	1.0	0.7	0.3	1.1	0.7	0.4	1.1
Se	20.3	378.7	399.0	7.7	417.9	425.6	26.9	393.3	420.2	37.8	375.8	413.6	37.6	355.2	392.8
Si	29.6	23.6	53.2	19.9	22.7	42.6	48.6	22.8	71.5	24.0	26.1	50.0	<0.1	25.6	25.6
Sr	1.1	37.9	39.0	0.5	35.8	36.3	2.2	33.2	35.4	2.9	34.0	36.9	3.1	33.8	36.9
Te	10.9	5.6	16.5	4.2	7.6	11.8	15.6	6.8	22.5	19.1	4.6	23.7	20.2	4.8	25.0
Ti	0.4	0.0	0.4	0.2	0.0	0.2	0.6	<0.1	0.6	0.7	<0.1	0.7	0.8	<0.1	0.8
Zn	2.2	31.4	33.6	0.9	31.5	32.5	3.2	30.1	33.3	4.2	31.9	36.0	4.5	31.7	36.2
Zr	4.5	1.9	6.3	1.9	2.1	4.0	5.1	2.1	7.2	9.5	1.6	11.1	8.4	1.7	10.1
Cl	NA	133.4	133.4	NA	152.8	152.8	NA	144.5	144.5	NA	132.1	132.1	NA	125.8	125.8
F	NA	90.1	90.1	NA	97.9	97.9	NA	96.6	96.6	NA	96.6	96.6	NA	92.7	92.7
I	<0.1	1.1	<0.1	<0.1	1.4	1.4	<0.1	1.2	1.2	<0.1	26.8	26.8	<0.1	29.8	29.8
Nitrate	NA	244.7	244.7	NA	225.9	225.9	NA	213.8	213.8	NA	216.0	216.0	NA	204.9	204.9
Nitrite	NA	<0.1	<0.1	NA	NA	NA	NA	<0.1	NA	NA	<0.1	NA	NA	<0.1	NA
Sulfate	<0.1	116.5	116.5	<0.1	126.9	126.9	1.9	117.4	119.3	1.9	112.2	114.1	2.0	111.3	113.3

S* - Suspended
D# - Dissolved

Table 4.4. Analytical Results for Samples of SBS Blowdown Fluids (mg/l). (continued).

	12D-S-116A			12D-S-121A			12D-S-121B			12D-S-128A		
Glass (kg)	5200			5450			5500			5670		
pH	2.90			2.93			3.04			3.09		
	Sus.*	Dis.#	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total
Total	480	2090	2570	382	2020	2402	423	1738	2161	413	1705	2118
Al	14.6	50.6	65.2	2.0	46.26	48.2	9.5	47.3	56.7	8.8	46.2	55.0
As	0.2	1.1	1.3	0.2	1.15	1.3	0.3	0.9	1.2	0.3	1.0	1.3
B	1.0	204.4	205.4	0.8	194.81	195.6	0.7	192.8	193.5	0.7	193.0	193.6
Ba	0.5	0.2	0.7	0.4	0.19	0.6	0.3	0.2	0.5	0.3	0.2	0.5
Ca	3.2	8.2	11.4	2.8	8.59	11.4	0.2	8.2	8.4	0.2	7.8	8.0
Cd	1.2	6.4	7.5	1.0	5.54	6.5	1.0	5.5	6.5	0.9	5.3	6.3
Cr	1.2	0.4	1.6	1.1	0.39	1.5	0.9	0.4	1.3	0.8	0.4	1.2
Cs	0.4	6.1	6.5	0.3		0.3	0.6	5.6	6.2	<0.1	6.2	6.2
Cu	0.1	0.3	0.4	0.1	0.32	0.4	0.1	0.3	0.4	0.1	0.3	0.4
Fe	103.9	0.9	104.8	81.6	0.95	82.5	89.0	0.5	89.5	86.9	0.5	87.4
K	0.3	9.7	10.0	0.2	10.2	10.4	0.2	8.8	9.0	0.1	9.9	10.0
Li	0.9	27.4	28.3	0.8	27.69	28.5	0.5	27.7	28.2	0.5	27.5	27.9
Mg	2.1	1.9	4.0	<0.1	1.69	1.7	0.1	1.6	1.7	0.1	1.5	1.6
Mn	3.2	6.0	9.2	2.4	5.75	8.1	2.4	5.9	8.3	2.2	5.7	8.0
Na	1.7	109.9	111.6	1.4	100.36	101.8	0.9	100.6	101.5	0.8	101.8	102.6
Ni	4.6	1.3	5.9	3.8	1.23	5.1	4.1	1.2	5.4	4.0	1.2	5.2
P	0.6	0.9	1.6	0.4	0.82	1.3	0.5	0.7	1.2	0.5	0.8	1.2
Pb	2.1	0.5	2.6	1.8	0.42	2.2	1.8	0.4	2.2	1.7	0.4	2.1
Sb	0.7	0.4	1.0	0.7	0.23	0.9	1.0	0.2	1.2	1.0	0.2	1.2
Se	29.3	348.9	378.2	25.2	324.52	349.7	26.4	298.3	324.7	24.4	297.7	322.1
Si	43.3	26.7	70.0	43.1	22.36	65.4	67.8	21.1	89.0	64.4	19.7	84.1
Sr	2.4	32.7	35.1	1.9	31.14	33.0	1.3	31.2	32.5	1.2	30.6	31.8
Te	15.7	4.7	20.4	13.4	4.23	17.6	14.0	3.4	17.3	13.2	3.4	16.6
Ti	0.7	<0.1	0.7	0.5	0.03	0.6	0.4	<0.1	0.4	0.4	<0.1	0.4
Zn	3.5	30.8	34.3	2.9	27.64	30.6	3.0	26.7	29.6	2.7	26.3	29.0
Zr	6.5	1.8	8.4	4.6	1.66	6.3	6.5	1.3	7.8	6.2	1.3	7.5
Cl	NA	132.1	132.1	NA	90.8	90.8	NA	86.6	86.6	NA	86.63	86.6
F	NA	89.4	89.4	NA	89.7	89.7	NA	86.7	86.7	NA	86.07	86.1
I	<0.1	27.8	27.8	<0.1	18.4	18.4	<0.1	23.1	23.1	<0.1	23.8	23.8
Nitrate	NA	244.7	244.7	NA	210.2	210.2	NA	205.7	205.7	NA	212.42	212.4
Nitrite	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1
Sulfate	0.9	117.4	118.3	1.6	310.4	312.1	2.1	285.8	287.9	2.6	287	289.6

S* - Suspended
D# - Dissolved

Table 4.4. Analytical Results for Samples of SBS Blowdown Fluids (mg/l). (continued).

	12D-S-129A			12D-S-129B			12D-S-132A			12D-S-137A			12D-S-140A		
Glass (kg)	5720			5770			5870			6050			6153		
pH	3.08			3.04			2.95			2.90			2.87		
	Sus.*	Dis.#	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total
Total	363	1208	1571	360	1573	1933	317	1603	1920	312	1250	1562	290	1212	1502
Al	7.4	43.9	51.3	7.0	43.4	50.4	5.7	41.1	46.7	5.0	40.4	45.4	4.6	37.3	41.9
As	0.3	1.0	1.3	0.3	1.0	1.4	0.3	0.8	1.1	0.2	0.9	1.1	0.3	0.8	1.0
B	0.6	189.3	189.8	0.6	193.0	193.6	0.5	182.7	183.1	0.5	173.8	174.3	0.4	168.5	168.9
Ba	0.3	0.2	0.5	0.3	0.2	0.5	0.2	0.2	0.4	0.2	0.2	0.4	0.2	0.2	0.4
Ca	0.1	7.6	7.7	0.2	7.4	7.5	0.1	7.0	7.1	0.1	6.6	6.7	0.1	6.1	6.2
Cd	0.9	5.3	6.2	0.8	5.2	6.0	0.7	4.9	5.6	0.7	5.0	5.6	0.6	4.7	5.4
Cr	0.8	0.4	1.1	0.8	0.4	1.1	0.7	0.4	1.1	0.7	0.4	1.0	0.6	0.4	1.0
Cs	<0.1	6.3	6.3	0.5	5.8	6.3	<0.1	5.5	5.5	<0.1	5.2	5.2	<0.1	4.8	4.8
Cu	0.1	0.3	0.4	0.1	0.3	0.4	0.1	0.3	0.3	0.1	0.3	0.3	0.1	0.3	0.3
Fe	81.8	0.6	82.4	80.3	0.7	81.0	72.4	1.2	73.6	69.0	1.2	70.2	65.1	1.4	66.5
K	0.1	9.7	9.8	0.1	9.1	9.2	0.1	8.5	8.6	0.1	7.9	8.0	0.1	7.3	7.4
Li	0.4	26.9	27.3	0.4	25.1	25.5	0.4	23.1	23.5	0.3	22.5	22.8	0.3	20.4	20.7
Mg	0.1	1.5	1.6	0.1	1.4	1.5	0.1	1.4	1.5	0.1	1.3	1.4	0.1	1.2	1.3
Mn	1.9	5.5	7.4	1.8	5.3	7.1	1.6	5.1	6.7	1.7	5.0	6.7	1.7	4.8	6.5
Na	0.7	98.6	99.3	0.7	95.0	95.7	0.6	88.6	89.2	0.5	82.8	83.3	0.5	78.2	78.7
Ni	3.6	1.2	4.8	3.6	1.1	4.8	3.2	1.1	4.3	3.2	1.1	4.2	3.0	1.0	4.0
P	0.5	0.8	1.3	0.4	0.8	1.2	0.4	0.7	1.1	0.5	0.8	1.3	0.4	0.6	1.0
Pb	1.6	0.4	1.9	1.5	0.4	1.9	1.4	0.4	1.8	1.3	0.3	1.7	1.3	0.3	1.6
Sb	0.9	0.2	1.1	0.8	0.1	0.9	0.8	0.3	1.1	0.6	0.3	0.8	0.7	0.3	0.9
Se	22.8	293.4	316.2	23.4	285.2	308.6	19.4	270.7	290.2	19.0	274.4	293.4	18.1	249.7	267.7
Si	58.5	19.7	78.2	57.4	18.9	76.3	48.9	18.1	67.0	52.2	17.4	69.6	46.5	16.5	63.0
Sr	1.1	29.3	30.3	1.0	28.3	29.3	0.9	26.2	27.0	0.8	25.3	26.1	0.7	23.2	23.8
Te	12.5	3.2	15.7	12.0	3.5	15.5	11.1	4.1	15.3	11.0	4.0	15.0	10.2	4.1	14.3
Ti	0.4	<0.1	0.4	0.4	<0.1	0.4	0.3	<0.1	0.3	0.3	<0.1	0.3	0.3	<0.1	0.3
Zn	2.5	25.5	28.0	2.5	24.3	26.7	2.1	22.8	24.9	2.1	21.7	23.9	2.0	20.7	22.7
Zr	4.8	1.5	6.2	4.3	1.6	6.0	3.7	2.0	5.7	3.8	2.1	5.8	3.5	2.2	5.6
Cl	NA	84.6	84.6	NA	82.4	82.4	NA	80.4	80.4	NA	89.8	89.8	NA	75.7	75.7
F	NA	80.5	80.5	NA	80.0	80.0	NA	82.8	82.8	NA	94.0	94.0	NA	76.5	76.5
I	<0.1	23.5	23.5	<0.1	26.5	26.5	<0.1	27.2	27.2	<0.1	17.8	17.8	<0.1	17.0	17.0
Nitrate	NA	207.9	207.9	NA	198.68	198.7	NA	196.61	196.6	NA	213.55	213.6	NA	179.16	179.2
Nitrite	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1
Sulfate	1.6	277.13	278.7	1.8	268.53	270.3	1	263.57	264.6	2.4	283.3	285.7	1.2	236.09	237.3

S* - Suspended
D# - Dissolved

Table 4.4. Analytical Results for Samples of SBS Blowdown Fluids (mg/l). (continued).

	12D-S-142A			12D-S-151A			12E-S-17A			12E-S-24A			12E-S-38A		
Glass (kg)	6153			6250			6300			6400			6550		
pH	2.84			2.88			2.87			2.81			2.91		
	Sus.*	Dis.#	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total
Total	265	1214	1479	290	1206	1496	234	1476	1710	214	1290	1504	192	1112	1304
Al	4.3	36.7	41.0	4.5	35.8	40.3	7.7	33.83	41.6	5.5	32.82	38.4	2.9	32.8	35.7
As	0.2	0.8	1.0	0.2	0.8	1.0	0.1	1.06	1.2	0.1	0.88	0.9	0.1	0.8	0.9
B	0.4	167.1	167.5	0.4	158.6	159.0	0.5	155.97	156.5	0.3	153.92	154.2	0.3	157.2	157.5
Ba	0.2	0.2	0.4	0.2	0.2	0.4	0.3	0.25	0.5	0.2	0.25	0.5	0.1	0.3	0.4
Ca	0.1	5.9	6.0	0.1	5.7	5.8	2.3	5.56	7.8	3.5	5.48	9.0	0.1	5.3	5.4
Cd	0.6	4.7	5.2	0.6	4.3	4.9	0.7	4.13	4.9	0.6	3.91	4.5	0.4	3.9	4.3
Cr	0.6	0.4	1.0	0.6	0.4	1.0	0.8	0.35	1.2	0.7	0.34	1.0	0.4	0.3	0.7
Cs	<0.1	4.6	4.6	<0.1	4.3	4.3	<0.1	4.2	4.2	<0.1	4.1	4.1	0.3	3.9	4.2
Cu	0.1	0.2	0.3	0.1	0.2	0.3	0.1	0.23	0.3	0.1	0.22	0.3	<0.1	0.2	0.2
Fe	63.2	1.4	64.6	62.7	1.3	64.0	76.3	1.55	77.9	60.7	1.77	62.5	46.4	1.4	47.8
K	0.1	7.0	7.1	0.1	6.6	6.7	<0.1	6.19	6.2	<0.1	11.26	11.3	0.1	5.6	5.7
Li	0.3	19.7	20.0	0.3	18.1	18.4	0.5	18.12	18.7	0.5	17.14	17.6	0.2	17.3	17.5
Mg	0.1	1.1	1.2	0.1	1.1	1.2	2.4	1.03	3.4	2.0	1	3.0	0.1	1.0	1.0
Mn	1.5	4.7	6.2	1.9	4.7	6.6	1.9	4.73	6.7	1.6	4.77	6.4	0.8	4.9	5.8
Na	0.5	76.8	77.2	0.5	71.5	72.0	0.8	69.42	70.3	0.7	67.46	68.2	0.3	69.2	69.5
Ni	2.9	1.0	3.9	3.0	1.0	3.9	3.8	0.94	4.7	3.1	0.93	4.0	2.2	0.9	3.1
P	0.3	0.6	0.9	0.4	0.7	1.1	0.5	0.53	1.0	0.3	0.6	0.9	0.2	0.6	0.8
Pb	1.2	0.3	1.5	1.2	0.3	1.5	1.6	0.34	2.0	1.3	0.32	1.6	0.9	0.3	1.2
Sb	0.5	0.2	0.6	0.5	0.2	0.6	0.3	0.14	0.5	0.1	0.16	0.3	0.4	0.2	0.6
Se	15.3	255.0	270.2	17.1	268.2	285.3	19.2	267.09	286.3	15.3	244.16	259.4	11.5	253.9	265.4
Si	43.4	15.9	59.3	49.5	15.1	64.6	9.2	14.57	23.8	16.4	14.17	30.6	28.6	13.5	42.1
Sr	0.7	22.9	23.5	0.6	22.4	23.0	1.2	22.18	23.3	0.9	20.97	21.9	0.4	21.0	21.4
Te	9.5	3.9	13.4	9.4	3.4	12.8	10.6	3.78	14.4	8.1	3.91	12.0	5.7	3.1	8.7
Ti	0.3	<0.1	0.3	0.3	<0.1	0.3	0.6	<0.1	0.6	0.5	<0.1	0.5	0.3	<0.1	0.3
Zn	1.8	20.1	22.0	1.9	19.4	21.2	2.3	19.22	21.5	1.8	18.8	20.6	1.3	18.8	20.1
Zr	2.9	2.2	5.1	3.6	2.3	5.9	3.8	2.04	5.8	3.1	2.08	5.2	1.9	2.1	4.0
Cl	NA	73.7	73.7	NA	70.2	70.2	NA	89.4	89.4	NA	95.5	95.5	NA	87.3	87.3
F	NA	74.1	74.1	NA	73.1	73.1	NA	74.7	74.7	NA	73.4	73.4	NA	71.7	71.7
I	<0.1	10.1	10.1	<0.1	11.7	11.7	<0.1	9.2	9.2	<0.1	11.2	11.2	<0.1	9.2	9.2
Nitrate	NA	179.16	179.2	NA	181.71	181.7	NA	178.9	178.9	NA	180.6	180.6	NA	182.24	182.2
Nitrite	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	0.0	NA	<0.1	<0.1
Sulfate	0.3	225.89	226.2	<0.1	214.77	214.8	<0.1	213.4	213.4	1.4	201.3	202.7	0.4	187.29	187.7

S* - Suspended
D# - Dissolved

Table 4.4. Analytical Results for Samples of SBS Blowdown Fluids (mg/l). (continued).

	12E-S-49A			12E-S-69A			12E-S-76A			12E-S-77A			12E-S-78A		
Glass (kg)	6679			6679			6720			6800			7000		
pH	2.93			3.00			2.97			2.85			2.95		
	Sus.*	Dis.#	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total
Total	270	1216	1486	301	1148	1449	223	1074	1297	233	838	1071	312	1296	1608
Al	6.9	32.9	39.8	6.1	34.0	40.0	3.9	31.0	34.9	4.5	31.3	35.8	7.4	33.7	41.1
As	0.2	0.79	1.0	0.1	0.7	0.8	0.2	0.7	0.8	0.2	0.8	1.0	0.2	0.9	1.0
B	0.0	144.9	144.9	0.5	151.2	151.7	0.3	142.9	143.2	0.4	144.1	144.5	0.4	153.1	153.6
Ba	0.3	0.27	0.5	0.1	0.3	0.4	0.1	0.3	0.4	0.1	0.3	0.4	0.1	0.3	0.4
Ca	4.8	5.47	10.3	0.2	6.7	6.9	0.1	5.4	5.6	0.1	5.8	5.9	0.1	6.0	6.1
Cd	0.7	3.88	4.6	0.5	3.8	4.4	0.5	3.5	3.9	0.5	3.6	4.0	0.6	4.0	4.6
Cr	0.8	0.28	1.1	0.5	0.3	0.8	0.4	0.3	0.7	0.4	0.3	0.7	0.5	0.3	0.9
Cs	<0.1	3.5	3.5	0.4	3.5	3.9	0.2	3.3	3.5	0.2	3.3	3.5	0.5	3.7	4.2
Cu	0.1	0.22	0.3	0.1	0.2	0.3	0.0	0.2	0.2	0.1	0.2	0.3	0.1	0.2	0.3
Fe	83.3	1.08	84.4	61.3	0.8	62.1	51.1	1.3	52.4	54.7	1.9	56.6	66.2	1.5	67.8
K	0.1	5.44	5.6	0.1	5.5	5.5	0.1	4.9	5.0	0.1	5.0	5.0	0.1	5.4	5.5
Li	0.6	17.24	17.8	0.3	18.1	18.4	0.2	16.0	16.2	0.2	16.1	16.3	0.3	17.8	18.1
Mg	0.8	0.96	1.8	0.1	1.2	1.3	0.1	1.0	1.1	0.1	1.1	1.2	0.1	1.1	1.2
Mn	2.6	4.96	7.5	2.0	5.3	7.3	1.1	4.9	6.0	1.2	5.0	6.2	1.6	5.5	7.2
Na	0.9	67.76	68.7	1.0	72.7	73.7	0.5	65.5	66.0	0.4	66.4	66.8	0.5	74.1	74.6
Ni	4.2	0.95	5.2	2.8	1.0	3.9	2.3	1.0	3.2	2.5	1.0	3.5	3.3	1.0	4.3
P	0.4	0.63	1.1	0.5	0.6	1.0	0.3	0.4	0.7	0.2	0.6	0.7	0.3	0.7	1.0
Pb	1.7	0.29	2.0	1.1	0.3	1.4	1.0	0.3	1.2	0.9	0.3	1.2	1.3	0.3	1.6
Sb	0.6	0.1	0.7	0.5	0.1	0.7	0.5	0.2	0.7	0.5	0.2	0.6	0.6	0.1	0.8
Se	23.0	254.9	277.9	18.1	268.5	286.6	14.2	282.2	296.4	13.7	278.1	291.8	18.1	274.1	292.2
Si	41.9	12.49	54.4	54.1	12.3	66.4	38.7	11.4	50.0	40.2	11.9	52.0	51.4	13.7	65.1
Sr	1.1	21.18	22.3	0.6	22.2	22.7	0.4	19.9	20.3	0.5	20.2	20.7	0.6	22.9	23.5
Te	9.8	2.59	12.4	7.0	2.5	9.6	6.0	2.7	8.7	6.7	3.3	10.0	8.3	3.3	11.6
Ti	0.6	<0.1	0.6	0.4	<0.1	0.4	0.3	<0.1	0.3	0.3	<0.1	0.3	0.4	<0.1	0.4
Zn	2.3	19.46	21.8	1.7	19.8	21.5	1.4	18.4	19.8	1.5	18.3	19.8	1.9	20.4	22.3
Zr	4.9	1.78	6.7	5.1	1.8	6.9	2.9	1.9	4.8	2.9	2.0	4.9	4.2	2.1	6.3
Cl	NA	83.7	83.7	NA	87.3	87.3	NA	82.7	82.7	NA	82.2	82.2	NA	88.8	88.8
F	NA	68.1	68.1	NA	74.9	74.9	NA	70.7	70.7	NA	71.2	71.2	NA	78.0	78.0
I	<0.1	8.9	8.9	<0.1	9.6	9.6	<0.1	8.3	8.3	<0.1	33.9	33.9	<0.1	36.2	36.2
Nitrate	NA	188.13	188.1	NA	175.51	175.5	NA	148.57	148.6	NA	167.09	167.1	NA	166.25	166.3
Nitrite	NA	<0.1	0.0	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1
Sulfate	<0.1	182.63	182.6	<0.1	191.95	192.0	<0.1	173.31	173.3	<0.1	182.63	182.6	<0.1	204.99	205.0

S* - Suspended
D# - Dissolved

Table 4.4. Analytical Results for Samples of SBS Blowdown Fluids (mg/l). (continued).

	12E-S-80A			12E-S-81A			12E-S-86A			12E-S-88A			12E-S-90A		
Glass (kg)	7050			7211			7250			7300			7500		
pH	2.92			2.88			2.94			2.98			2.88		
	Sus.*	Dis.#	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total
Total	323	1326	1649	340	1406	1746	405	1542	1947	450	1614	2064	453	1656	2109
Al	7.8	34.1	41.9	8.1	35.5	43.6	10.3	36.8	47.1	12.4	39.4	51.8	11.5	40.9	52.4
As	0.2	1.0	1.3	0.2	1.0	1.2	0.3	0.9	1.2	0.2	0.9	1.2	0.3	1.1	1.4
B	0.5	159.6	160.0	0.5	171.1	171.6	0.6	170.0	170.6	0.7	177.2	177.9	0.8	184.3	185.0
Ba	0.1	0.4	0.5	0.1	0.4	0.5	0.1	0.4	0.5	0.2	0.4	0.6	0.2	0.4	0.6
Ca	0.1	6.3	6.4	0.1	6.1	6.2	0.2	6.4	6.6	0.2	6.6	6.8	0.2	6.8	7.0
Cd	0.6	4.2	4.8	0.7	4.3	4.9	0.8	4.6	5.3	0.8	4.9	5.7	0.8	5.1	6.0
Cr	0.5	0.3	0.9	0.5	0.4	0.9	0.5	0.4	0.9	0.6	0.4	0.9	0.6	0.4	1.0
Cs	0.3	4.0	4.3	0.6	4.3	4.9	0.4	4.6	5.0	0.8	5.0	5.8	0.7	5.9	6.6
Cu	0.1	0.2	0.3	0.1	0.3	0.3	0.1	0.3	0.4	0.1	0.3	0.4	0.1	0.3	0.4
Fe	68.2	1.7	69.9	69.1	1.9	71.1	78.6	1.9	80.5	87.7	1.6	89.3	83.3	2.1	85.3
K	0.1	5.6	5.7	0.1	5.8	5.9	0.1	6.1	6.2	0.1	6.5	6.6	0.1	6.8	6.9
Li	0.3	19.4	19.7	0.4	19.8	20.2	0.4	20.9	21.3	0.5	22.8	23.3	0.5	23.7	24.2
Mg	0.1	1.1	1.2	0.1	1.1	1.2	0.1	1.1	1.2	0.1	1.2	1.3	0.1	1.2	1.3
Mn	1.9	5.7	7.6	2.1	5.9	8.0	2.9	6.5	9.3	2.9	6.8	9.7	2.6	7.1	9.7
Na	0.6	77.7	78.3	0.6	79.4	80.0	0.7	83.4	84.1	0.9	91.3	92.2	0.9	93.3	94.2
Ni	3.4	1.0	4.4	3.4	1.0	4.4	3.8	1.1	4.9	4.3	1.1	5.4	4.5	1.1	5.6
P	0.3	0.7	1.0	0.3	0.7	1.0	0.3	0.7	1.0	0.4	0.6	1.1	0.4	0.7	1.2
Pb	1.3	0.3	1.7	1.4	0.3	1.7	1.6	0.4	1.9	1.7	0.4	2.1	1.7	0.4	2.1
Sb	0.6	0.1	0.8	0.9	0.3	1.1	1.0	0.3	1.3	1.1	0.3	1.4	1.6	0.2	1.8
Se	19.3	266.8	286.1	18.9	279.9	298.9	22.6	303.4	326.0	29.5	308.2	337.7	26.6	352.0	378.6
Si	52.6	14.6	67.2	58.3	15.5	73.8	70.9	16.9	87.8	77.5	18.0	95.5	66.8	18.8	85.7
Sr	0.6	21.7	22.3	0.6	22.5	23.1	0.7	24.6	25.3	0.9	26.7	27.6	1.0	27.5	28.5
Te	9.0	4.1	13.1	9.7	4.4	14.1	11.6	4.5	16.1	13.6	4.1	17.7	15.2	4.8	19.9
Ti	0.3	<0.1	0.3	0.4	<0.1	0.4	0.4	<0.1	0.4	0.4	<0.1	0.4	0.4	<0.1	0.4
Zn	2.0	21.2	23.1	2.1	21.5	23.5	2.3	23.3	25.6	2.6	24.7	27.3	2.8	25.4	28.2
Zr	4.9	2.4	7.3	5.3	2.7	8.0	7.1	3.2	10.3	7.6	3.4	11.0	6.6	4.5	11.2
Cl	NA	94.0	94.0	NA	99.1	99.1	NA	101.6	101.6	NA	110.4	110.4	NA	105.7	105.7
F	NA	78.7	78.7	NA	82.3	82.3	NA	85.0	85.0	NA	86.8	86.8	NA	87.8	87.8
I	<0.1	35.9	35.9	<0.1	35.2	35.2	<0.1	34.0	34.0	<0.1	29.5	29.5	<0.1	32.2	32.2
Nitrate	NA	163.72	163.7	NA	163.72	163.7	NA	150.26	150.3	NA	152.78	152.8	NA	141.84	141.8
Nitrite	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1
Sulfate	<0.1	218.04	218.0	1.3	235.74	237.0	0.6	249.72	250.3	0.8	277.67	278.5	0.1	281.4	281.5

S* - Suspended
D# - Dissolved

Table 4.4. Analytical Results for Samples of SBS Blowdown Fluids (mg/l). (continued).

	12E-S-95A			12E-S-97A			12E-S-98A			12E-S-98B			12E-S-99A		
Glass (kg)	7733			7800			7850			7900			7950		
pH	2.87			2.89			2.87			2.83			2.86		
	Sus.*	Dis.#	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total
Total	458	1766	2224	499	1905	2404	488	1888	2376	470	1896	2366	482	812	1294
Al	11.7	41.8	53.5	12.7	42.6	55.3	12.3	42.8	55.1	11.2	43.2	54.4	12.1	43.3	55.4
As	0.3	1.0	1.3	0.3	1.0	1.3	0.3	0.9	1.2	0.4	1.1	1.5	0.3	1.0	1.4
B	0.8	194.9	195.7	0.9	197.4	198.3	0.8	198.7	199.5	0.8	199.5	200.3	0.8	204.9	205.7
Ba	0.2	0.4	0.6	0.2	0.4	0.6	0.2	0.4	0.6	0.2	0.3	0.6	0.2	0.4	0.6
Ca	0.2	7.0	7.2	0.2	7.4	7.5	0.2	7.2	7.4	0.2	7.3	7.5	0.2	7.2	7.4
Cd	0.9	5.4	6.3	1.0	5.4	6.4	1.0	5.5	6.5	0.9	5.5	6.4	0.9	5.6	6.5
Cr	0.6	0.4	1.0	0.6	0.4	1.0	0.7	0.4	1.0	0.6	0.4	1.0	0.6	0.4	1.0
Cs	0.7	6.4	7.1	0.8	6.5	7.3	0.8	6.6	7.4	0.7	6.8	7.5	0.7	7.3	8.0
Cu	0.1	0.3	0.4	0.1	0.3	0.4	0.1	0.3	0.4	0.1	0.3	0.4	0.1	0.4	0.4
Fe	88.7	1.8	90.5	98.4	1.8	100.2	96.7	2.0	98.6	92.5	1.9	94.4	95.0	2.2	97.2
K	0.1	7.0	7.1	0.1	7.2	7.3	0.1	7.3	7.4	0.1	7.3	7.4	0.1	7.5	7.6
Li	0.5	25.1	25.6	0.6	25.8	26.3	0.5	26.9	27.4	0.5	26.3	26.8	0.5	26.6	27.1
Mg	0.1	1.2	1.3	0.1	1.3	1.4	0.1	1.3	1.4	0.1	1.3	1.4	0.1	1.3	1.4
Mn	2.8	7.3	10.1	2.9	7.5	10.4	2.8	7.5	10.4	2.8	7.4	10.3	2.9	7.6	10.5
Na	0.9	100.1	101.0	1.0	98.9	99.9	1.0	101.2	102.2	1.0	100.1	101.0	1.0	101.6	102.6
Ni	4.4	1.2	5.6	4.9	1.2	6.1	4.8	1.2	6.0	4.6	1.2	5.8	4.7	1.3	6.0
P	0.5	0.9	1.3	0.4	0.8	1.2	0.4	0.8	1.2	0.5	0.8	1.2	0.4	0.8	1.2
Pb	1.7	0.4	2.1	2.0	0.4	2.4	2.0	0.5	2.4	1.9	0.5	2.4	2.0	0.5	2.4
Sb	1.1	0.2	1.3	1.2	0.2	1.4	1.3	0.1	1.4	1.3	0.2	1.4	1.3	0.2	1.5
Se	27.6	335.9	363.5	31.1	305.9	336.9	30.6	333.0	363.5	32.2	341.7	373.9	30.3	322.2	352.5
Si	75.7	19.7	95.4	83.6	19.1	102.7	75.4	19.8	95.2	78.9	19.7	98.6	79.2	19.7	98.9
Sr	1.0	28.2	29.2	1.1	28.8	29.9	1.1	29.1	30.2	1.1	29.1	30.2	1.1	29.6	30.8
Te	14.4	4.6	19.1	16.6	4.7	21.3	16.7	5.0	21.7	16.4	4.6	21.0	16.9	5.2	22.2
Ti	0.4	<0.1	0.4	0.4	<0.1	0.4	0.4	<0.1	0.4	0.4	<0.1	0.4	0.4	<0.1	0.4
Zn	2.7	26.4	29.1	3.0	27.8	30.9	3.0	27.6	30.6	2.8	27.2	30.1	2.9	27.5	30.4
Zr	7.1	4.9	12.1	7.2	5.2	12.4	6.9	5.3	12.2	6.8	5.5	12.2	6.9	5.6	12.5
Cl	NA	90.3	90.3	NA	96.8	96.8	NA	92.9	92.9	NA	89.6	89.6	NA	98.1	98.1
F	NA	120.1	120.1	NA	122.2	122.2	NA	121.5	121.5	NA	112.4	112.4	NA	134.8	134.8
I	<0.1	29.8	29.8	<0.1	31.5	31.5	<0.1	35.2	35.2	<0.1	32.7	32.7	<0.1	31.5	31.5
Nitrate	NA	159.61	159.6	NA	154.9	154.9	NA	147.85	147.9	NA	143.15	143.2	NA	152.55	152.6
Nitrite	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1
Sulfate	0.9	323.97	324.9	2.3	341.33	343.6	1.2	330.17	331.4	1.3	311.56	312.9	1.3	354.98	356.3

S* - Suspended

D# - Dissolved

Table 4.4. Analytical Results for Samples of SBS Blowdown Fluids (mg/l). (continued).

	12E-S-105A			12E-S-105B			12E-S-109A			12E-S-109B			12E-S-110A		
Glass (kg)	8200			8250			8400			8400			8550		
pH	2.86			2.82			2.86			2.83			2.84		
	Sus.*	Dis.#	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total
Total	498	1556	2054	497	1676	2173	518	1786	2304	512	1572	2084	507	1380	1887
Al	11.8	44.31	56.1	11.6	45	56.6	12.6	45.95	58.5	13.1	45.3	58.4	12.3	46.5	58.8
As	0.4	1.14	1.5	0.3	1.1	1.4	0.5	1.06	1.6	0.4	1.1	1.5	0.3	1.1	1.4
B	0.9	211.74	212.6	0.9	214.94	215.8	0.9	216.87	217.8	0.9	216.6	217.6	0.9	212.2	213.1
Ba	0.3	0.3	0.6	0.3	0.3	0.6	0.3	0.3	0.6	0.3	0.3	0.6	0.3	0.3	0.6
Ca	0.2	7.3	7.4	0.2	6.9	7.1	0.2	7.1	7.3	0.2	7.7	7.9	0.2	7.0	7.1
Cd	0.9	5.6	6.5	0.9	5.7	6.6	1.0	5.7	6.7	0.9	5.9	6.8	1.0	5.9	6.9
Cr	0.6	0.4	1.0	0.6	0.4	1.0	0.6	0.4	1.0	0.6	0.4	1.0	0.6	0.4	1.0
Cs	0.8	7.6	8.4	0.6	7.2	7.8	0.6	7.7	8.3	0.5	8.2	8.7	0.9	7.1	8.0
Cu	0.1	0.4	0.4	0.1	0.4	0.5	0.1	0.4	0.5	0.1	0.4	0.5	0.1	0.4	0.5
Fe	96.6	2.1	98.7	95.3	2.3	97.6	104.3	2.4	106.7	102.3	2.6	104.9	104.7	2.7	107.4
K	0.1	7.4	7.5	0.1	7.4	7.5	0.1	7.6	7.7	0.1	7.6	7.7	0.1	7.6	7.7
Li	0.5	26.4	27.0	0.5	26.5	27.1	0.6	27.2	27.8	0.6	26.9	27.4	0.5	27.0	27.5
Mg	0.1	1.3	1.4	0.1	1.2	1.3	0.1	1.2	1.3	0.1	1.4	1.5	0.1	1.2	1.3
Mn	3.1	7.8	10.9	3.0	7.9	10.9	3.0	7.1	10.1	3.2	7.0	10.3	2.9	7.1	10.0
Na	1.1	104.7	105.8	1.1	106.8	107.9	1.1	107.6	108.7	1.1	107.1	108.2	1.0	105.1	106.1
Ni	4.9	1.3	6.1	4.9	1.3	6.2	5.2	1.3	6.5	5.3	1.3	6.6	4.9	1.3	6.2
P	0.5	0.7	1.2	0.5	0.9	1.3	0.5	0.8	1.3	0.5	1.1	1.6	0.5	0.9	1.4
Pb	1.9	0.5	2.4	1.9	0.5	2.4	2.1	0.5	2.5	2.1	0.5	2.6	2.1	0.5	2.6
Sb	1.2	0.2	1.4	1.2	0.3	1.5	1.2	0.3	1.5	1.3	0.2	1.5	1.3	0.2	1.5
Se	30.6	354.2	384.8	32.0	342.4	374.4	33.3	348.6	381.9	33.5	343.2	376.7	32.9	364.3	397.3
Si	83.2	19.7	102.9	82.9	20.1	103.1	63.6	20.4	84.0	85.5	20.2	105.8	84.3	20.5	104.8
Sr	1.3	30.0	31.2	1.3	30.3	31.6	1.4	31.3	32.7	1.4	30.8	32.3	1.4	30.8	32.2
Te	16.8	5.8	22.6	16.8	6.0	22.8	17.3	6.1	23.4	17.3	6.1	23.3	18.2	7.6	25.9
Ti	0.5	<0.1	0.5	0.4	<0.1	0.4	0.4	<0.1	0.4	0.4	<0.1	0.4	0.4	<0.1	0.4
Zn	3.0	27.4	30.3	3.0	28.4	31.3	3.2	28.6	31.8	3.1	28.5	31.6	3.1	28.4	31.5
Zr	7.2	5.8	13.1	7.0	6.1	13.1	7.0	6.2	13.2	7.2	6.4	13.6	6.6	6.5	13.1
Cl	NA	94.8	94.8	NA	100.71	100.7	NA	100.06	100.1	NA	103.33	103.3	NA	103.98	104.0
F	NA	132.0	132.0	NA	130.6	130.6	NA	134.8	134.8	NA	140.39	140.4	NA	136.2	136.2
I	<0.1	30.6	30.6	<0.1	33.2	33.2	<0.1	22.9	22.9	<0.1	21.7	21.7	<0.1	21.6	21.6
Nitrate	NA	138.45	138.5	NA	143.15	143.2	NA	143.15	143.2	NA	150.2	150.2	NA	147.85	147.9
Nitrite	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1
Sulfate	1	348.77	349.8	1	371.1	372.1	0.5	376.06	376.6	0.8	385.98	386.8	5	393.43	398.4

S* - Suspended
D# - Dissolved

Table 4.4. Analytical Results for Samples of SBS Blowdown Fluids (mg/l). (continued).

	12E-S-118A			12E-S-130A			12E-S-130C		
Glass (kg)	8650			8650			8650		
pH	2.59			2.74			2.77		
	Sus.*	Dis.#	Total	Sus.	Dis.	Total	Sus.	Dis.	Total
Total	690	2270	2960	402	2062	2464	370	1484	1854
Al	16.7	50.0	66.7	10.6	51.6	62.2	10.5	37.3	47.8
As	0.6	1.1	1.7	0.2	1.2	1.4	0.3	0.9	1.1
B	1.2	217.4	218.6	0.8	222.6	223.4	0.7	168.3	169.0
Ba	0.4	0.3	0.6	0.2	0.2	0.5	0.2	0.2	0.4
Ca	0.2	7.5	7.7	0.2	8.7	8.9	0.2	15.9	16.1
Cd	1.1	6.2	7.3	0.7	6.4	7.1	0.7	4.7	5.4
Cr	0.7	0.4	1.1	0.5	0.4	0.8	0.4	0.3	0.7
Cs	0.9	7.7	8.6	0.7	8.1	8.8	0.4	6.2	6.6
Cu	0.1	0.4	0.5	0.1	0.4	0.5	0.1	0.3	0.4
Fe	118.9	2.1	121.0	74.7	2.4	77.0	68.7	1.9	70.6
K	0.2	7.9	8.1	0.1	8.4	8.5	0.1	6.7	6.8
Li	0.7	28.8	29.4	0.4	28.0	28.5	0.4	21.8	22.2
Mg	0.1	1.3	1.4	0.1	1.5	1.6	0.1	4.0	4.1
Mn	6.2	8.0	14.2	2.4	8.9	11.3	2.2	7.2	9.4
Na	1.4	112.1	113.5	0.9	122.4	123.3	0.8	89.9	90.7
Ni	6.1	1.4	7.5	3.9	1.7	5.6	3.6	1.2	4.8
P	0.7	1.0	1.7	0.4	1.0	1.4	0.4	0.6	1.0
Pb	2.6	0.5	3.0	1.5	0.5	2.0	1.4	0.4	1.8
Sb	2.0	0.2	2.2	1.3	0.2	1.5	0.9	0.2	1.1
Se	40.8	404.1	444.9	25.9	426.1	452.0	24.0	302.1	326.1
Si	124.1	21.6	145.7	61.7	22.5	84.2	60.0	17.2	77.2
Sr	1.8	32.2	34.1	1.3	34.6	35.9	1.1	25.0	26.1
Te	21.5	5.9	27.4	13.9	6.3	20.2	12.1	4.9	17.1
Ti	0.5	<0.1	0.5	0.4	<0.1	0.4	0.3	<0.1	0.3
Zn	3.8	30.1	33.9	2.5	32.6	35.1	2.3	24.3	26.6
Zr	16.1	6.5	22.6	5.1	7.0	12.1	4.9	5.0	9.9
Cl	NA	107.9	107.9	NA	114.44	114.4	NA	89.59	89.6
F	NA	144.59	144.6	NA	147.39	147.4	NA	116.61	116.6
I	<0.1	21.1	21.1	<0.1	15.3	15.3	<0.1	12.2	12.2
Nitrate	NA	138.45	138.5	NA	131.39	131.4	NA	96.37	96.4
Nitrite	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1
Sulfate	1.1	426.13	427.2	2.3	433.88	436.2	0.7	323.97	324.7

S* - Suspended
D# - Dissolved

Table 4.4. Analytical Results for Samples of SBS Blowdown Fluids (mg/l). (continued).

	12E-S-137A			12E-S-137B			12E-S-137C			12E-S-138A			12E-S-138B		
Glass (kg)	8700			8700			8700			8750			8750		
pH	2.79			2.82			2.82			3.01			3.09		
	Sus.*	Dis.#	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total
Total	346	1560	1906	350	1416	1766	365	1292	1657	412	1340	1752	390	1480	1870
Al	5.6	35.8	41.4	5.5	40.6	46.2	5.7	38.8	44.6	8.2	39.8	48.0	8.7	39.8	48.5
As	0.1	1.0	1.1	0.2	1.1	1.3	0.2	1.0	1.2	0.3	0.9	1.2	0.3	0.8	1.1
B	0.3	165.7	166.0	0.5	163.8	164.3	1.0	153.9	155.0	0.7	159.8	160.5	0.6	172.5	173.1
Ba	0.1	0.2	0.3	0.2	0.2	0.4	0.2	0.2	0.4	0.2	0.2	0.4	0.2	0.2	0.4
Ca	0.1	15.6	15.7	0.1	14.6	14.8	0.1	13.7	13.9	0.2	12.5	12.7	0.2	12.3	12.5
Cd	0.4	4.6	4.9	0.7	4.3	5.0	0.7	4.0	4.7	0.8	4.3	5.1	0.8	4.5	5.2
Cr	0.2	0.3	0.5	0.4	0.3	0.7	0.4	0.3	0.7	0.5	0.3	0.7	0.4	0.3	0.7
Cs	0.2	6.6	6.8	0.5	5.1	5.6	0.4	5.3	5.7	0.7	4.8	5.5	<0.1	4.9	4.9
Cu	0.0	0.3	0.3	0.1	0.3	0.4	0.1	0.3	0.3	0.1	0.3	0.4	0.1	0.3	0.4
Fe	40.9	1.8	42.8	70.9	0.9	71.8	73.4	0.8	74.2	78.5	0.5	79.0	72.2	0.4	72.6
K	0.0	6.4	6.5	0.1	5.7	5.8	0.5	5.1	5.6	0.1	5.2	5.3	0.1	5.4	5.5
Li	0.2	20.8	21.0	0.3	19.6	19.9	0.3	18.2	18.5	0.4	18.9	19.3	0.4	20.0	20.5
Mg	0.0	3.9	4.0	0.1	3.8	3.9	0.1	3.6	3.7	0.1	3.4	3.5	0.1	3.3	3.4
Mn	1.3	7.0	8.3	2.3	6.2	8.5	2.5	6.0	8.4	2.9	5.8	8.7	3.1	6.2	9.3
Na	0.4	86.6	87.0	0.6	92.6	93.2	0.6	86.5	87.1	0.7	90.3	91.0	0.8	97.6	98.3
Ni	2.1	1.2	3.3	3.5	1.2	4.7	3.6	1.1	4.7	3.9	1.1	5.0	3.6	1.1	4.8
P	0.2	0.7	0.9	0.4	0.6	1.0	0.3	0.5	0.8	0.5	0.7	1.1	0.4	0.7	1.1
Pb	0.8	0.4	1.1	1.5	0.3	1.8	1.5	0.3	1.8	1.7	0.3	2.0	1.5	0.3	1.8
Sb	0.5	0.1	0.6	0.9	0.2	1.1	1.0	0.2	1.2	1.1	0.2	1.3	1.0	0.2	1.2
Se	9.3	304.4	313.7	24.4	317.7	342.1	25.2	285.8	311.1	26.8	289.7	316.5	24.2	262.8	287.0
Si	36.8	16.6	53.4	61.0	16.3	77.3	65.1	15.5	80.6	73.2	16.4	89.6	71.0	18.5	89.6
Sr	0.6	23.6	24.2	1.0	23.7	24.7	1.0	23.3	24.2	1.0	23.6	24.6	0.9	24.3	25.2
Te	6.4	5.0	11.4	12.9	4.1	17.0	13.5	3.6	17.1	14.1	2.9	17.0	13.5	2.7	16.2
Ti	0.2	<0.1	0.2	0.3	<0.1	0.3	0.3	<0.1	0.3	0.3	<0.1	0.3	0.3	<0.1	0.3
Zn	1.3	22.7	24.0	2.1	21.9	24.0	2.2	21.0	23.2	2.5	22.0	24.5	2.4	22.7	25.1
Zr	2.7	4.9	7.5	5.7	3.9	9.6	6.3	3.6	9.9	8.3	3.0	11.3	9.0	2.7	11.6
Cl	NA	88.29	88.3	NA	80.4	80.4	NA	87.0	87.0	NA	74.7	74.7	NA	74.7	74.7
F	NA	115.21	115.2	NA	79.4	79.4	NA	85.9	85.9	NA	77.0	77.0	NA	79.4	79.4
I	<0.1	11.5	11.5	<0.1	11.0	11.0	<0.1	10.4	10.4	<0.1	27.6	27.6	<0.1	35.1	35.1
Nitrate	NA	90.3	90.3	NA	78.5	78.5	NA	72.5	72.5	NA	77.9	77.9	NA	83.2	83.2
Nitrite	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1
Sulfate	2.8	316.52	319.3	0.3	295.49	295.8	0.2	307.6	307.8	<0.1	288.22	288.2	<0.1	300.33	300.3

S* - Suspended
D# - Dissolved

Table 4.4. Analytical Results for Samples of SBS Blowdown Fluids (mg/l). (continued).

	12E-S-139A			12E-S-141A			12E-S-141B			12E-S-142A			12E-S-142B		
Glass (kg)	8800			8850			8900			8950			9000		
pH	3.17			3.37			3.67			3.71			3.58		
	Sus.*	Dis.#	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total
Total	512	1536	2048	518	1616	2134	555	1596	2151	547	1700	2247	555	1400	1955
Al	14.0	42.1	56.1	15.0	42.6	57.5	17.4	43.2	60.6	16.9	44.9	61.9	15.9	45.8	61.6
As	0.4	0.9	1.3	0.4	0.8	1.2	0.6	0.9	1.5	0.5	0.9	1.4	0.5	1.0	1.5
B	0.8	178.1	178.9	0.9	185.8	186.6	1.0	190.6	191.5	0.9	189.3	190.2	0.9	201.9	202.8
Ba	0.2	0.2	0.4	0.2	0.2	0.4	0.3	0.2	0.5	0.3	0.2	0.5	0.3	0.2	0.5
Ca	0.2	12.8	13.0	0.2	12.3	12.5	0.3	11.7	12.0	0.2	11.7	12.0	0.3	11.1	11.4
Cd	1.0	4.8	5.8	1.1	5.0	6.0	1.3	5.0	6.3	1.3	5.1	6.4	1.3	5.1	6.4
Cr	0.6	0.3	0.8	0.6	0.3	0.9	0.7	0.3	0.9	0.7	0.3	1.0	0.7	0.3	1.0
Cs	0.7	5.4	6.1	0.7	5.5	6.2	<0.1	5.9	5.9	0.7	5.8	6.5	<0.1	5.3	5.3
Cu	0.1	0.3	0.4	0.1	0.3	0.4	0.1	0.3	0.4	0.1	0.3	0.5	0.1	0.3	0.4
Fe	91.8	0.2	92.0	93.6	0.2	93.8	99.5	0.1	99.6	100.6	0.1	100.7	101.2	0.1	101.3
K	0.1	5.7	5.8	0.1	5.9	6.0	0.2	6.1	6.3	0.2	6.2	6.3	0.1	6.1	6.3
Li	0.6	23.6	24.2	0.7	24.6	25.2	0.8	26.6	27.4	0.8	28.0	28.8	0.8	28.3	29.1
Mg	0.1	3.2	3.3	0.1	3.1	3.3	0.1	3.0	3.2	0.1	2.9	3.0	0.1	2.7	2.9
Mn	4.0	7.0	11.0	3.9	7.1	11.0	3.8	7.4	11.1	3.5	7.6	11.1	3.5	7.5	11.0
Na	1.1	100.2	101.3	1.2	104.8	106.0	1.4	109.2	110.5	1.4	105.6	107.0	1.4	110.4	111.8
Ni	4.7	1.1	5.8	4.9	1.1	6.0	5.3	1.1	6.4	5.4	1.1	6.5	5.4	1.1	6.5
P	0.5	0.5	1.0	0.7	0.6	1.3	0.8	0.5	1.3	0.7	0.6	1.3	0.6	0.6	1.2
Pb	1.9	0.4	2.3	1.9	0.4	2.3	2.1	0.4	2.5	2.1	0.4	2.5	2.1	0.4	2.6
Sb	1.2	0.2	1.5	1.2	0.2	1.5	1.5	0.1	1.6	1.5	0.1	1.6	1.5	0.1	1.6
Se	30.3	255.7	286.0	30.8	225.3	256.1	32.6	252.5	285.0	32.4	252.0	284.4	32.5	244.0	276.5
Si	90.3	22.7	113.0	89.8	23.4	113.1	91.3	25.1	116.4	87.2	26.1	113.3	87.2	25.6	112.8
Sr	1.3	27.3	28.6	1.3	28.5	29.8	1.4	29.8	31.2	1.4	31.8	33.1	1.5	31.8	33.3
Te	17.7	2.3	20.0	18.1	2.4	20.6	19.6	2.2	21.8	20.5	2.3	22.8	21.6	2.5	24.2
Ti	0.4	<0.1	0.4	0.4	<0.1	0.4	0.4	<0.1	0.4	0.4	<0.1	0.4	0.3	<0.1	0.3
Zn	3.1	24.2	27.3	3.3	24.6	27.8	3.8	26.5	30.3	3.7	26.1	29.9	3.8	26.4	30.2
Zr	12.2	2.1	14.4	11.8	1.6	13.4	12.5	0.8	13.3	11.3	0.9	12.1	10.5	1.5	11.9
Cl	NA	72.9	72.9	NA	71.0	71.0	NA	76.6	76.6	NA	74.7	74.7	NA	76.2	76.2
F	NA	83.5	83.5	NA	78.8	78.8	NA	85.9	85.9	NA	87.1	87.1	NA	95.6	95.6
I	<0.1	54.4	54.4	<0.1	64.9	64.9	<0.1	82.5	82.5	<0.1	98.7	98.7	<0.1	96.0	96.0
Nitrate	NA	84.5	84.5	NA	84.5	84.5	NA	81.2	81.2	NA	81.9	81.9	NA	77.4	77.4
Nitrite	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1
Sulfate	1.1	295.49	296.6	0.2	300.33	300.5	<0.1	329.41	329.4	0.6	341.52	342.1	<0.1	362.76	362.8

S* - Suspended
D# - Dissolved

Table 4.4. Analytical Results for Samples of SBS Blowdown Fluids (mg/l). (continued).

	12E-S-147A			12E-S-147B			12E-S-147C			12E-S-149A		
Glass (kg)	9200			9250			9300			9350		
pH	3.54			3.61			3.60			3.53		
	Sus.*	Dis.#	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total
Total	558	1404	1962	579	1428	2007	577	1512	2089	580	1636	2216
Al	16.2	44.8	61.0	16.4	45.6	62.0	16.0	46.8	62.8	15.8	47.0	62.8
As	0.5	0.9	1.5	0.6	0.9	1.5	0.6	1.1	1.7	0.6	1.0	1.6
B	0.9	209.3	210.2	1.0	210.3	211.3	1.3	219.2	220.5	1.1	225.6	226.7
Ba	0.3	0.2	0.5	0.4	0.2	0.5	0.3	0.2	0.5	0.4	0.2	0.6
Ca	0.3	10.4	10.7	0.3	10.1	10.3	0.3	9.9	10.2	0.5	9.5	10.0
Cd	1.3	5.4	6.7	1.4	5.4	6.8	1.4	5.6	7.0	1.4	5.6	7.0
Cr	0.7	0.3	1.0	0.8	0.3	1.1	0.8	0.3	1.1	0.9	0.3	1.1
Cs	1.2	5.6	6.8	<0.1	5.7	5.7	<0.1	6.1	6.1	0.9	6.2	7.1
Cu	0.1	0.4	0.5	0.1	0.3	0.4	0.1	0.4	0.5	0.1	0.3	0.5
Fe	102.0	0.2	102.2	107.5	0.1	107.6	106.6	0.2	106.7	111.4	0.1	111.6
K	0.1	12.1	12.2	0.2	6.4	6.6	0.3	6.5	6.9	0.2	9.2	9.4
Li	0.8	28.8	29.5	0.8	29.8	30.6	0.8	27.7	28.5	0.9	28.4	29.3
Mg	0.1	2.6	2.8	0.2	2.5	2.7	0.2	2.4	2.6	0.2	2.3	2.5
Mn	3.8	7.7	11.5	4.0	7.9	11.9	3.8	8.4	12.2	3.8	8.3	12.1
Na	1.4	112.7	114.1	1.4	113.2	114.6	1.4	115.5	116.9	1.6	117.2	118.8
Ni	5.4	1.1	6.5	5.7	1.1	6.8	5.7	1.1	6.8	5.9	1.1	7.0
P	0.7	0.6	1.4	0.8	0.5	1.3	0.8	0.4	1.2	0.7	0.6	1.3
Pb	2.2	0.4	2.6	2.3	0.4	2.7	2.3	0.5	2.7	2.3	0.5	2.8
Sb	1.6	0.1	1.7	1.7	0.1	1.8	1.6	0.2	1.9	1.7	0.1	1.9
Se	33.1	243.0	276.1	35.1	242.7	277.9	33.2	241.6	274.9	33.4	235.0	268.4
Si	92.1	25.8	117.9	95.5	26.6	122.1	94.5	27.4	121.9	79.0	27.3	106.3
Sr	1.5	30.8	32.3	1.6	31.7	33.2	1.6	32.1	33.6	1.7	32.1	33.8
Te	22.5	2.8	25.3	24.0	2.8	26.8	24.2	2.6	26.8	24.1	2.8	26.9
Ti	0.4	<0.1	0.4	0.4	<0.1	0.4	0.3	<0.1	0.3	0.4	<0.1	0.4
Zn	3.8	27.1	30.9	3.9	27.2	31.1	3.8	28.0	31.8	3.9	27.5	31.4
Zr	11.7	1.6	13.3	12.1	1.6	13.6	10.8	2.0	12.8	11.0	2.0	13.1
Cl	NA	85.6	85.6	NA	90.4	90.4	NA	79.0	79.0	NA	83.7	83.7
F	NA	99.9	99.9	NA	104.2	104.2	NA	103.0	103.0	NA	106.0	106.0
I	<0.1	109.5	109.5	<0.1	106.8	106.8	<0.1	108.1	108.1	<0.1	104.1	104.1
Nitrate	NA	69.9	69.9	NA	65.9	65.9	NA	61.8	61.8	NA	59.8	59.8
Nitrite	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1
Sulfate	0.6	374.8	375.4	0.3	377.21	377.5	1.4	379.62	381.0	0.6	379.62	380.2

S* - Suspended
D# - Dissolved

Table 4.4. Analytical Results for Samples of SBS Blowdown Fluids (mg/l). (continued).

	12F-S-10A			12F-S-11A			12F-S-13A			12F-S-14A			12F-S-14B		
Glass (kg)	9400			9500			9636			9650			9700		
PH	3.42			3.53			3.58			3.34			3.31		
	Sus.*	Dis.#	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total
Total	503	1532	2035	512	1512	2024	500	1572	2072	453	1528	1981	505	1520	2025
Al	12.5	50.4	62.9	13.1	49.7	62.8	13.0	49.2	62.2	10.1	48.8	58.9	11.7	49.8	61.5
As	0.5	1.1	1.6	0.5	1.2	1.7	0.5	1.0	1.5	0.4	1.0	1.4	0.5	1.2	1.7
B	0.9	218.4	219.3	0.9	214.7	215.6	0.8	216.0	216.8	0.8	221.1	221.9	0.9	218.9	219.8
Ba	0.3	0.2	0.5	0.3	0.2	0.5	0.3	0.2	0.5	0.3	0.2	0.5	0.3	0.2	0.5
Ca	0.3	9.3	9.6	0.3	8.9	9.2	0.2	8.6	8.8	0.2	8.3	8.5	0.2	8.2	8.4
Cd	1.2	5.7	6.9	1.2	5.7	6.9	1.2	5.8	7.0	1.0	5.7	6.7	1.1	5.7	6.9
Cr	0.8	0.3	1.1	0.8	0.3	1.1	0.7	0.3	1.1	0.7	0.3	1.0	0.8	0.3	1.1
Cs	0.7	5.9	6.6	0.7	5.7	6.4	0.9	6.2	7.1	0.5	6.1	6.6	0.7	6.5	7.2
Cu	0.1	0.3	0.4	0.1	0.3	0.4	0.1	0.3	0.4	0.1	0.3	0.4	0.1	0.3	0.4
Fe	96.3	0.2	96.5	97.5	0.2	97.6	94.1	0.2	94.2	89.0	0.3	89.3	94.8	0.3	95.1
K	0.1	6.4	6.5	0.1	6.4	6.5	0.1	6.5	6.6	0.1	6.1	6.2	0.1	6.2	6.3
Li	0.7	30.9	31.6	0.7	30.5	31.2	0.7	30.6	31.3	0.6	29.8	30.5	0.7	30.9	31.6
Mg	0.1	2.1	2.2	0.1	2.1	2.2	0.1	2.0	2.2	0.1	1.9	2.0	0.1	1.9	2.0
Mn	3.5	8.3	11.8	3.5	8.1	11.6	3.5	8.0	11.5	2.9	7.8	10.8	3.5	7.9	11.3
Na	1.3	112.9	114.2	1.2	111.0	112.3	1.2	112.2	113.4	1.1	111.2	112.3	1.2	109.3	110.5
Ni	5.2	1.2	6.4	5.5	1.2	6.7	5.1	1.3	6.4	4.6	1.2	5.8	5.3	1.1	6.4
P	0.5	0.6	1.1	0.5	0.7	1.2	0.5	0.9	1.3	0.6	0.7	1.3	0.6	0.6	1.2
Pb	1.9	0.7	2.6	2.0	0.7	2.7	1.9	0.7	2.6	1.8	0.7	2.5	2.0	0.7	2.7
Sb	1.4	0.2	1.6	1.5	0.2	1.6	1.4	0.2	1.6	1.2	0.2	1.4	1.4	0.3	1.7
Se	31.3	255.8	287.0	30.5	236.9	267.4	29.7	234.6	264.3	28.4	246.3	274.6	32.1	240.9	273.0
Si	82.4	25.1	107.5	83.1	23.5	106.5	82.6	23.0	105.6	73.1	22.6	95.8	79.1	23.3	102.4
Sr	1.5	34.2	35.7	1.6	33.5	35.1	1.5	33.7	35.1	1.4	32.5	33.9	1.5	32.8	34.3
Te	22.4	2.9	25.3	24.0	2.8	26.8	22.6	2.7	25.3	21.8	3.2	24.9	24.2	3.2	27.4
Ti	0.3	<0.1	0.3	0.4	<0.1	0.4	0.3	<0.1	0.3	0.3	<0.1	0.3	0.3	<0.1	0.3
Zn	3.4	27.8	31.2	3.4	27.1	30.5	3.3	27.0	30.3	3.1	26.4	29.4	3.4	25.4	28.8
Zr	8.7	2.2	10.9	9.2	2.1	11.2	9.0	2.0	11.0	6.7	2.5	9.2	8.2	2.5	10.7
Cl	NA	76.9	76.9	NA	78.1	78.1	NA	79.3	79.3	NA	73.1	73.1	NA	66.2	66.2
F	NA	109.1	109.1	NA	105.6	105.6	NA	105.6	105.6	NA	99.4	99.4	NA	107.1	107.1
I	<0.1	90.04	90.0	<0.1	92.37	92.4	<0.1	92.37	92.4	<0.1	75.2	75.2	<0.1	79.0	79.0
Nitrate	NA	61.1	61.1	NA	59.4	59.4	NA	61.2	61.2	NA	46.6	46.6	NA	51.7	51.7
Nitrite	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1
Sulfate	1.4	412.83	414.2	0.8	390.53	391.3	0.8	390.53	391.3	1.0	423.34	424.3	0.5	360.41	360.9

S* - Suspended
D# - Dissolved

Table 4.4. Analytical Results for Samples of SBS Blowdown Fluids (mg/l). (continued).

	12F-S-16A			12F-S-17A			12F-S-20A			12F-S-20B		
Glass (kg)	9750			9800			9850			9900		
pH	3.46			3.47			3.77			3.99		
	Sus.*	Dis.#	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total
Total	528	1452	1980	568	1412	1980	585	1600	2185	649	1448	2097
Al	13.3	50.5	63.9	14.0	51.2	65.2	15.9	51.4	67.3	19.7	51.0	70.8
As	0.6	1.2	1.7	0.6	1.1	1.8	0.7	1.2	1.9	0.8	1.1	1.8
B	0.9	223.4	224.3	1.1	229.5	230.6	1.1	227.1	228.1	1.3	234.2	235.5
Ba	0.3	0.2	0.5	0.4	0.2	0.5	0.3	0.2	0.5	0.3	0.2	0.5
Ca	0.2	7.9	8.1	0.3	7.8	8.1	0.3	8.1	8.3	0.3	7.7	8.0
Cd	1.2	5.9	7.1	1.3	6.1	7.4	1.4	6.0	7.5	1.7	6.0	7.7
Cr	0.8	0.3	1.2	0.9	0.3	1.2	1.0	0.3	1.3	1.1	0.2	1.3
Cs	0.4	6.7	7.1	0.9	7.4	8.3	1.2	6.9	8.1	1.6	7.2	8.8
Cu	0.1	0.3	0.4	0.1	0.3	0.4	0.1	0.3	0.4	0.1	0.3	0.5
Fe	100.7	0.2	101.0	106.7	0.2	107.0	104.5	0.1	104.6	120.2	0.1	120.2
K	0.2	6.1	6.3	0.1	6.1	6.3	0.1	6.4	6.5	0.2	6.4	6.6
Li	0.8	31.7	32.5	0.8	32.1	33.0	0.9	33.5	34.4	1.0	35.0	36.0
Mg	0.1	1.8	2.0	0.2	1.8	1.9	0.2	1.7	1.9	0.2	1.7	1.9
Mn	3.5	8.0	11.5	3.9	8.0	11.9	4.1	8.5	12.6	4.6	8.0	12.7
Na	1.3	111.1	112.4	1.4	114.5	115.9	1.6	116.3	117.9	1.9	120.3	122.2
Ni	5.3	1.2	6.5	6.0	1.2	7.1	5.7	1.3	7.0	6.6	1.3	7.9
P	0.5	1.0	1.4	0.8	0.9	1.7	0.7	1.1	1.8	0.8	1.1	1.8
Pb	2.2	0.7	2.8	2.2	0.7	2.9	2.1	0.7	2.9	2.3	0.8	3.1
Sb	0.3	0.2	0.6	1.6	0.2	1.9	1.6	0.2	1.8	1.8	0.2	1.9
Se	30.5	247.1	277.5	37.0	238.8	275.7	37.7	246.7	284.4	40.7	219.3	260.0
Si	86.2	23.5	109.7	91.3	23.4	114.7	93.5	25.1	118.6	105.8	24.5	130.2
Sr	1.4	33.0	34.4	1.8	33.7	35.5	1.8	36.0	37.8	2.0	37.0	38.9
Te	24.5	2.9	27.4	26.8	2.8	29.6	27.2	2.2	29.3	29.6	2.1	31.6
Ti	0.3	<0.1	0.3	0.4	<0.1	0.4	0.4	<0.1	0.4	0.4	<0.1	0.4
Zn	3.6	25.7	29.2	3.8	25.9	29.7	3.9	27.7	31.6	4.4	28.0	32.4
Zr	9.4	2.3	11.7	9.5	2.2	11.7	10.6	1.0	11.6	12.4	0.4	12.8
Cl	NA	77.5	77.5	NA	79.4	79.4	NA	75.0	75.0	NA	78.8	78.8
F	NA	105.4	105.4	NA	107.1	107.1	NA	107.1	107.1	NA	101.1	101.1
I	<0.1	81.2	81.2	<0.1	86.5	86.5	<0.1	120.5	120.5	<0.1	111.4	111.4
Nitrate	NA	51.7	51.7	NA	50.7	50.7	NA	51.2	51.2	NA	60.3	60.3
Nitrite	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1
Sulfate	1	401.32	402.3	0.5	423.34	423.8	1.3	410.76	412.1	1.4	439.08	440.5

S* - Suspended
D# - Dissolved

Table 4.4. Analytical Results for Samples of SBS Blowdown Fluids (mg/l). (continued).

	12F-S-25A			12F-S-25B			12F-S-27A			12F-S-28A		
Glass (kg)	10000			10050			10150			10200		
pH	3.75			3.64			3.68			3.84		
	Sus.*	Dis.#	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total
Total	590	1508	2098	555	1452	2007	582	1584	2166	560		560
Al	16.0	50.3	66.3	14.1	51.2	65.4	14.1	50.3	64.4	15.4	50.4	65.8
As	0.7	1.0	1.7	0.7	1.2	1.9	0.7	0.9	1.7	0.8	0.9	1.7
B	1.2	234.7	235.9	1.1	211.0	212.1	1.0	240.2	241.2	1.1	244.6	245.6
Ba	0.3	0.2	0.5	0.3	0.2	0.5	0.3	0.2	0.5	0.3	0.2	0.5
Ca	0.3	7.3	7.5	0.3	6.9	7.2	0.2	6.8	7.0	0.3	6.7	7.0
Cd	1.5	6.2	7.7	1.4	5.8	7.2	1.4	5.9	7.3	1.4	6.0	7.4
Cr	1.0	0.3	1.3	1.0	0.3	1.3	1.0	0.3	1.2	1.0	0.2	1.2
Cs	0.7	7.0	7.7	0.7	6.4	7.1	<0.1	6.7	6.7	<0.1	6.9	6.9
Cu	0.1	0.3	0.4	0.1	0.3	0.4	0.1	0.3	0.4	0.1	0.3	0.4
Fe	110.0	0.1	110.1	104.6	0.1	104.8	102.6	0.1	102.7	100.6	0.1	100.7
K	0.2	6.3	6.5	0.1	6.1	6.2	0.1	7.0	7.1	0.1	6.2	6.3
Li	0.9	34.2	35.1	0.9	34.0	34.9	0.9	34.8	35.7	0.9	34.6	35.5
Mg	0.2	1.6	1.8	0.2	1.5	1.7	0.2	1.5	1.7	0.1	1.5	1.6
Mn	4.1	8.0	12.1	3.8	7.6	11.4	4.3	7.8	12.1	3.7	7.7	11.4
Na	1.7	118.1	119.7	1.5	103.0	104.4	1.5	118.0	119.5	1.7	119.9	121.5
Ni	5.8	1.2	7.0	5.7	1.1	6.8	5.8	1.2	7.0	5.7	1.1	6.9
P	0.7	0.9	1.6	0.6	1.1	1.7	0.6	1.0	1.6	0.8	1.0	1.8
Pb	2.2	0.8	2.9	2.1	0.7	2.8	2.1	0.8	2.9	2.1	0.8	2.9
Sb	1.6	0.2	1.8	1.6	0.2	1.8	1.7	0.2	1.8	1.6	0.3	1.9
Se	38.2	249.3	287.5	36.2	216.1	252.3	37.6	271.2	308.7	38.0	238.9	276.9
Si	81.3	24.5	105.8	89.4	23.9	113.3	95.6	24.8	120.3	87.0	24.7	111.6
Sr	1.8	35.1	36.9	1.7	34.7	36.4	1.7	34.2	35.9	1.8	34.9	36.7
Te	27.1	2.2	29.3	26.6	2.4	29.0	27.2	2.3	29.5	25.3	2.1	27.4
Ti	0.4	<0.1	0.4	0.3	<0.1	0.3	0.4	<0.1	0.4	0.3	<0.1	0.3
Zn	3.9	27.2	31.2	3.7	27.8	31.5	3.8	28.8	32.5	3.7	28.4	32.1
Zr	9.9	1.1	11.0	9.2	1.5	10.7	11.0	1.3	12.3	9.7	0.7	10.4
Cl	NA	87.6	87.6	NA	78.8	78.8	NA	76.3	76.3	NA	78.2	78.2
F	NA	100.2	100.2	NA	99.4	99.4	NA	100.9	100.9	NA	100.9	100.9
I	<0.1	125.3	125.3	<0.1	103.3	103.3	<0.1	109.9	109.9	<0.1	131.9	131.9
Nitrate	NA	51.1	51.1	NA	45.9	45.9	NA	44.2	44.2	NA	42.5	42.5
Nitrite	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1
Sulfate	0.9	411.72	412.6	0.5	390.53	391.0	0.9	408.69	409.6	0.5	420.79	421.3

S* - Suspended
D# - Dissolved

Table 4.4. Analytical Results for Samples of SBS Blowdown Fluids (mg/l). (continued).

	12F-S-33A			12F-S-33B			12F-S-34A			12F-S-36A		
Glass (kg)	10300			10350			10450			10549		
PH	3.83			3.83			3.79			3.60		
	Sus.*	Dis.#	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total
Total	592	1576	2168	573	1640	2213	590	1528	2118	570	1580	2150
Al	16.0	49.6	65.6	15.6	48.8	64.4	14.6	49.4	64.0	14.1	48.7	62.8
As	0.8	0.9	1.7	0.7	0.9	1.6	0.8	0.9	1.7	0.8	1.0	1.7
B	1.1	239.4	240.4	1.1	244.1	245.1	1.1	241.5	242.6	1.0	241.5	242.6
Ba	0.3	0.2	0.5	0.3	0.2	0.5	0.3	0.2	0.5	0.3	0.2	0.5
Ca	0.3	6.6	6.9	0.2	6.6	6.9	0.3	6.4	6.7	0.2	6.3	6.5
Cd	1.5	6.0	7.5	1.5	6.0	7.5	1.4	5.8	7.2	1.4	5.9	7.2
Cr	1.1	0.2	1.3	1.1	0.2	1.3	1.0	0.2	1.2	1.1	0.2	1.3
Cs	1.2	7.3	8.5	1.1	7.2	8.3	1.4	6.8	8.2	1.0	6.8	7.8
Cu	0.1	0.3	0.4	0.1	0.3	0.4	0.1	0.3	0.4	0.1	0.3	0.4
Fe	106.9	0.1	107.0	104.0	0.1	104.1	106.0	0.1	106.1	106.0	0.1	106.1
K	0.1	6.3	6.4	0.1	6.3	6.4	0.1	6.2	6.3	0.1	6.1	6.2
Li	1.0	35.4	36.3	0.9	34.4	35.3	0.9	35.0	35.9	0.9	33.6	34.5
Mg	0.2	1.5	1.6	0.2	1.5	1.7	0.2	1.5	1.6	0.2	1.4	1.6
Mn	4.1	7.7	11.8	3.8	7.8	11.6	4.0	7.7	11.7	3.6	7.5	11.1
Na	1.7	116.9	118.6	1.6	120.4	122.0	1.7	117.6	119.3	1.6	117.6	119.2
Ni	5.7	1.2	7.0	5.7	1.2	6.8	5.3	1.2	6.5	5.5	1.2	6.7
P	0.7	1.1	1.8	0.8	0.9	1.7	0.8	1.0	1.8	0.6	1.0	1.6
Pb	2.2	0.8	3.0	2.1	0.8	2.9	2.1	0.8	2.9	2.2	0.8	3.0
Sb	1.6	0.3	2.0	1.6	0.3	2.0	1.0	0.3	1.3	1.6	0.3	1.9
Se	39.2	245.1	284.3	38.7	272.9	311.6	39.3	264.9	304.2	38.8	279.8	318.6
Si	94.2	24.6	118.8	90.1	24.4	114.5	92.8	24.3	117.1	74.5	24.4	98.9
Sr	1.7	35.1	36.8	1.7	34.3	36.0	1.7	34.1	35.9	1.7	33.9	35.6
Te	27.9	2.1	30.0	27.0	2.1	29.1	27.5	2.1	29.6	27.6	2.3	29.9
Ti	0.4	<0.1	0.4	0.4	<0.1	0.4	0.3	<0.1	0.3	0.3	<0.1	0.3
Zn	4.0	28.1	32.1	3.9	28.7	32.6	3.9	27.6	31.5	3.9	27.8	31.7
Zr	10.1	0.8	10.9	9.8	0.7	10.5	9.5	0.9	10.3	8.5	1.1	9.6
Cl	NA	78.8	78.8	NA	78.2	78.2	NA	73.7	73.7	NA	76.8	76.8
F	NA	105.5	105.5	NA	95.6	95.6	NA	93.97	94.0	NA	93.97	94.0
I	<0.1	127.8	127.8	<0.1	128.9	128.9	<0.1	130.6	130.6	<0.1	112.0	112.0
Nitrate	NA	44.7	44.7	NA	44.7	44.7	NA	42.8	42.8	NA	49.1	49.1
Nitrite	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1
Sulfate	1.9	429.87	431.8	0.2	387.51	387.7	0.6	388.69	389.3	0.9	394.71	395.6

S* - Suspended
D# - Dissolved

Table 4.5. Calculated Speciation of DM1200 SBS Sample 12D-S-116A.

Element	Species	Percent	Element	Species	Percent
Al	AlF2+ AlF3(aq) AlF++	56.71 39.05 3.50	Li	Li+	99.66
As	HAsO3F-	99.85	Mn	Mn++ MnSeO4(aq) MnSO4(aq)	70.57 23.60 5.19
B	B(OH)3(aq)	100.00	N	NO3-	99.81
Ba	Ba++ BaNO3+	98.24 1.70	Na	Na+	99.58
Ca	Ca++ CaSO4(aq) CaNO3+	94.88 4.00 1.06	Ni	Ni++ NiSeO4(aq) NiSO4(aq)	62.17 34.86 2.62
Cd	CdCl+	100.00	P	H2PO4- FeHPO4+ H3PO4(aq)	63.81 24.74 11.29
Cl	Cl- CdCl+	98.08 1.53	Pb	Pb++ PbCl+	94.69 5.23
Cr	HCrO4-	99.88	S	SO4- HSO4- SrSO4(aq) NaSO4- LiSO4- CaSO4(aq) MgSO4(aq)	86.59 7.25 1.80 1.48 1.09 6.700E-01 5.153E-01
Cu	Cu++	99.31	Sb	Sb(OH)2F(aq) Sb(OH)3(aq) Sb(OH)2+	55.53 42.34 2.12
F	AlF2+ AlF3(aq) HF(aq) F- AlF++ HAsO3F- AlF4-	45.20 46.68 2.77 1.57 1.40 3.115E-01 1.16	Se	SeO4- HSeO4- ZnSeO4(aq)	91.09 6.44 1.71
Fe	FeHPO4+ FeOH++ Fe+++ FeF++ Fe(OH)2+ FeF2+	44.61 29.95 11.06 5.63 4.55 3.74	Si	SiO2(aq)	100.00
I	IO3-	99.63	Sr	Sr++ SrSO4(aq) SrNO3+	92.71 5.90 1.27
K	K+	99.56	Zn	Zn++ ZnSeO4(aq)	83.57 16.08
Mg	Mg++ MgSO4(aq)	91.71 8.06	Zr	Zr(OH)4(aq) ZrF5- ZrF4(aq) ZrF6- ZrF3+	60.60 16.57 9.58 8.55 3.81

Table 4.6. Analytical Results for Samples of WESP Sump Fluids (mg/l).

	12D-W-96A			12E-W-60A			12E-W-118A			12F-W-41A		
Test	End of TO			End of 1			End of 2			End of 3		
pH	2.76			2.52			2.31			2.31		
	Sus.*	Dis.#	Total	Sus.	Dis.	Total	Sus.	Dis.	Total	Sus.	Dis.	Total
Total	84	11990	12074	154	19178	19332	305	23528	23833	334	31836	32170
Al	<0.1	4.0	4.0	2.7	5.7	8.4	1.5	10.8	12.3	1.2	5.7	6.9
As	0.1	14.5	14.6	0.2	26.4	26.6	0.2	38.3	38.5	0.2	26.4	26.6
B	1.5	345.5	347.0	1.0	525.7	526.8	0.4	665.8	666.2	0.5	525.7	526.2
Ba	0.0	0.2	0.2	0.1	0.1	0.3	<0.1	0.1	0.2	<0.1	0.1	0.2
Ca	<0.1	23.1	23.1	1.5	27.5	29.0	0.6	32.2	32.8	0.5	27.5	28.0
Cd	0.9	30.3	31.1	4.1	53.8	57.8	1.8	79.7	81.5	2.4	53.8	56.1
Cr	7.1	11.4	18.5	32.3	17.8	50.1	15.1	23.4	38.5	17.7	17.8	35.5
Cs	1.1	181.6	182.7	1.4	280.4	281.8	2.6	349.2	351.8	9.9	482.2	492.1
Cu	<0.1	1.1	1.1	0.2	2.1	2.2	<0.1	3.0	3.0	<0.1	2.1	2.1
Fe	2.7	0.1	2.8	26.7	0.5	27.2	9.9	0.8	10.6	11.6	0.5	12.0
K	1.2	364.4	365.6	5.4	542.8	548.2	1.3	619.0	620.3	1.5	542.8	544.3
Li	0.4	142.8	143.1	1.7	252.5	254.2	0.2	351.3	351.5	0.1	252.5	252.6
Mg	1.0	4.9	5.9	1.1	6.8	7.9	0.2	8.0	8.2	0.2	6.8	7.0
Mn	<0.1	0.5	0.5	0.2	1.0	1.2	0.1	2.0	2.1	0.1	1.0	1.1
Na	3.2	1149.9	1153.2	14.8	1407.9	1422.7	2.1	1722.9	1725.0	1.3	1407.9	1409.2
Ni	0.1	3.8	3.9	1.8	7.0	8.8	0.5	10.8	11.3	0.5	7.0	7.5
P	0.2	2.0	2.1	0.6	3.0	3.6	0.2	3.6	3.8	<0.1	3.0	3.1
Pb	0.6	0.7	1.3	3.8	0.8	4.6	1.5	1.1	2.6	1.8	0.8	2.7
Sb	<0.1	1.3	1.3	0.2	1.8	2.1	0.6	3.3	3.9	0.8	1.8	2.6
Se	28.1	4439.4	4467.5	146.3	6712.4	6858.6	44.3	8776.8	8821.1	68.3	6712.4	6780.7
Si	<0.1	8.0	8.0	<0.1	11.5	11.5	4.7	11.8	16.5	5.8	11.5	17.3
Sr	<0.1	5.0	5.1	0.1	7.8	8.0	<0.1	7.5	7.5	<0.1	7.8	7.9
Te	6.2	169.2	175.4	41.5	261.6	303.2	20.1	321.2	341.3	31.0	261.6	292.6
Ti	0.1	<0.1	0.1	0.7	0.2	0.9	0.3	0.3	0.6	0.3	0.2	0.5
Zn	0.1	15.0	15.1	0.4	24.1	24.5	0.1	33.5	33.6	0.1	24.1	24.2
Zr	<0.0	0.1	0.1	0.2	0.1	0.3	0.1	0.1	0.2	0.1	0.1	0.2
Cl	NA	656.6	656.6	NA	946.8	946.8	NA	1029.4	1029.4	NA	764	764.0
F	NA	26.2	26.2	NA	48.4	48.4	NA	53.7	53.7	NA	61.5	61.5
I	<0.1	2.0	2.0	<0.1	1.6	1.6	<0.1	1.7	1.7	<0.1	1.9	1.9
Nitrate	NA	490.6	490.6	NA	716.2	716.2	NA	811.3	811.3	NA	1273.3	1273.3
Nitrite	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1	NA	<0.1	<0.1
Sulfate	6.9	2221.3	2228.2	20.7	3317.3	3338.0	1.7	4242.3	4244.0	1.7	4954.4	4956.1

S* - Suspended
D# - Dissolved

Table 5.1. DM1200 Glass Discharge Samples and Analyses Performed.

Test	Dis. Date	Glass Name	Analysis Performed	Measured Mass (kg)	Mass per Test (kg)	Overall Cumulative Mass (kg)
1	5/9/01	12D-G-115A 12D-G-116A, 12D-G-116B, 12D-G-116C, 12D-G-120A, 12D-G-120B, 12D-G-121A, 12D-G-121B, 12D-G-127A, 12D-G-127B	MD/DCP, XRF	528.5	1587.0	528.5
	5/10/ 01	12D-G-128A, 12D-G-129A, 12D-G-129B, 12D-G-131A, 12D-G-131B, 12D-G-132A, 12D-G-137A, 12D-G-139A, 12D-G-139B	MD/DCP, XRF	532.5		1061
	5/10-11/01	12D-G-150A, 12D-G-151A, 12E-G-12A, 12E-G-18A, 12E-G-23A, 12E-G-30A, 12E-G-31A, 12E-G-38A, 12E-G-40A, 12E-G-48A	MD/DCP, XRF	526.0		1587
2	5/14/01	12E-G-76A, 12E-G-76B, 12E-G-77A, 12E-G-77B, 12E-G-77C, 12E-G-78A, 12E-G-80A, 12E-G-80B, 12E-G-81A	MD/DCP, XRF	531.5	1947.5	2118.5
	5/15/01	12E-G-86A, 12E-G-86B, 12E-G-89A, 12E-G-89B, 12E-G-89C, 12E-G89D, 12E-G-90A, 12E-G-90B, 12E-G-95A	MD/DCP, XRF	522.5		2641
	5/15/01	12E-G-95B, 12E-G-97A, 12E-G-98A, 12E-G-98B, 12E-G-99A, 12E-G-99B, 12E-G-99C, 12E-G-105A, 12E-G-105B, 12E-G-107A	MD/DCP, XRF	550.0		3191
	5/16/01	12E-G-107B, 12E-G-109A, 12E-G-109B, 12E-G-109C, 12E-G-110A, 12E-G-110B	MD/DCP, XRF	344.0		3535
3	5/21/01	12E-G-137A, 12E-G-138A, 12E-G-139A, 12E-G-139B, 12E-G-141A, 12E-G-141B 12E-G-142A, 12E-G-142B, 12E-G-142C	MD/DCP, XRF	512.0	1921.5	4047
	5/22/01	12E-G-142D, 12E-G-147A, 12E-G-147B, 12E-G-147C, 12E-G-149A, 12E-G-149B 12F-G-10A, 12F-G-11A, 12F-G-13A	MD/DCP, XRF	497.0		4544
	5/22/ 01	12F-G-14A, 12F-G-16A, 12F-G-17A 12F-G-17B, 12F-G-20A, 12F-G-20B 12F-G-20C, 12F-G-25A, 12F-G-25B	MD/DCP, XRF	511.0		5055
	5/23/01	12F-G-27A, 12F-G-28A, 12F-G-28B 12F-G-28C, 12F-G-33A, 12F-G-33B 12F-G-34A, 12F-G-36A	MD/DCP, XRF, TCLP	401.5		5456.5
	5/24/01	12F-G-55A, 12F-G-55B, 12F-G-56A, 12F-G-58A	MD/DCP, XRF	313.0	313.0	5769.5

Table 5.2. Chemical Compositions of Glass Samples Discharged during DM1200 Commissioning tests (wt%).

Test #		1						2					
Sample	Target	12D-G-127B		12D-G-139B		12E-G-48A		12E-G-81A		12E-G-95A		12E-G-107A	
Cumulative kg		528.5		1061		1587		2118.5		2641		3191	
		XRF	DCP	XRF	DCP	XRF	DCP	XRF	DCP	XRF	DCP	XRF	DCP
Al2O3	7.40	8.07	7.85	7.88	7.64	7.90	7.39	7.71	7.39	7.75	7.42	7.54	7.24
As2O3	0.04	0.04	0.05	0.04	0.04	0.04	0.02	0.04	0.04	0.04	0.01	0.04	0.04
B2O3	10.00	10.47	10.47	10.38	10.38	10.43	10.43	10.46	10.46	10.68	10.68	10.70	10.70
BaO	0.04	NA	0.06	NA	0.06	NA	0.06	NA	0.06	NA	0.06	NA	0.06
CaO	0.25	0.41	0.42	0.40	0.42	0.39	0.41	0.39	0.40	0.39	0.41	0.42	0.43
CdO	0.37	0.39	0.31	0.41	0.32	0.44	0.33	0.42	0.34	0.44	0.34	0.43	0.33
CeO2	0.08	0.07	NA	0.07	NA	0.07	NA	0.08	NA	0.06	NA	0.09	NA
Cl	0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cr2O3	0.04	0.07	0.06	0.06	0.06	0.04	0.05	0.04	0.04	0.04	0.03	0.03	0.03
Cs2O	0.08	0.08	0.08	0.09	0.09	0.10	0.08	0.09	0.08	0.10	0.08	0.10	0.09
CuO	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.03
F	0.04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fe2O3	10.39	10.47	8.58	10.52	8.90	10.10	8.63	10.41	8.85	10.35	8.73	10.66	10.34
K2O	0.17	0.34	0.28	0.31	0.26	0.30	0.26	0.29	0.24	0.28	0.25	0.27	0.23
La2O3	0.32	0.24	NA	0.20	NA	0.18	NA	0.18	NA	0.17	NA	0.18	NA
Li2O	6.00	5.13	5.13	5.12	5.12	5.08	5.08	5.22	5.22	5.29	5.29	5.18	5.18
MgO	0.06	NA	0.23	NA	0.20	NA	0.18	NA.	0.16	NA	0.15	NA	0.14
MnO	3.03	3.17	2.62	3.20	2.64	3.13	2.74	3.22	2.73	3.20	2.79	3.27	2.79
Na2O	6.59	7.18	6.65	7.30	6.52	7.81	6.39	7.16	6.61	7.08	6.48	6.93	6.49
NiO	0.54	0.51	0.48	0.52	0.48	0.50	0.49	0.51	0.50	0.51	0.52	0.53	0.51
P2O5	0.13	0.34	0.42	0.31	0.36	0.25	0.36	0.24	0.31	0.21	0.25	0.19	0.27
PbO	0.15	0.14	0.18	0.14	0.19	0.13	0.20	0.14	0.20	0.13	0.19	0.13	0.19
Sb2O3	0.21	0.17	0.24	0.19	0.22	0.21	0.31	0.19	0.29	0.20	0.22	0.20	0.21
SeO2	0.15	0.03	0.00	0.04	0.03	0.06	0.03	0.04	0.03	0.04	0.04	0.04	0.01
SiO2	45.53	45.12	41.19	45.06	41.45	45.25	41.95	45.15	41.50	45.37	41.52	44.97	40.66
SO3	0.25	0.15	NA	0.17	NA	0.21	NA	0.20	NA	0.21	NA	0.23	NA
SrO	2.32	2.14	1.94	2.17	1.95	2.10	1.95	2.16	1.96	2.13	1.97	2.21	1.96
TeO2	0.14	0.11	0.13	0.13	0.12	0.16	0.13	0.13	0.14	0.15	0.15	0.14	0.15
TiO2	0.06	0.08	0.09	0.07	0.09	0.07	0.10	0.07	0.09	0.07	0.10	0.07	0.10
ZnO	2.00	2.04	1.96	2.03	1.95	1.92	1.94	1.98	1.93	1.96	1.90	2.03	1.88
ZrO2	3.56	3.87	3.46	3.99	3.54	3.96	3.56	4.03	3.59	4.00	3.62	4.18	3.66
Sum	100.00	100.87	92.86	100.84	92.98	100.87	93.03	100.58	93.10	100.86	93.19	100.80	93.64

Target: HLW98-31; NA: Not analyzed. The Cs2O contents in the DCP column were obtained by atomic absorption spectroscopy analysis.

Table 5.2. Chemical Compositions of Glass Samples Discharged during DM1200 Commissioning Tests (wt%) (continued).

Test #		2		3						
Sample	Target	12E-G-110B		12F-G-13A		12F-G-25B	12F-G-36A		12F-G-58A	
Cumulative kg		3535		4544		5055	5456.5		5769.5	
Method		XRF	DCP	XRF	DCP	XRF	XRF	DCP	XRF	DCP
Al2O3	7.40	7.55	7.22	7.71	7.52	7.68	7.59	7.85	7.78	7.63
As2O3	0.04	0.04	0.01	0.04	0.02	0.04	0.04	0.03	0.04	0.03
B2O3	10.00	10.69	10.69	11.05	11.05	11.19	11.51	11.51	10.92	10.92
BaO	0.04	NA	0.06	NA	0.06	NA	NA	0.06	NA	0.06
CaO	0.25	0.37	0.40	0.38	0.38	0.39	0.39	0.39	0.40	0.39
CdO	0.37	0.45	0.33	0.43	0.33	0.44	0.44	0.38	0.47	0.37
CeO2	0.08	0.08	NA	0.07	NA	0.08	0.08	NA	0.08	NA
Cl	0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cr2O3	0.04	0.03	0.03	0.04	0.04	0.05	0.05	0.04	0.05	0.04
Cs2O	0.08	0.12	0.08	0.08	0.08	0.08	0.08	0.10	0.09	0.10
CuO	0.03	0.04	0.03	0.04	0.03	0.04	0.04	0.04	0.03	0.03
F	0.04	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fe2O3	10.39	10.52	9.12	10.48	9.36	10.39	10.33	9.09	10.19	9.03
K2O	0.17	0.26	0.23	0.27	0.22	0.27	0.26	0.23	0.27	0.24
La2O3	0.32	0.18	NA	0.18	NA	0.18	0.18	NA	0.18	NA
Li2O	6.00	5.20	5.20	5.29	5.29	5.19	5.34	5.34	5.16	5.16
MgO	0.06	NA	0.13	NA	0.11	NA	NA	0.11	NA	0.11
MnO	3.03	3.27	2.78	3.33	2.81	3.35	3.37	2.93	3.27	2.75
Na2O	6.59	7.14	6.44	6.92	6.65	7.12	7.18	6.78	6.52	6.68
NiO	0.54	0.53	0.52	0.54	0.49	0.54	0.54	0.51	0.53	0.50
P2O5	0.13	0.19	0.26	0.19	0.26	0.18	0.18	0.32	0.18	0.32
PbO	0.15	0.13	0.20	0.14	0.20	0.15	0.14	0.19	0.14	0.20
Sb2O3	0.21	0.22	0.26	0.18	0.21	0.18	0.17	0.16	0.20	0.19
SeO2	0.15	0.04	0.07	0.03	0.01	0.03	0.03	0.02	0.03	0.01
SiO2	45.53	45.03	41.07	44.90	43.84	44.93	44.94	43.97	45.57	43.31
SO3	0.25	0.22	NA	0.20	NA	0.19	0.20	NA	0.20	NA
SrO	2.32	2.19	1.96	2.28	2.04	2.25	2.25	2.10	2.24	2.04
TeO2	0.14	0.16	0.16	0.13	0.11	0.12	0.12	0.15	0.14	0.12
TiO2	0.06	0.06	0.10	0.07	0.09	0.07	0.07	0.10	0.07	0.10
ZnO	2.00	1.98	1.90	2.01	1.88	2.03	2.03	1.85	1.98	1.89
ZrO2	3.56	4.17	3.61	4.26	3.66	4.21	4.19	3.78	4.24	3.57
Sum	100.00	100.83	92.76	101.26	96.67	101.35	101.72	97.91	100.97	95.70

Target: HLW98-31; NA: Not analyzed. The Cs2O contents in the DCP column were obtained by atomic absorption spectroscopy analysis.

Table 5.3. TCLP Leachate Concentrations for DM1200 Commissioning Test Glass Product.
(mg/l)

Sample ID	Ag	As	Ba	Cd	Cr	Cu	Ni	Pb	Se	Zn
UTS Limit	0.140	5.000	21.000	0.110	0.600		11.000	0.750	5.700	4.300
12F-G-36A	<0.003	<0.049	0.584	0.072	<0.006	0.051	0.071	0.032	<0.053	0.522
Detection Limit	0.003	0.049	0.002	0.003	0.006	0.001	0.008	0.024	0.053	0.003

Table 6.1. Particulate and Gaseous Emissions Sampling Results During Test 1.

		Feed Flux (g/hr)	Melter Emissions						SBS		
			Run 1			Run 2			mg/min	% of Feed	DF across SBS
			mg/min	% of Feed	DF	mg/min	% of Feed	DF			
	Total[$]	9655	78.0	0.05	2063	60.0	0.04	2682	37.8	0.02	2.1
Particles	Al	303.6	1.7	0.03	2976	1.8	0.03	2811	0.2	<0.01	10.0
	As	2.4	0.1	0.32	400	0.1	0.25	400	<0.1	0.08	3.8
	B	120.3	0.8	0.04	2506	2.1	0.10	955	0.1	<0.01	22.1
	Ba	2.8	<0.1	0.02	>470	<0.1	0.04	>470	<0.1	<0.01	NC
	Ca	13.9	0.9	0.38	257	1.0	0.43	232	0.5	0.21	1.9
	Cd	25.7	0.1	0.03	4283	0.3	0.07	1428	<0.1	<0.01	21.8
	Cr	1.1	<0.1	0.08	>180	0.1	0.51	183	<0.1	0.02	13.0
	Cs	6.2	0.1	0.09	1033	0.4	0.39	258	<0.1	<0.01	NC
	Cu	1.9	<0.1	0.02	>320	<0.1	0.11	>320	<0.1	0.09	0.7
	Fe	563.1	4.0	0.04	2346	4.2	0.05	2235	0.5	0.01	7.6
	I	7.8	<0.1	<0.01	>1300	<0.1	<0.01	>1300	<0.1	<0.01	NC
	K	10.9	0.3	0.15	606	0.4	0.22	454	0.1	0.04	4.9
	Li	216.0	0.6	0.02	6000	1.2	0.03	3000	<0.1	<0.01	56.4
	Mg	2.8	0.2	0.45	233	0.1	0.32	467	0.1	0.19	2.0
	Mn	181.9	0.3	0.01	10106	0.4	0.01	7579	<0.1	<0.01	14.4
	Na	378.9	4.4	0.07	1435	6.2	0.10	1019	0.5	0.01	10.0
	Ni	32.9	0.2	0.03	2742	0.3	0.06	1828	<0.1	<0.01	NC
	P	113.7	0.1	0.01	18950	<0.1	<0.01	>18950	<0.1	<0.01	8.4
	Pb	10.8	0.1	0.06	1800	0.1	0.07	1800	<0.1	0.01	5.5
	S	7.8	2.6	2.00	50	1.8	1.42	72	0.7	0.55	3.1
	Sb	12.3	0.1	0.03	2050	<0.1	<0.01	>2050	<0.1	0.01	2.6
	Se	8.3	8.3	6.03	17	21.2	15.37	7	0.4	0.31	34.0
	Si	1649.5	5.1	0.02	5391	2.2	0.01	12496	1.1	<0.01	3.3
	Sr	152.0	0.8	0.03	3167	1.2	0.05	2111	<0.1	<0.01	NC
	Te	8.7	0.5	0.33	290	1.9	1.31	76	0.1	0.10	8.6
	Ti	2.8	<0.1	0.10	>470	0.1	0.13	467	<0.1	0.04	2.6
	Zn	124.5	0.8	0.04	2594	1.3	0.06	1596	<0.1	<0.01	36.0
	Zr	204.3	0.3	0.01	11350	0.1	<0.01	34050	<0.1	<0.01	NC
Gas	B	120.3	17.2	0.86	117	4.9	0.24	409	0.7	0.03	15.8
	Cl	0.8	8.7	67.60	2	2.9	22.69	5	<0.1	<0.01	NC
	F	3.1	4.4	8.47	12	4.3	8.23	12	<0.1	<0.01	NC
	I	7.8	47.2	36.51	3	122.3	94.67	1	93.0	72.02	1.8
	S	7.8	5.2	4.01	25	1.8	1.36	72	<0.1	<0.01	NC
	Se	8.3	17.4	12.65	8	12.7	9.24	11	0.3	0.20	50.2

NC – Not calculated
[$] - From gravimetric analysis of filters and rinse dry downs

Table 6.2. Particulate and Gaseous Melter Emissions Sampling Results from Early During Commissioning Test 2.

		Feed Flux (g/hr)	Melter Emissions		
			Run 1		
			mg/min	% of Feed	DF
	Total	42045	1879	0.27	373
Particles	Al	1322.2	40.3	0.18	547
	As	10.2	1.7	1.02	100
	B	523.7	32.7	0.37	267
	Ba	12.1	0.5	0.24	403
	Ca	60.3	5.4	0.54	186
	Cd	111.8	6.3	0.34	296
	Cr	4.6	1.0	1.33	77
	Cs	27.0	9.5	2.10	47
	Cu	8.1	0.4	0.29	338
	Fe	2452.0	97.7	0.24	418
	I	33.8	<0.1	<0.01	>5630
	K	47.6	7.3	0.92	109
	Li	940.7	21.7	0.14	723
	Mg	12.2	0.9	0.45	226
	Mn	792.0	8.2	0.06	1610
	Na	1650.2	91.4	0.33	301
	Ni	143.2	6.2	0.26	385
	P	495.0	0.3	<0.01	27500
	Pb	47.0	3.1	0.39	253
	S	33.8	35.7	6.33	16
	Sb	53.4	1.1	0.13	809
	Se	36.0	345.9	57.62	2
	Si	7183.2	114.0	0.10	1050
	Sr	662.1	21.8	0.20	506
	Te	37.8	43.1	6.84	15
	Ti	12.1	0.5	0.26	403
	Zn	542.3	20.7	0.23	437
	Zr	889.5	10.5	0.07	1412
Gas	B	523.7	141.5	1.62	62
	Cl	3.4	65.5	116.41	1
	F	13.5	72.8	32.36	3
	I	33.8	475.9	84.61	1
	S	33.8	95.0	16.87	6
	Se	36.0	38.0	6.34	16

NC – Not Calculated

Table 6.3. Particulate and Gaseous Emissions Sampling Results During Commissioning Test 2.

		Feed Flux (g/hr)	Melter Emissions			SBS		
			Run 2					
			mg/min	% of Feed	DF	mg/min	% of Feed	DF across SBS
	Total[$]	46717	1951	0.25	399	124	0.02	15.7
Particles	Al	1469.1	46.1	0.19	531	0.2	<0.01	283.8
	As	11.4	1.5	0.78	127	0.3	0.17	4.7
	B	581.9	27.4	0.28	354	0.2	<0.01	135.2
	Ba	13.4	0.5	0.21	447	<0.1	<0.01	105.8
	Ca	67.0	4.9	0.44	228	0.5	0.05	9.0
	Cd	124.2	5.4	0.26	383	1.0	0.05	5.5
	Cr	5.1	0.7	0.84	121	0.2	0.28	3.0
	Cs	30.0	6.9	1.39	72	1.9	0.38	3.7
	Cu	9.0	0.4	0.26	375	0.1	0.03	7.4
	Fe	2724.5	96.7	0.21	470	0.3	<0.01	378.0
	I	37.5	<0.1	<0.01	>6250	<0.1	<0.01	NC
	K	52.9	6.0	0.68	147	1.1	0.12	5.5
	Li	1045.2	19.7	0.11	884	1.9	0.01	10.5
	Mg	13.6	0.9	0.38	252	0.1	0.04	9.7
	Mn	880.0	7.1	0.05	2066	0.1	<0.01	114.8
	Na	1833.5	78.0	0.26	392	8.6	0.03	9.1
	Ni	159.1	6.3	0.24	421	<0.1	<0.01	170.5
	P	550.0	<0.1	<0.01	>91660	<0.1	<0.01	1.0
	Pb	52.2	2.7	0.32	322	0.3	0.04	8.1
	S	37.6	30.3	4.84	21	7.4	1.19	4.1
	Sb	59.3	0.6	0.06	1647	0.2	0.02	2.5
	Se	40.0	323.1	48.43	2	23.4	3.51	13.8
	Si	7981.4	111.0	0.08	1198	0.3	<0.01	370.2
	Sr	735.7	20.5	0.17	598	0.1	<0.01	305.3
	Te	42.0	34.3	4.91	20	8.6	1.23	4.0
	Ti	13.5	0.7	0.29	321	<0.1	0.01	30.2
	Zn	602.5	20.6	0.20	487	0.2	<0.01	98.8
	Zr	988.3	9.4	0.06	1752	<0.1	<0.01	1539.5
Gas	B	581.9	197.9	2.04	49	5.9	0.06	33.5
	Cl	3.8	78.7	125.92	1	<0.1	NC	NC
	F	15.0	103.3	41.31	2	0.9	0.35	114.8
	I	37.5	584.6	93.54	1	458.8	73.41	1.3
	S	37.6	119.1	19.02	5	0.1	0.02	1191
	Se	40.0	63.1	9.46	11	18.1	2.71	3.5

NC – Not calculated

[$] - From gravimetric analysis of filters and rinse dry downs

Table 6.4. Particulate and Gaseous Emissions Sampling Results During Commissioning Test 3.

		Feed Flux (g/hr)	Melter Emissions*			SBS		
			mg/min	% of Feed	DF	mg/min	% of Feed	DF across SBS
	Total[#]	41746	1704	0.24	408	22.1	<0.01	77.1
Particles	Al	1371.2	47.7	0.21	479	0.1	<0.01	382.0
Particles	As	10.6	2.5	1.42	71	<0.1	<0.01	NC
Particles	B	543.1	276.4	3.05	33	<0.1	<0.01	NC
Particles	Ba	12.5	0.5	0.24	417	<0.1	<0.01	118.8
Particles	Ca	62.5	24.9	2.39	42	0.4	0.04	64.8
Particles	Cd	116.0	8.6	0.45	225	0.1	<0.01	121.6
Particles	Cl	3.5	41.6[$]	71.35	1	N/A	N/A	NC
Particles	Cr	4.8	2.0	2.53	40	<0.1	0.03	87.5
Particles	Cs	28.0	9.9	2.12	47	0.1	0.03	73.9
Particles	Cu	8.4	0.4	0.27	350	<0.1	0.01	19.0
Particles	F	14.0	0.5[$]	0.20	467	N/A	N/A	NC
Particles	Fe	2542.8	90.8	0.21	467	0.1	<0.01	670.4
Particles	I	35.0	181.8	31.17	3	<0.1	<0.01	NC
Particles	K	49.4	8.8	1.07	94	0.2	0.03	41.0
Particles	Li	975.5	28.4	0.17	572	0.1	<0.01	282.0
Particles	Mg	12.7	4.6	2.17	46	0.1	0.03	65.7
Particles	Mn	821.3	8.7	0.06	1573	<0.1	<0.01	493.1
Particles	Na	1711.3	661.8	2.32	43	0.9	<0.01	719.5
Particles	Ni	148.5	6.0	0.24	413	<0.1	<0.01	457.3
Particles	P	513.3	0.7	0.01	12221	<0.1	<0.01	NC
Particles	Pb	48.7	3.9	0.48	208	<0.1	<0.01	188.7
Particles	S	35.1	190.2	32.55	3	0.2	0.03	NC
Particles	Sb	55.3	2.6	0.28	354	<0.1	<0.01	308.3
Particles	Se	37.4	400.4	64.31	2	3.2	0.51	NC
Particles	Si	7449.3	97.3	0.08	1276	0.3	<0.01	332.8
Particles	Sr	686.6	24.1	0.21	475	<0.1	<0.01	3606.5
Particles	Te	39.2	64.4	9.87	10	0.2	0.03	393.0
Particles	Ti	12.6	0.4	0.20	525	<0.1	<0.01	92.4
Particles	Zn	562.4	20.9	0.22	448	<0.1	<0.01	453.0
Particles	Zr	922.4	7.7	0.05	1997	<0.1	<0.01	1020.6
Gas	B	543.10				5.7	0.06	48.5[&]
Gas	Cl	3.50				2.0	3.49	20.8
Gas	F	14.00				0.3	0.15	NC
Gas	I	35.00				102.8	17.63	1.7[&]
Gas	S	35.07				2.7	0.46	65.1[&]
Gas	Se	37.36				23.9	3.84	14.8[&]

NC – Not calculated.
* Melter emissions include gas and particle fractions combined due to filter breach.
$ Cl and F values only analyzed for gas fractions.
[#] From gravimetric analysis of filters and rinse dry-downs.
& DF calculated for combined particulate and gaseous emissions.

Table 6.5. Comparison of Total SBS Accumulations and Melter Emissions Results for DM1200 Commissioning Tests.

	% Feed Accumulated in SBS	% Feed Sampled in Melter Emissions	
		Minimum	Maximum
Al	0.21	0.03	0.18
As	0.7	0.25	1.02
B	1.0	0.34	1.99
Ba	<0.1	0.04	0.24
Ca	0.7	0.43	0.54
Cd	0.3	0.07	0.34
Cr	0.5	0.51	1.33
Cs	1.3	0.39	2.10
Cu	0.2	0.11	0.29
Fe	0.2	0.05	0.24
K	0.6	0.22	0.92
Li	0.1	0.03	0.14
Mg	0.7	0.32	0.45
Mn	0.1	0.01	0.06
Na	0.3	0.10	0.33
Ni	0.2	0.06	0.26
P	<0.1	<0.01	<0.01
Pb	0.3	0.07	0.39
Sb	0.1	0.00	0.13
Se	41.7	24.61	63.96
Si	0.1	0.01	0.10
Sr	0.2	0.05	0.20
Te	3.0	1.31	6.84
Ti	0.2	0.13	0.26
Zn	0.3	0.06	0.23
Zr	0.1	<0.01	0.07
Cl	113.8	22.69	116.41
F	36.6	8.23	32.36
I	11.1	84.81	94.67
Sulfate	22.3	2.78	23.20

Table 6.6. Particle Size Distributions for DM1200 Melter Exhaust.

	Particle Size (microns)	Net Weight (mg)	Concentration (mg/dscf)	Mass Fraction (%)
Test 1	>23.04	0.3	0.0273	12.4
	9.22 – 23.04	0.1	0.0091	4.1
	4.98 – 9.22	1.02	0.0930	42.3
	2.20 – 4.98	0.36	0.0328	14.9
	1.18 – 2.20	0.14	0.0128	5.8
	0.68 – 1.18	0.02	0.0018	0.8
	0.39 – 0.68	0.0	0.0000	0.0
	0.04 – 0.39	0.47	0.0428	19.5
	Total			100.0
Test 2	>24.31	1.46	0.4885	10.7
	10.26 – 24.31	1.37	0.4583	10.1
	5.54 – 10.26	1.4	0.4684	10.3
	2.44 – 5.54	1.3	0.4349	9.5
	1.31 – 2.44	0.96	0.3212	7.0
	0.75 – 1.31	1.23	0.4115	9.0
	0.43 – 0.75	1.9	0.6424	14.1
	0.04 – 0.43	3.98	1.3315	29.2
	Total			100.0
Test 3	>24.05	3.54	0.6219	10.9
	10.05 – 24.05	3.95	0.6940	12.2
	5.42 – 10.05	3.18	0.5587	9.8
	2.39 – 5.42	4.6	0.8082	14.2
	1.29 – 2.39	3.22	0.5657	10.0
	0.73 – 1.29	4.14	0.7273	12.8
	0.42 – 0.73	6.8	1.1929	21.0
	0.04 – 0.42	2.94	0.5165	9.1
	Total			100.0

Table 6.7. Particle Size Distributions for SBS Exhaust.

	Particle Size (microns)	Net Weight (mg)	Concentration (mg/dscf)	Mass Fraction (%)
Test 1	>23.60	0.28	0.0037	4.03
	9.67 – 23.60	0.26	0.0035	3.74
	5.22 – 9.67	0.26	0.0035	3.74
	2.30 – 5.22	0.19	0.0025	2.73
	1.24 – 2.30	0.18	0.0024	2.59
	0.70 – 1.24	1.18	0.0158	16.98
	0.41 – 0.70	0.54	0.0072	7.77
	0.04 – 0.41	4.06	0.0543	58.42
	Total			100.00
Test 2	>23.63	0.25	0.0221	1.82
	9.70 – 23.63	0.20	0.0176	1.46
	5.24 – 9.70	0.13	0.0115	0.95
	2.31 – 5.24	0.14	0.0124	1.02
	1.24 – 2.31	0.40	0.0353	2.91
	0.71 – 1.24	4.29	0.3785	31.22
	0.41 – 0.71	4.35	0.3838	31.66
	0.04 – 0.41	3.98	0.3512	28.97
	Total			100.00
Test 3	>23.58	0.14	0.0205	4.03
	9.65 – 23.58	0.21	0.0307	6.05
	5.21 – 9.65	0.11	0.0161	3.17
	2.30 – 5.21	0.08	0.0117	2.30
	1.24 – 2.30	0.18	0.0263	5.19
	0.70 – 1.24	0.80	0.1169	23.05
	0.41 – 0.70	1.61	0.2352	46.38
	0.04 – 0.41	0.34	0.0497	9.82
	Total			100.00

Table 6.8. Chemical Analysis of Particle Size Fractions for Melter Exhaust from DM1200 Commissioning Test 2.

Particle Size (microns)	>24.31	10.26 – 24.31	5.54 – 10.26	2.44 – 5.54	1.31 – 2.44	0.75 – 1.31	0.43 – 0.75	0.04 – 0.43
Total Mass (mg)	1.5	1.4	1.4	1.3	1.0	1.2	1.9	4.0
Mass Fraction (%)	10.7	10.1	10.3	9.6	7.1	9.0	14.0	29.3
Al	3.4	3.2	2.1	0.7	1.0	0.4	<0.1	<0.1
As	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	0.2	0.3
B	1.2	0.7	0.6	0.1	0.4	0.2	<0.1	<0.1
Ba	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ca	0.5	0.5	1.4	0.2	1.5	0.4	<0.1	<0.1
Cd	0.2	0.2	0.2	0.3	0.3	0.7	0.7	0.8
Cr	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	0.2	0.2
Cs	<0.1	<0.1	<0.1	<0.1	<0.1	1.9	2.2	2.3
Cu	<0.1	0.1	0.5	0.4	1.0	<0.1	0.5	<0.1
Fe	5.5	6.6	6.9	8.1	6.3	4.2	0.7	0.2
I	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
K	<0.1	0.1	0.1	0.2	0.2	0.5	0.7	0.7
Li	0.8	0.8	0.9	1.0	0.9	1.7	1.5	1.6
Mg	<0.1	0.1	0.3	<0.1	0.4	0.1	<0.1	<0.1
Mn	1.0	0.5	0.4	0.2	0.2	<0.1	<0.1	<0.1
Na	7.7	4.0	3.8	4.0	3.5	7.1	6.6	6.4
Ni	0.2	0.8	1.5	1.3	2.4	<0.1	1.0	<0.1
P	<0.1	<0.1	<0.1	0.3	<0.1	<0.1	<0.1	<0.1
Pb	0.1	0.1	0.1	0.2	0.2	0.3	0.2	0.3
S	<0.1	<0.1	<0.1	<0.1	<0.1	2.9	3.7	5.6
Sb	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Se	9.6	18.1	18.1	22.4	21.0	27.7	21.8	24.4
Si	11.7	8.6	8.3	2.5	5.2	2.3	<0.1	0.2
Sr	1.1	1.2	1.3	1.5	1.3	0.8	0.1	<0.1
Te	0.7	1.2	1.6	3.5	4.8	8.5	6.9	7.7
Ti	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.2
Zn	1.1	1.2	1.3	1.4	1.0	0.7	0.2	0.1
Zr	1.6	0.7	0.4	0.1	<0.1	<0.1	<0.1	<0.1
Mass Fraction Sum (%)	46.4	48.9	49.8	48.4	51.7	60.7	47.1	51.1

Table 6.9. Chemical Analysis of Particle Size Fractions for Melter Exhaust from DM1200 Commissioning Test 3.

Particle Size (microns)	>24.05	10.05 – 24.05	5.42 – 10.05	2.39 – 5.42	1.29 – 2.39	0.73 – 1.29	0.42 – 0.73	0.04 – 0.42
Total Mass (mg)	3.5	4.0	3.2	4.6	3.2	4.1	6.8	2.9
Mass Fraction (%)	10.9	12.2	9.8	14.2	10.0	12.8	21.0	9.1
Al	4.2	3.5	1.8	0.7	0.3	<0.1	<0.1	0.1
As	<0.1	<0.1	0.2	0.2	0.2	0.4	0.5	0.5
B	2.5	2.3	1.8	0.8	0.3	0.2	0.1	0.1
Ba	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ca	0.1	0.2	0.3	0.3	0.2	<0.1	<0.1	<0.1
Cd	0.3	0.3	0.3	0.4	0.6	1.0	1.1	1.2
Cr	<0.1	<0.1	<0.1	<0.1	0.1	0.4	0.2	0.3
Cs	0.2	0.2	0.3	0.4	0.8	1.7	1.9	1.9
Cu	<0.1	0.3	0.1	0.5	0.5	0.3	0.2	<0.1
Fe	6.0	7.3	8.6	10.4	9.3	2.8	0.2	0.4
I	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
K	<0.1	<0.1	0.2	0.2	0.3	0.6	0.7	0.9
Li	1.3	1.5	1.6	1.5	1.5	1.8	1.9	1.8
Mg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mn	1.0	0.6	0.4	0.2	0.1	<0.1	<0.1	<0.1
Na	4.1	4.2	4.5	4.8	5.2	7.4	7.8	8.6
Ni	0.3	1.1	0.8	1.2	1.2	0.7	0.4	<0.1
P	<0.1	<0.1	<0.1	<0.1	<0.1	0.3	<0.1	<0.1
Pb	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4
S	<0.1	<0.1	1.0	1.5	3.0	6.5	7.4	7.7
Sb	<0.1	<0.1	<0.1	<0.1	0.1	0.3	0.3	0.3
Se	6.8	12.2	14.2	17.1	18.9	20.6	22.4	23.0
Si	10.8	8.1	5.8	2.7	1.3	0.3	<0.1	0.2
Sr	1.4	1.6	1.9	2.3	1.6	0.3	<0.1	<0.1
Te	0.7	1.2	2.2	4.6	7.0	7.7	8.0	8.6
Ti	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Zn	1.4	1.5	1.7	1.9	1.4	0.4	0.2	0.3
Zr	1.8	0.7	0.4	0.1	<0.1	<0.1	<0.1	<0.1
Mass Fraction Sum (%)	43.0	47.0	48.3	51.9	54.0	53.8	53.7	56.3

Table 6.10. Average Concentrations [ppm] of Selected Species in Off-Gas Measured by FTIR Spectroscopy during DuraMelter 1200 AZ-101 Commissioning Tests.

Test #	**1** 05/07/01 - 05/11/01			**2** 05/14/01 - 05/16/01			**3** 05/21/01 - 05/23/01		
Port *	**Melter Outlet**	**SBS Outlet**	**WESP Outlet**	**Melter Outlet**	**SBS Outlet**	**WESP Outlet**	**Melter Outlet**	**SBS Outlet**	**WESP Outlet**
Total Sampling Time [h]	6.6	8.8	8.1	4.0	5.5	6.8	1.4	4.8	6.9
NO	160.2	297.0	206.4	531.3	683.5	502.6	538.0	693.4	633.3
N_2O	2.8	4.6	3.4	7.1	12.0	9.0	5.6	7.8	7.7
NO_2	21.9	37.6	34.9	38.6	83.7	92.8	5.1	53.4	88.1
HCN	< 1.0	< 1.0	< 1.0	< 1.0	1.4	1.0	< 1.0	1.3	1.3
HNO_2	< 1.0	< 1.0	< 1.0	< 1.0	1.4	1.3	< 1.0	< 1.0	1.5
HNO_3	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
NH_3	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Acetonitrile	< 1.0	< 1.0	< 1.0	1.8	< 1.0	< 1.0	3.2	< 1.0	< 1.0
Acrylonitrile	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
HCl	1.2	< 1.0	< 1.0	5.4	< 1.0	< 1.0	2.2	< 1.0	< 1.0
HF	4.6	< 1.0	< 1.0	16.2	1.0	< 1.0	10.9	1.1	< 1.0
SO_2	< 1.0	< 1.0	< 1.0	8.8	< 1.0	< 1.0	5.4	< 1.0	< 1.0
CO	< 1.0	< 1.0	< 1.0	1.3	2.1	1.7	1.7	2.6	2.2
CO_2 [%]	0.3	0.5	0.4	0.8	1.2	0.9	0.7	1.1	1.0
H_2O [%]	8.4	3.1	3.3	23.1	4.5	5.5	38.5	5.8	5.9

* NOTE: Each of the three ports was samples sequentially, not simultaneously, and therefore each data set corresponds to a different time interval.

Table 6.11. Average NO and NO_2 Fluxes in Off-Gas Measured by FTIR Spectroscopy during DuraMelter 1200 AZ-101 Commissioning Tests.

Test #	Run Time Range [h]	NO [mol/h]	NO_2 [mol/h]	Feed [mol/h]
1	4.80 - 9.03	7.9	0.9	5.2
	31.28 - 33.05	7.1	0.8	4.6
	49.55 - 55.43	1.9	0.4	1.3
	73.69 - 80.21	2.3	0.4	1.6
	96.70 - 103.35	1.6	0.3	1.3
2	1.82 - 8.82	6.8	0.7	5.3
	25.51 - 32.63	9.4	1.2	6.1
	48.94 - 52.07	10.1	1.6	7.7
3	2.87 - 9.43	9.9	0.8	6.0
	25.37 - 29.88	9.4	0.9	5.5
	50.03 - 52.62	9.4	1.4	6.0

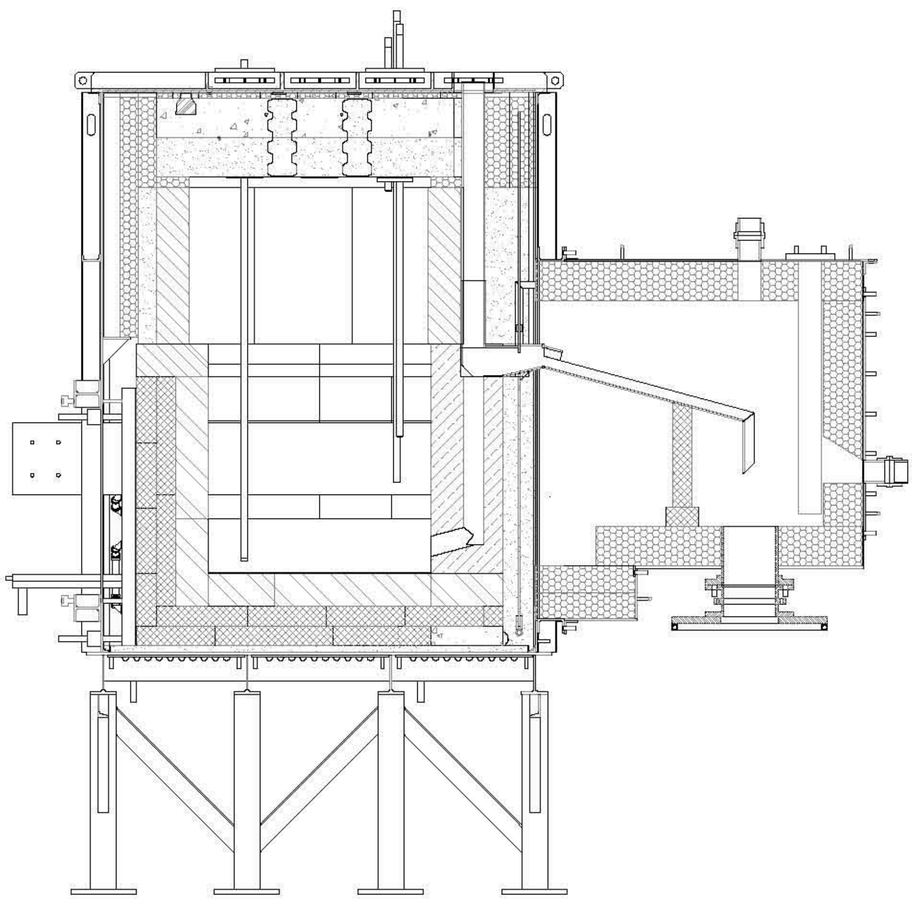


Figure 1.1 Cross-section of the DM1200 melter through the discharge chamber.

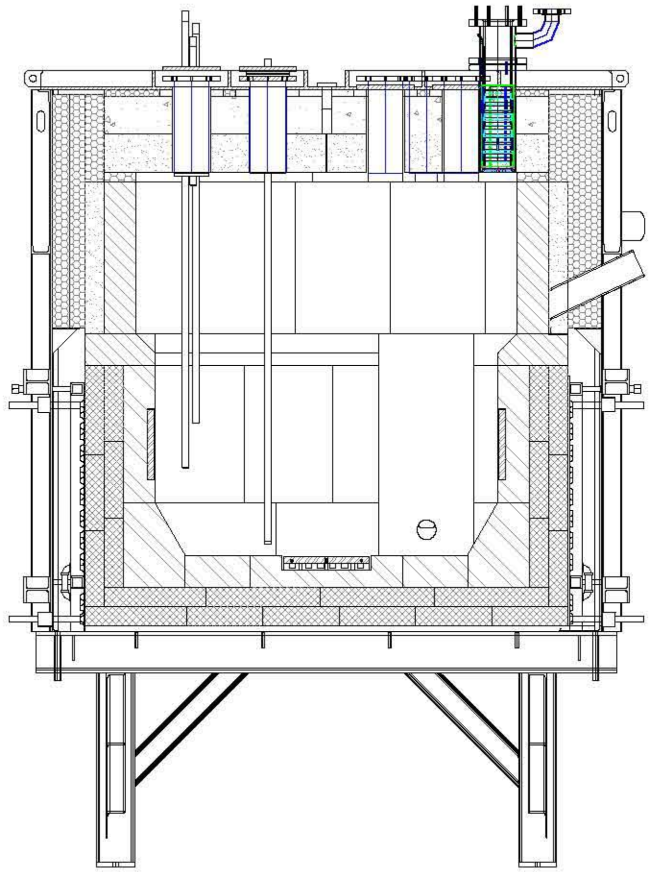


Figure 1.2. Cross-section of the DM1200 melter showing electrodes.

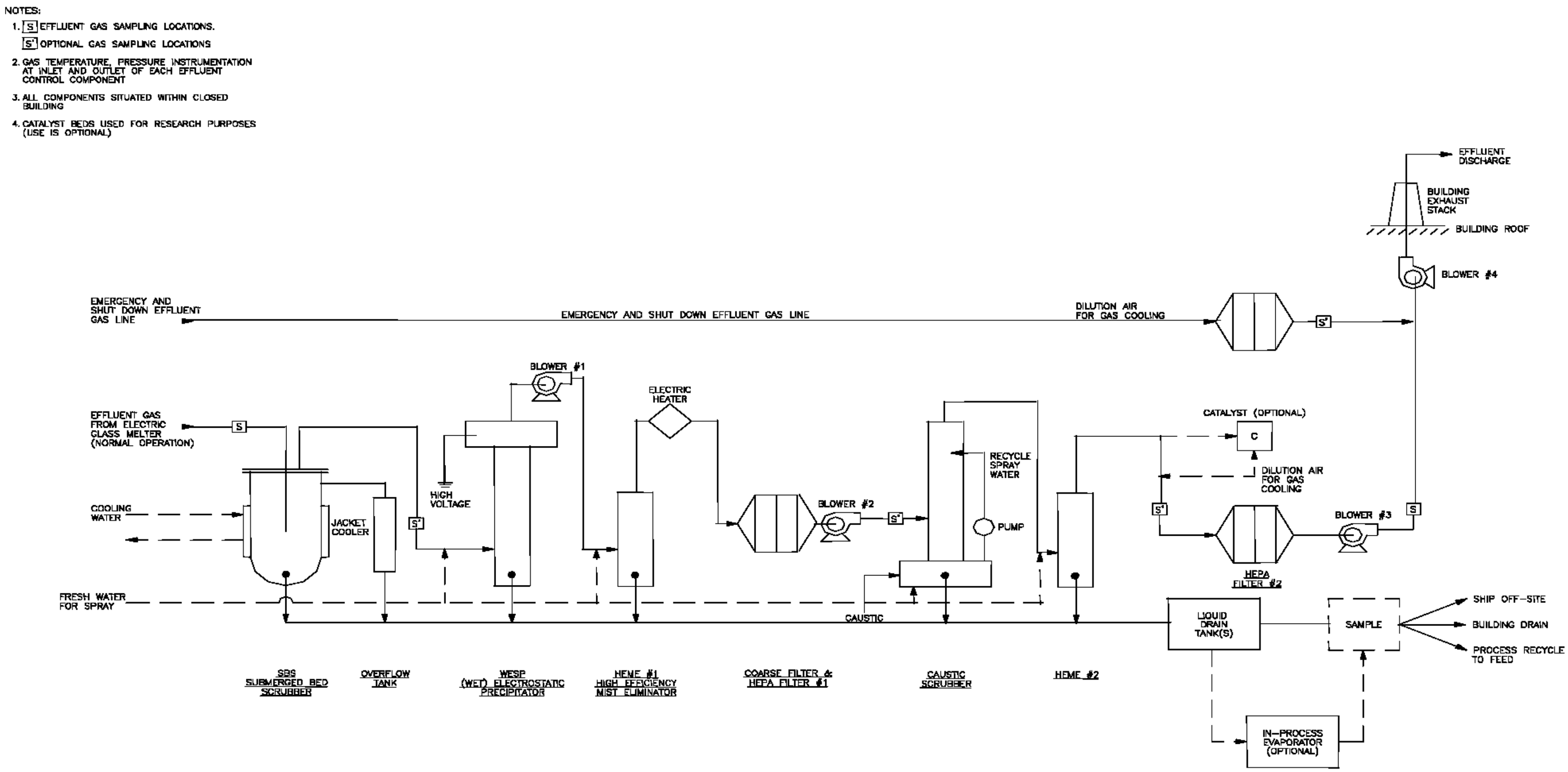


Figure 1.3. Schematic diagram of the DM1200 off-gas system.

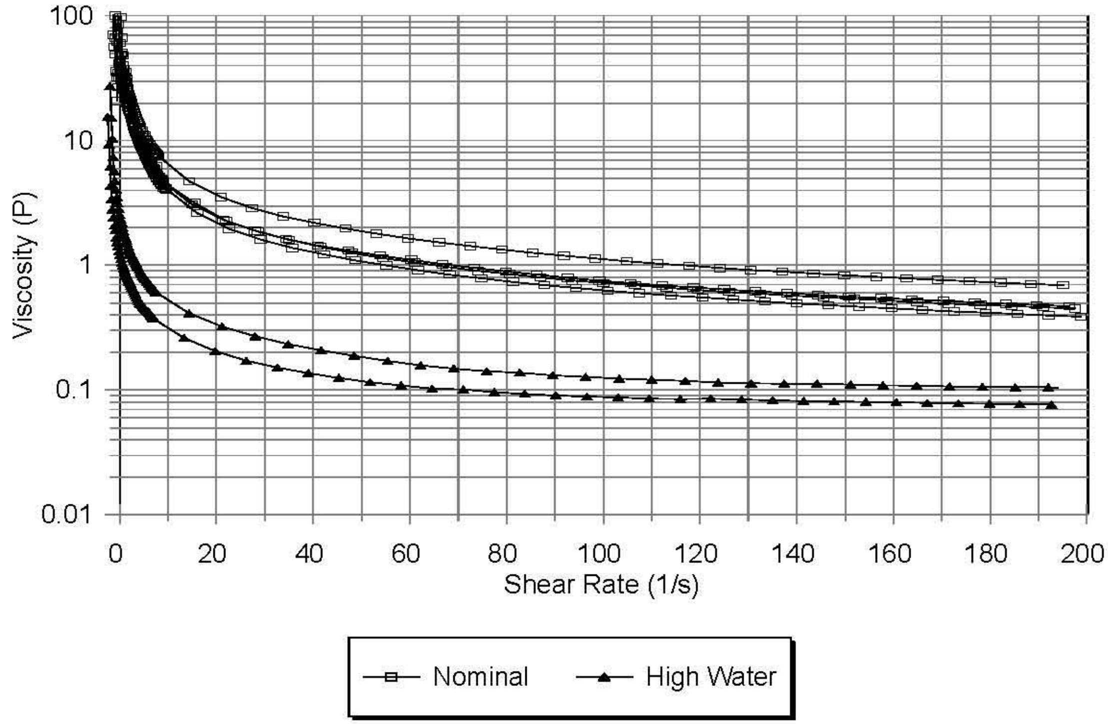


Figure 2.1. Rheograms comparing AZ-101 melter feeds from DM1200 commissioning at two solids contents.

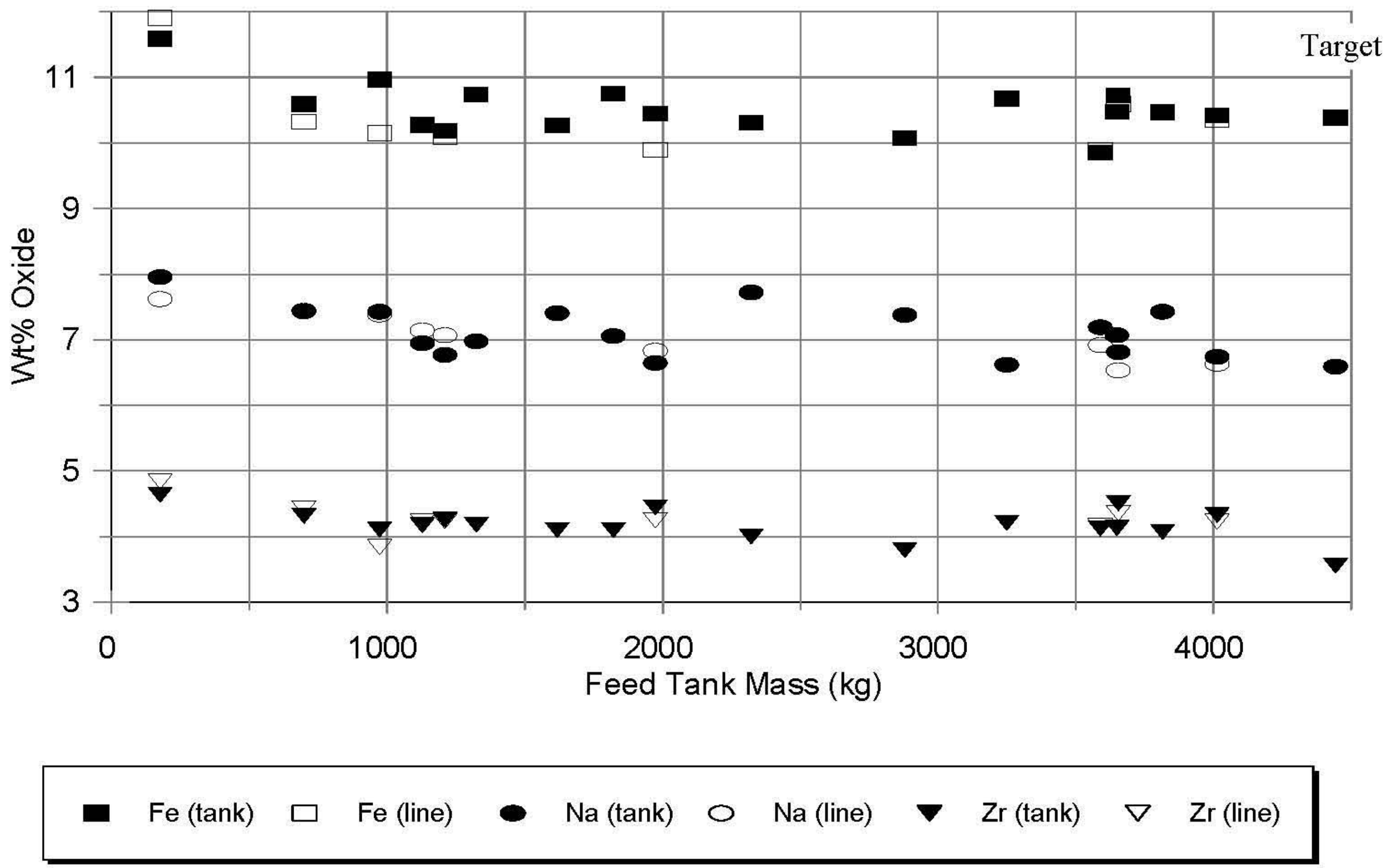


Figure 2.2. Analysis of select elements in feed samples from DM1200 commissioning tests.

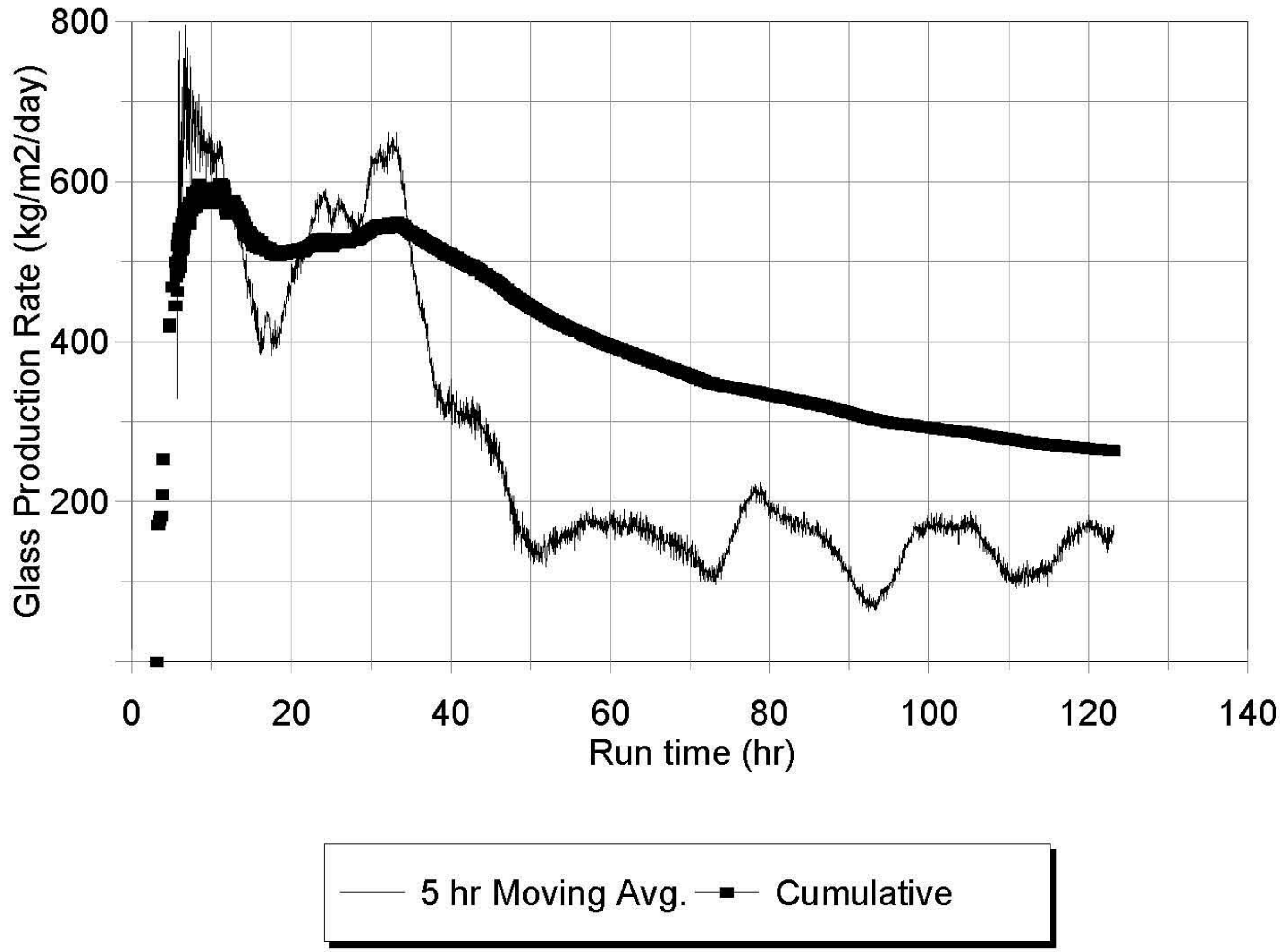


Figure 3.1. Glass production rates for DM1200 commissioning Test 1 (AZ-101 570 g/l with no bubbling).

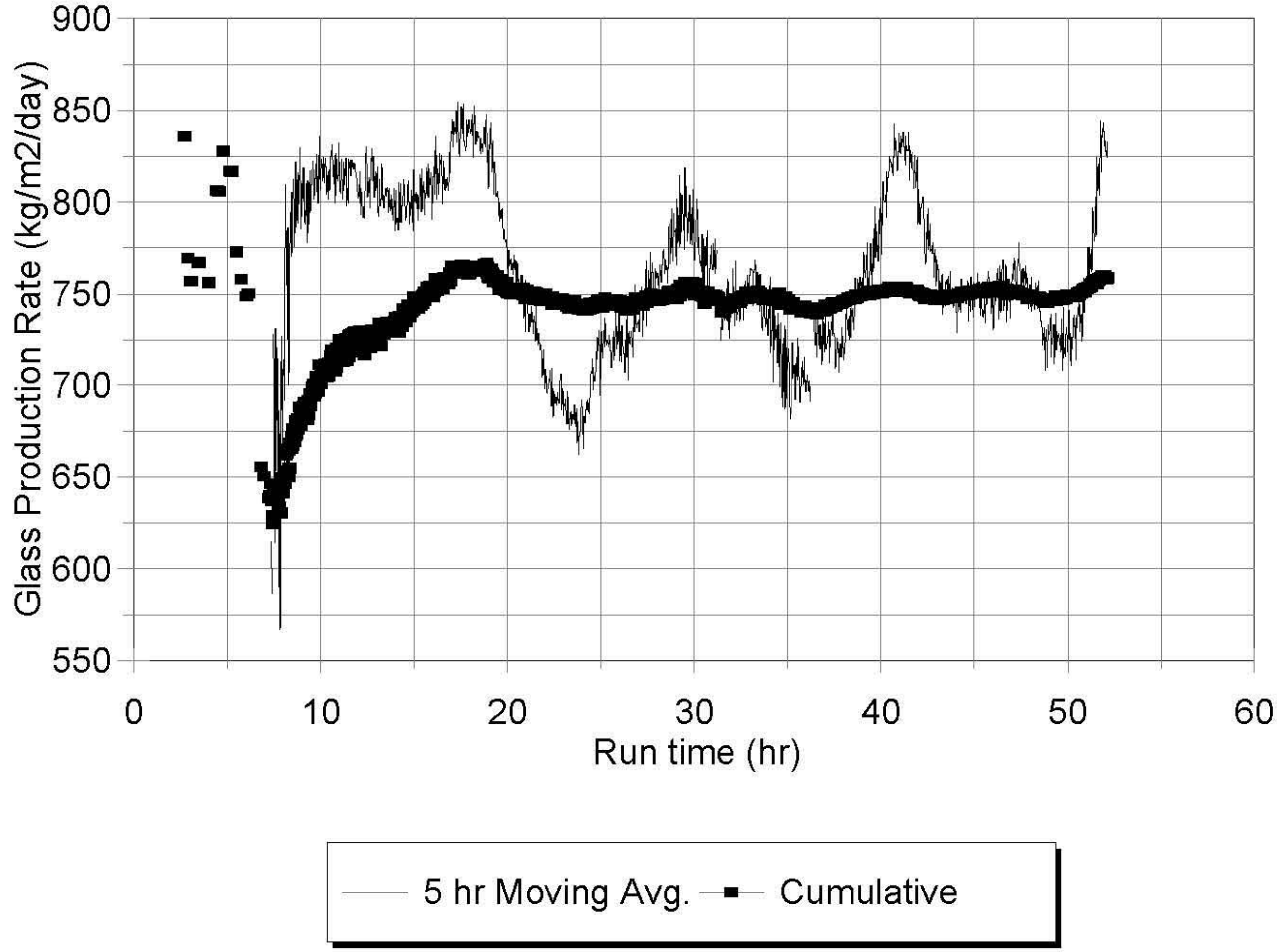


Figure 3.2. Glass production rates for DM1200 commissioning Test 2 (AZ-101 570 g/l with bubbling).

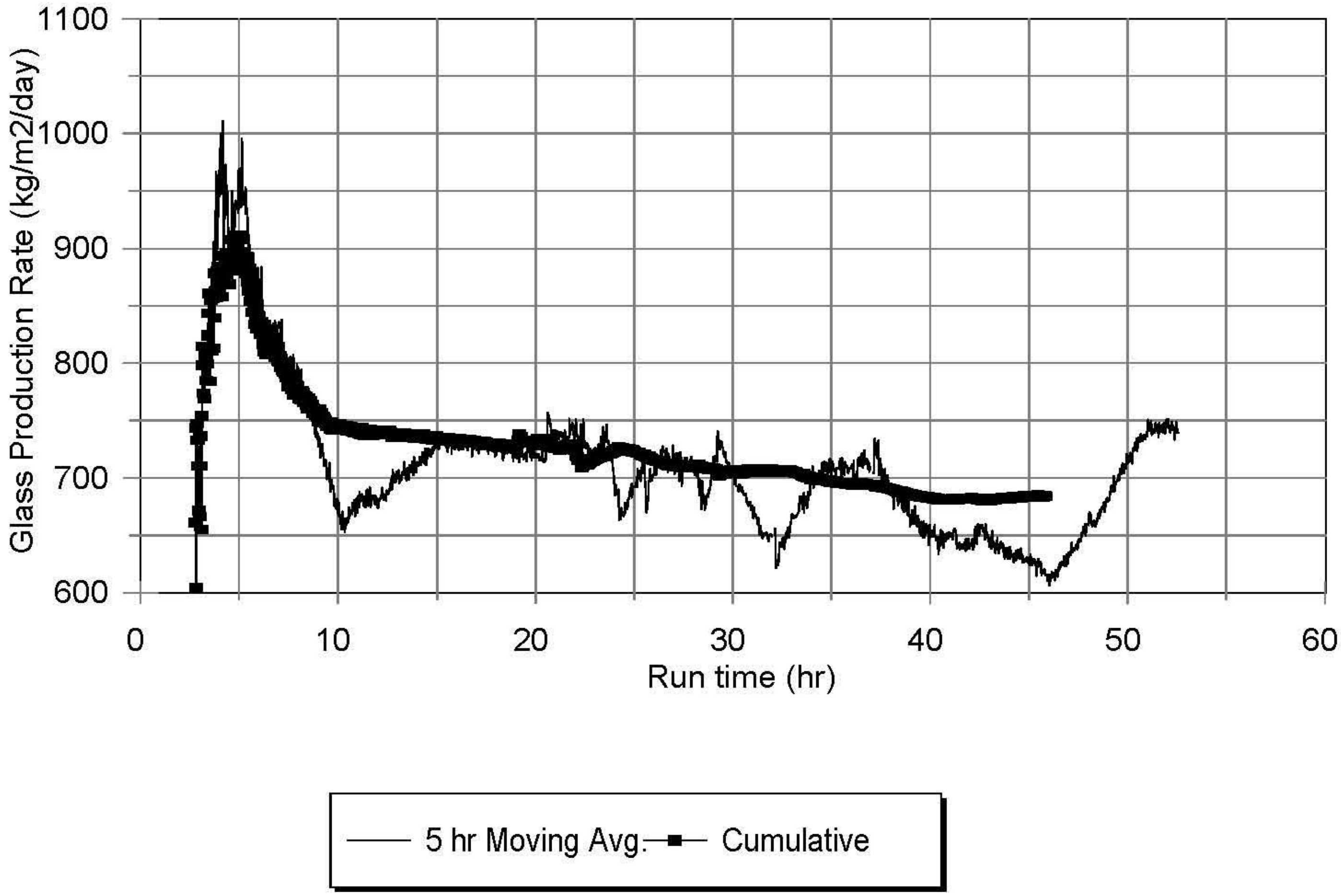


Figure 3.3. Glass production rates for DM1200 commissioning Test 3 (AZ-101 350 g/l with bubbling).

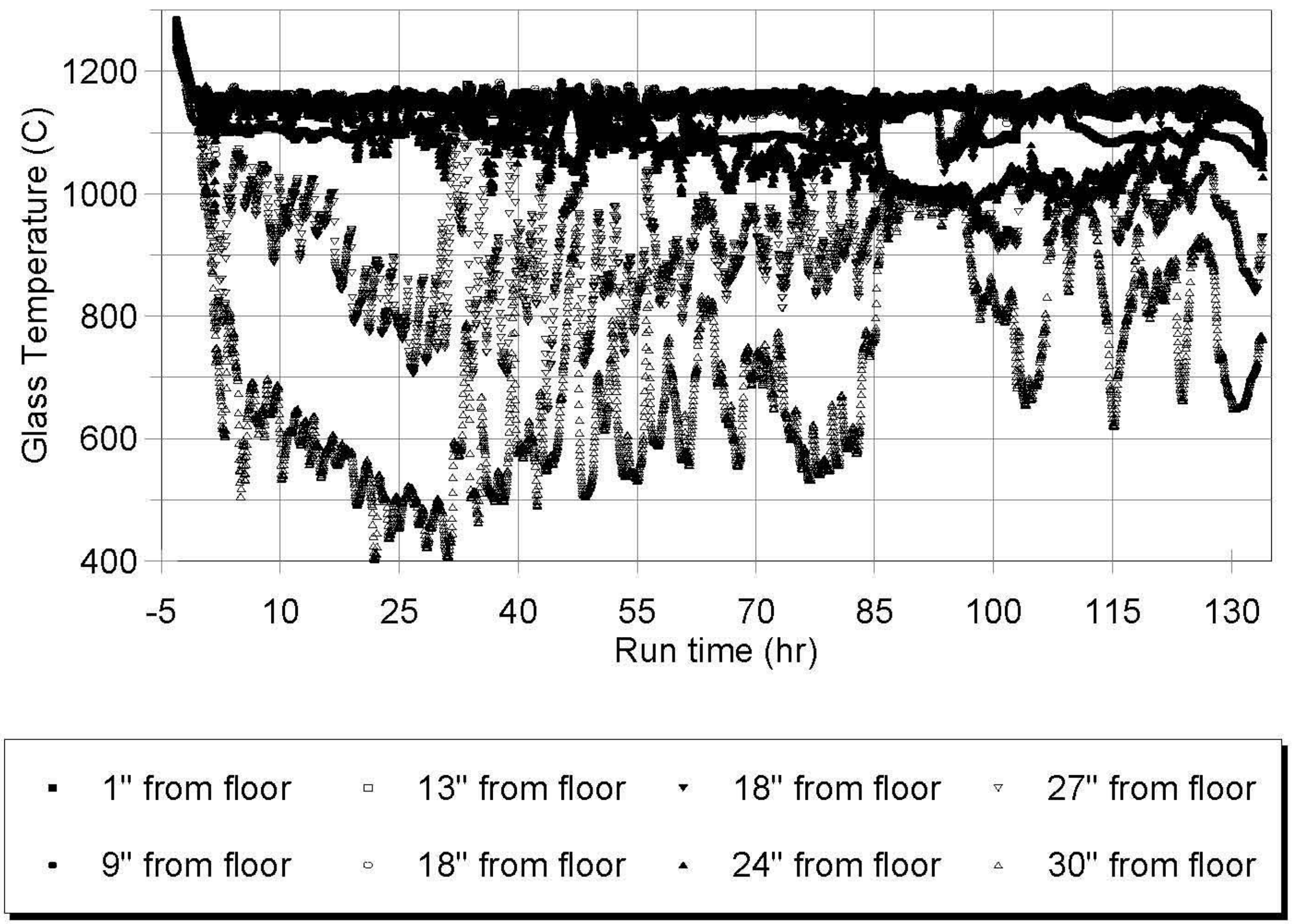


Figure 3.4. Glass temperature for DM1200 commissioning Test 1 (AZ-101 570 g/l with no bubbling).

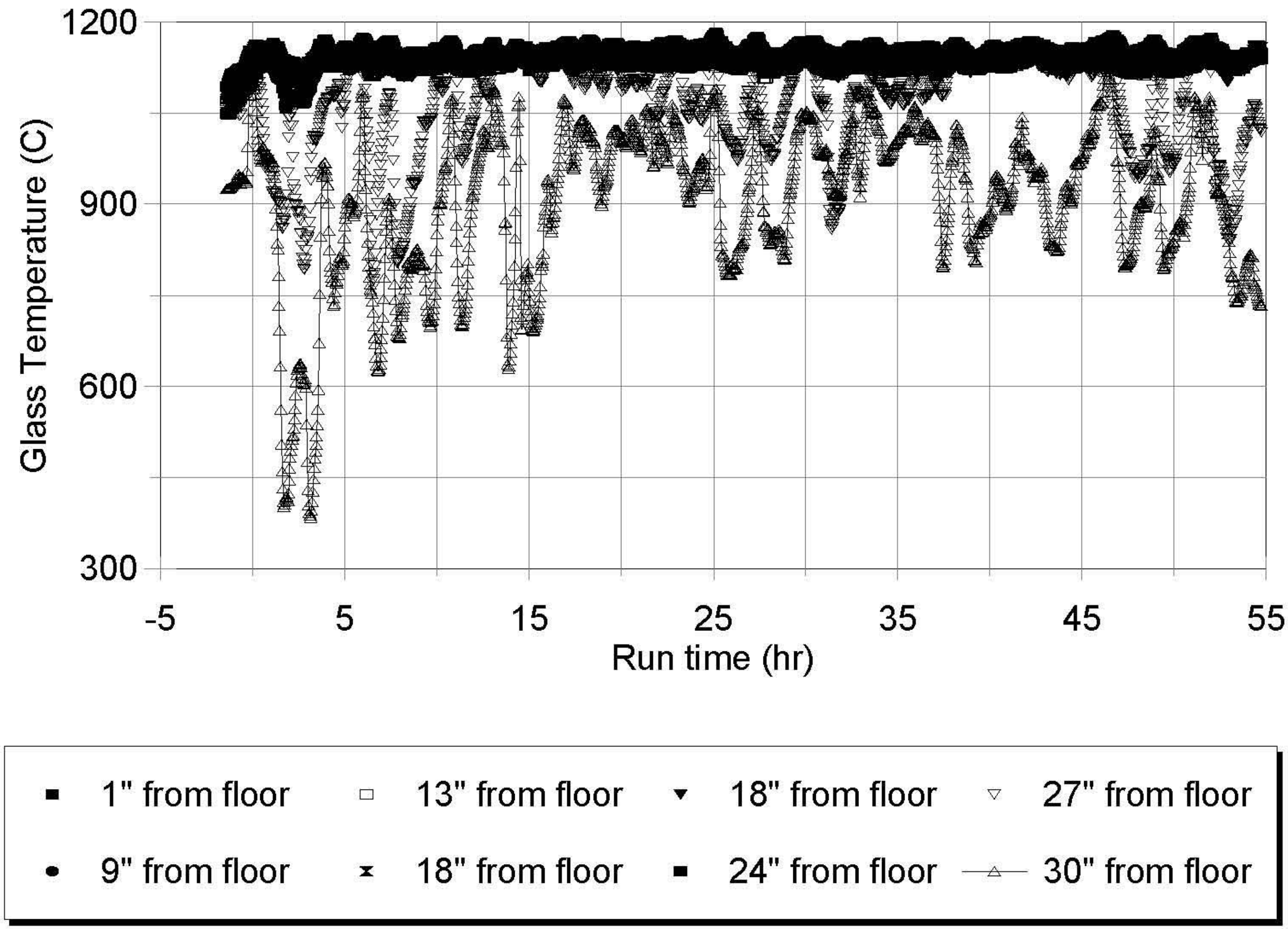


Figure 3.5. Glass temperature for DM1200 commissioning Test 2 (AZ-101 570 g/l with bubbling).

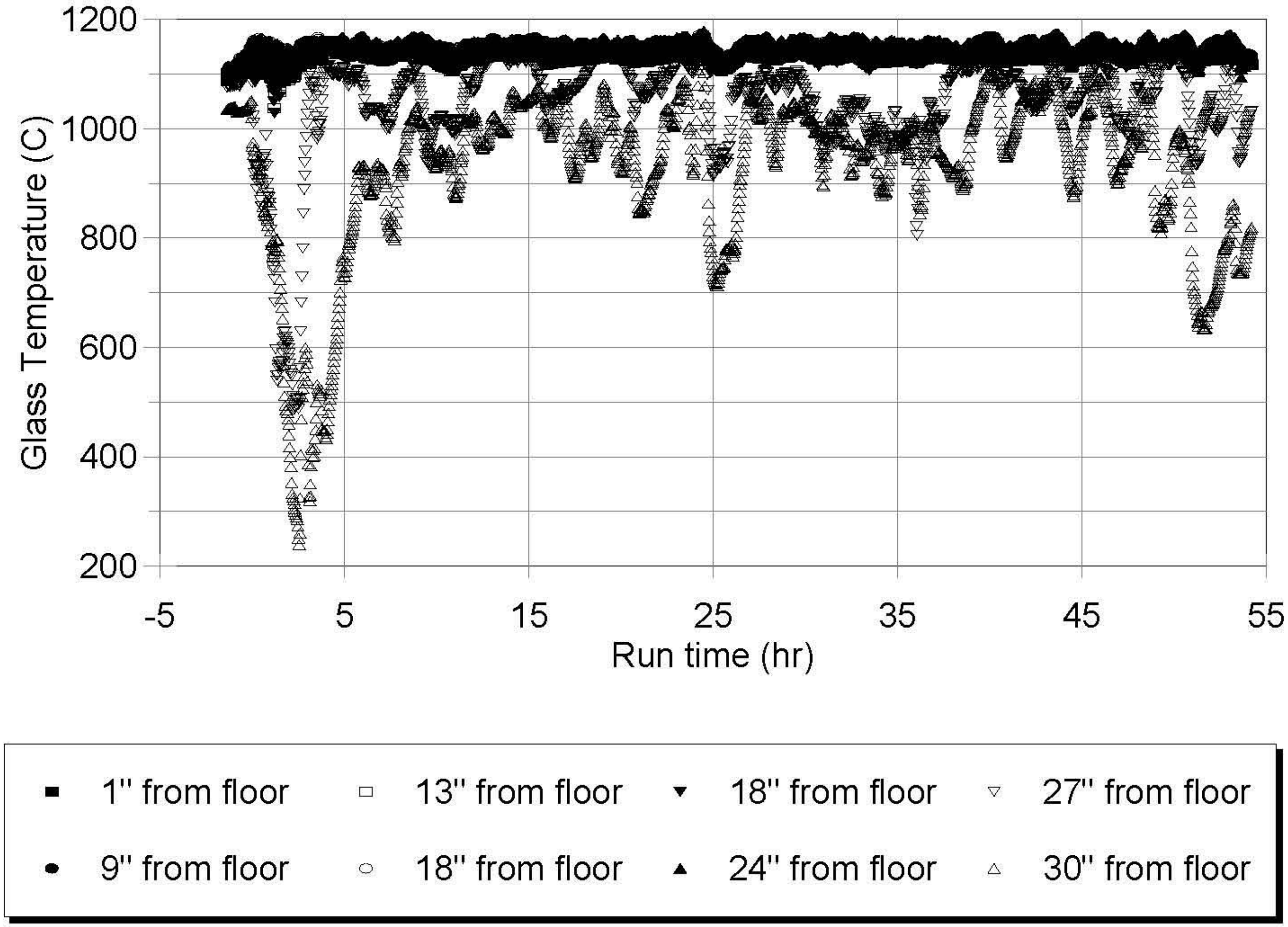


Figure 3.6. Glass temperatures for DM1200 commissioning Test 3 (AZ-101 350 g/l with bubbling).

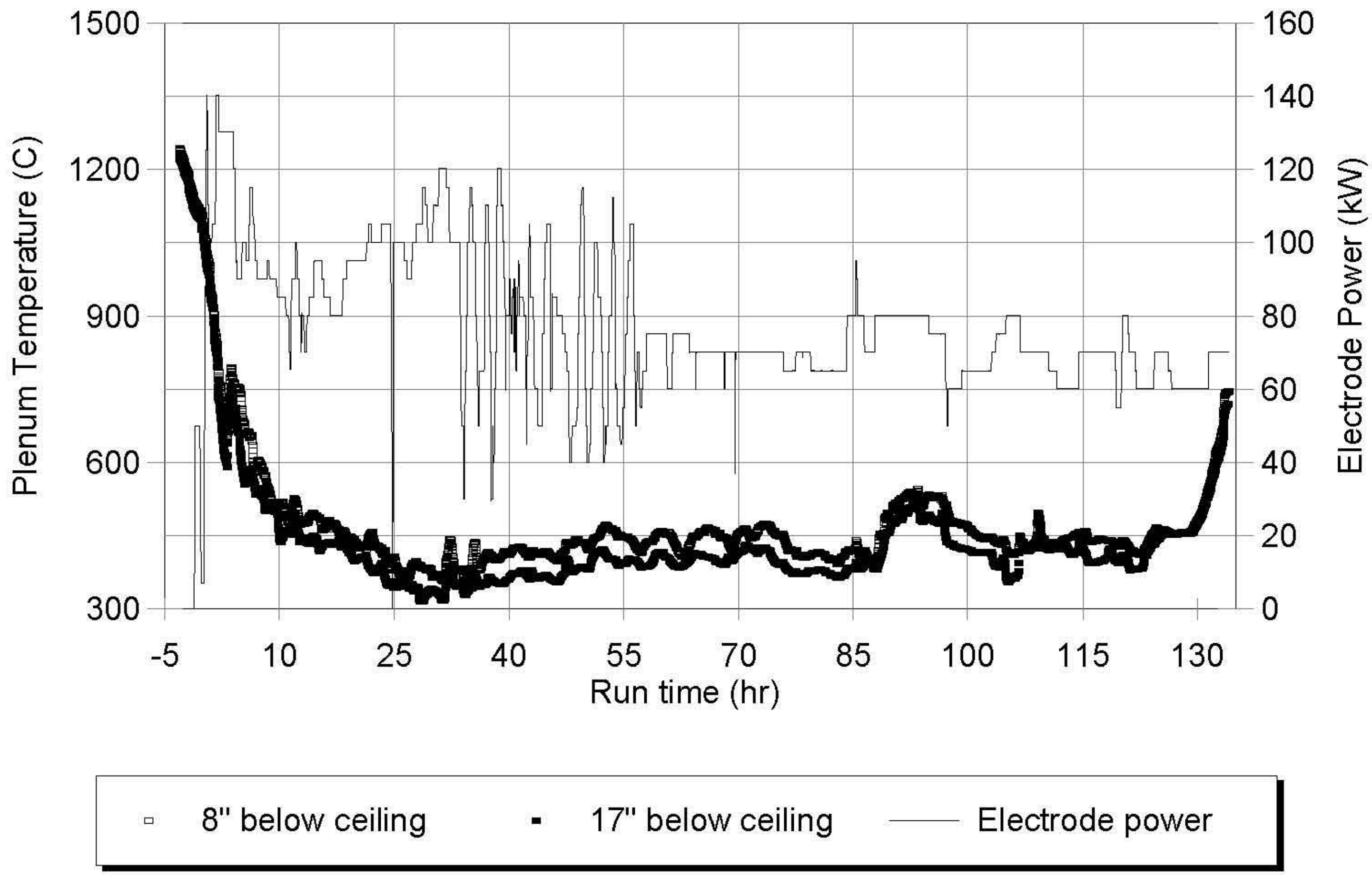


Figure 3.7. Plenum temperatures and electrode power for DM1200 commissioning Test 1 (AZ-101 570 g/l with no bubbling).

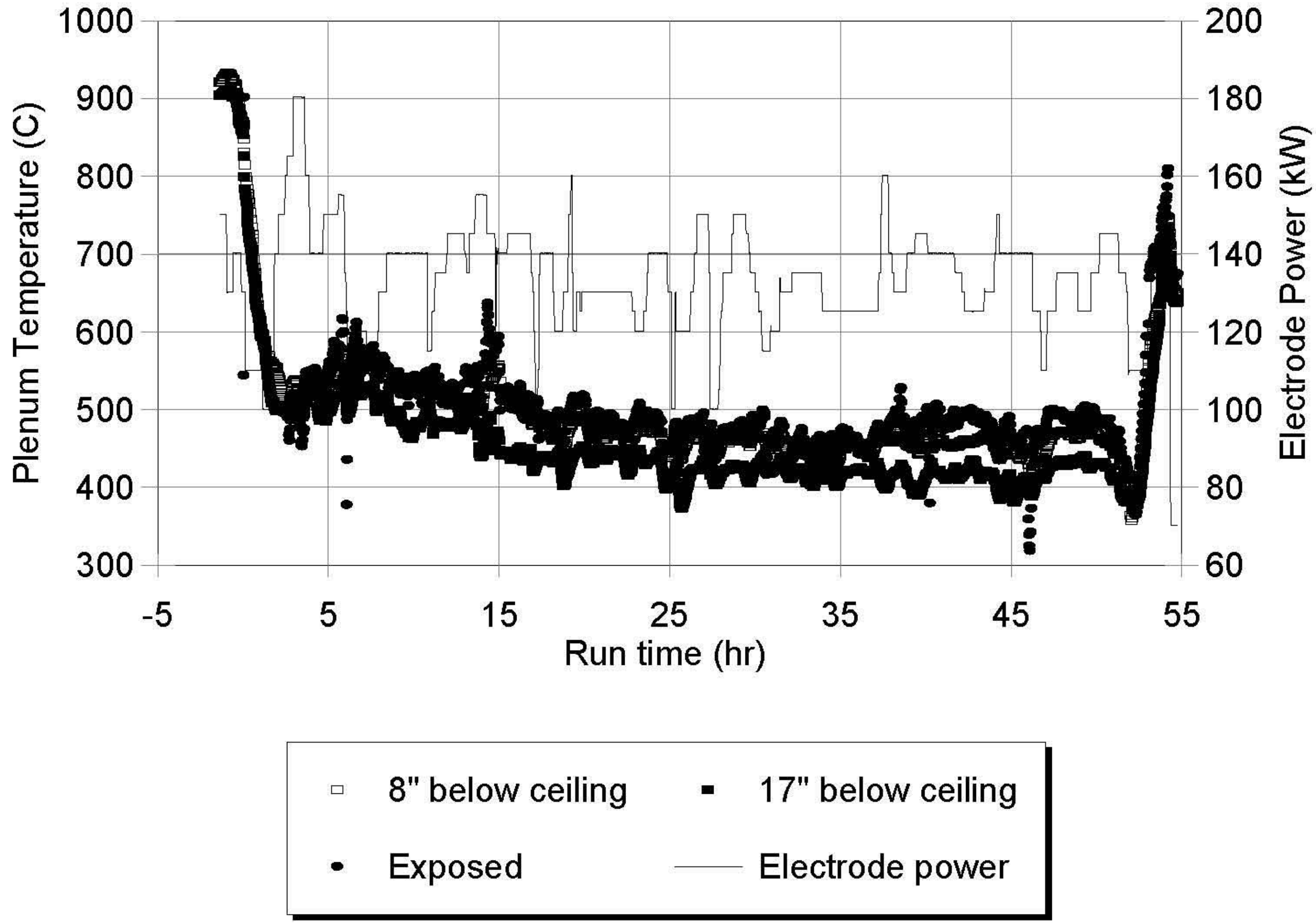


Figure 3.8. Plenum temperatures and electrode power for DM1200 commissioning Test 2 (AZ-101 570 g/l with bubbling).

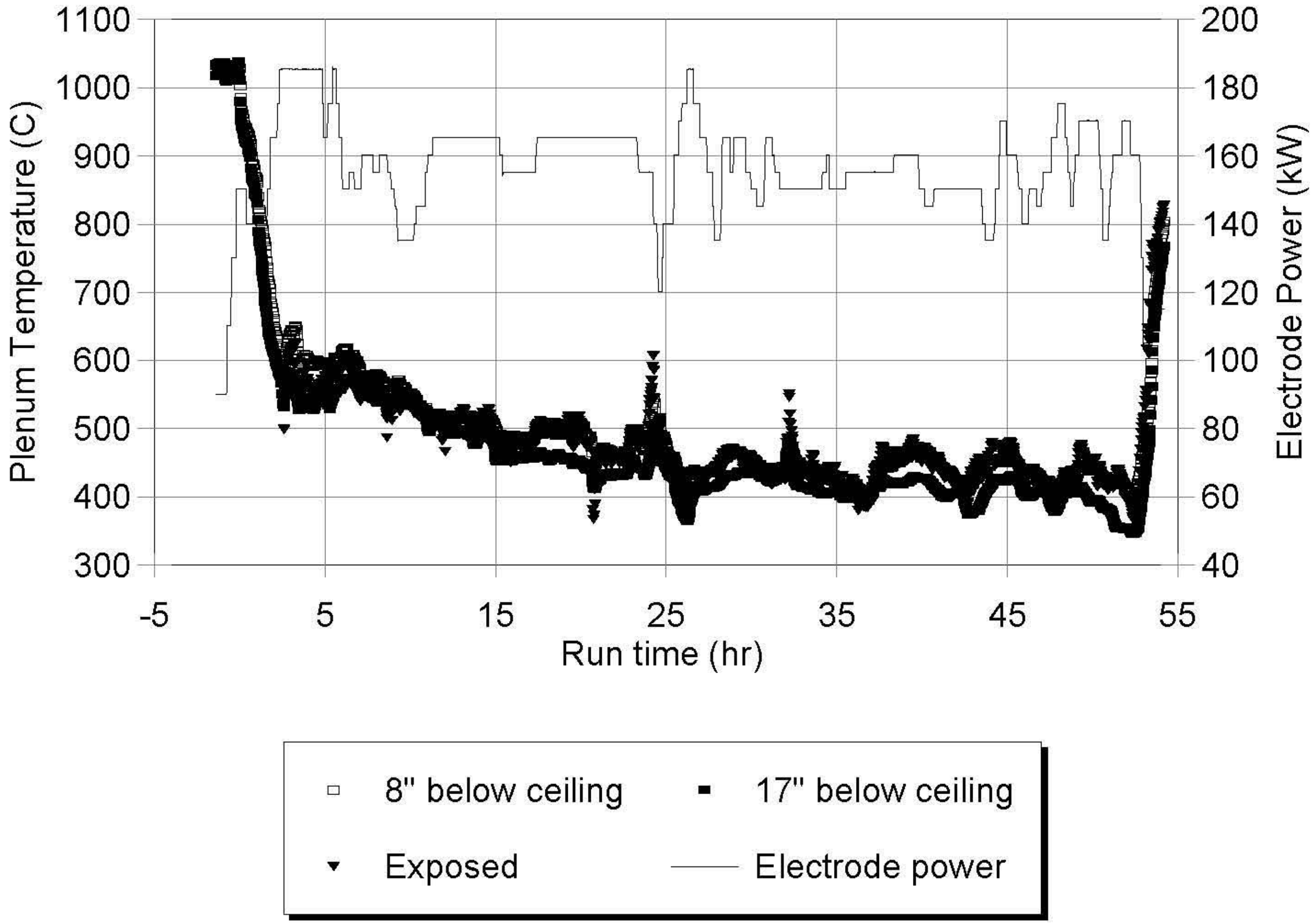


Figure 3.9. Plenum temperatures and electrode power for DM1200 commissioning Test 3 (AZ-101 350 g/l with bubbling)

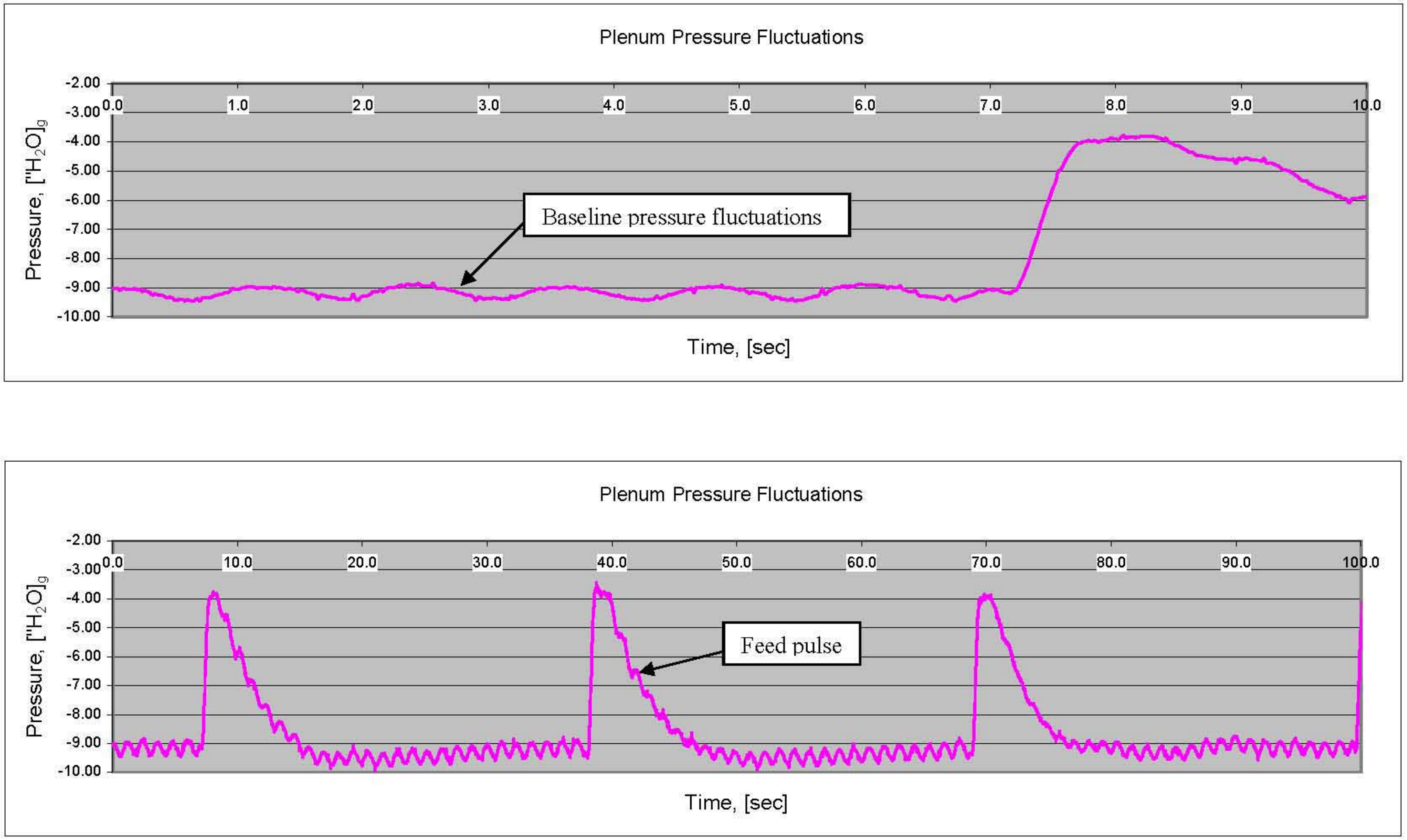


Figure 4.1. DM1200 plenum pressure measured with a fast response sensor (5 ms) showing pressure fluctuations due to feed pulses (upper plot represents a 10X time scale expansion of the first 10 seconds). Conditions: Start of Test 2; AZ-101 feed; average of 0.57 kg of feed per feed pulse; about 80% cold cap coverage.

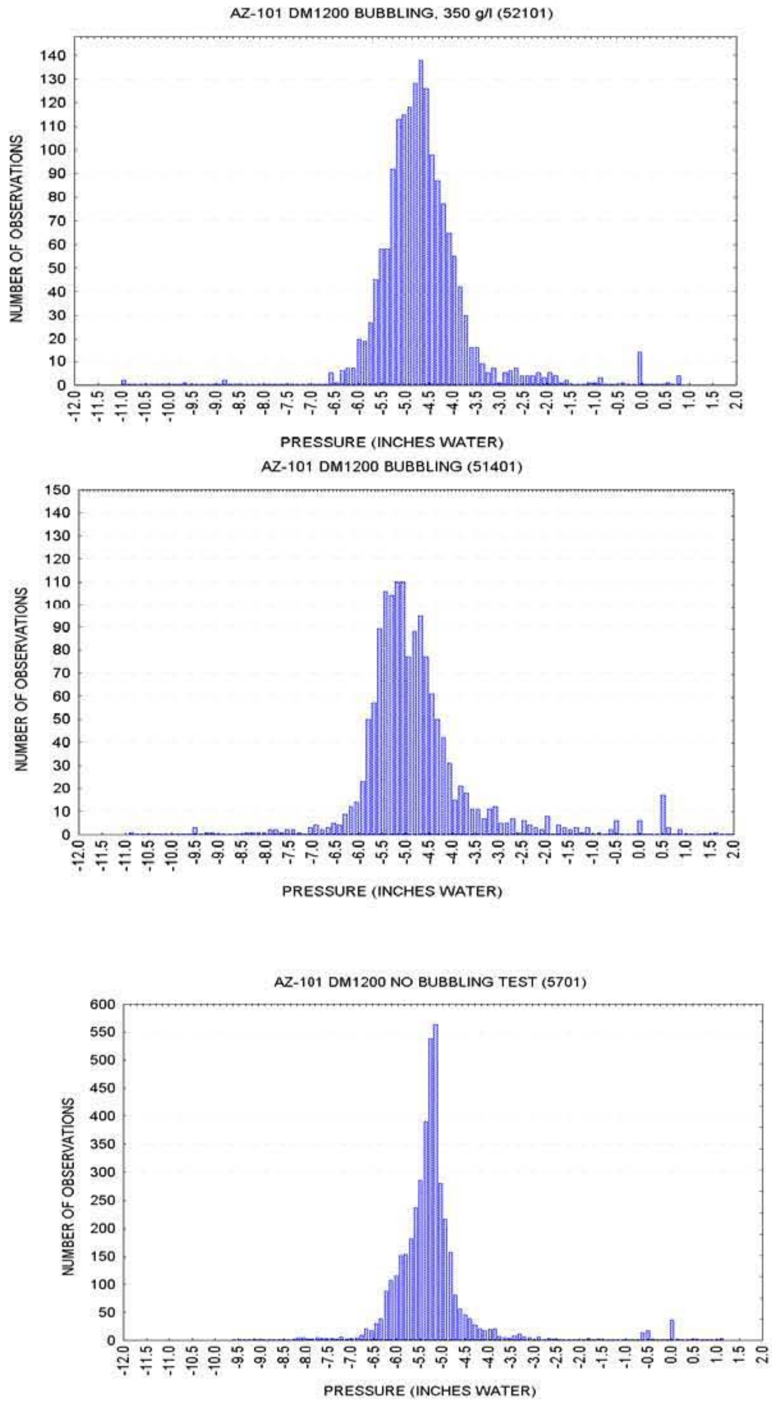
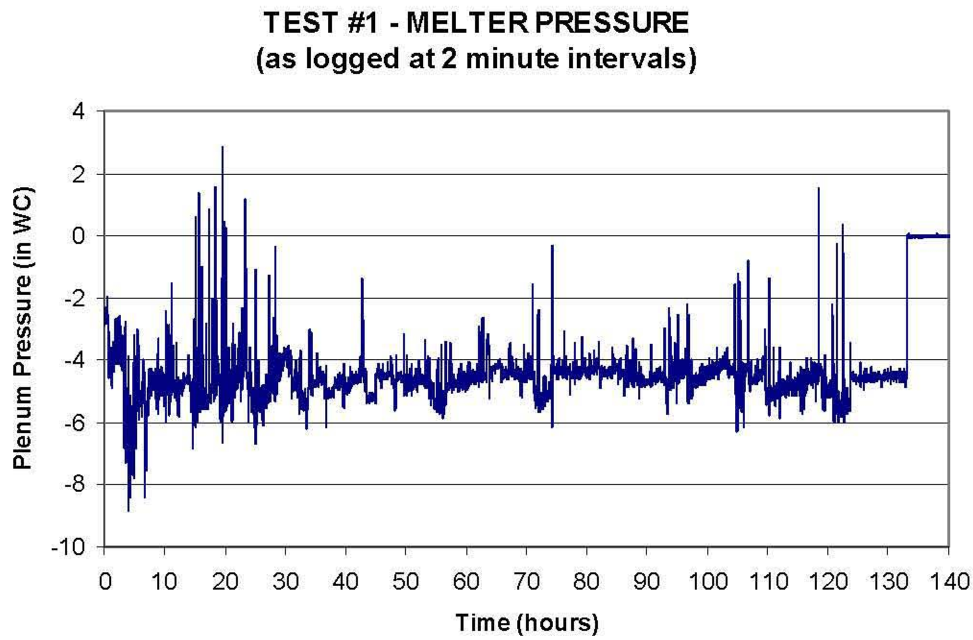


Figure 4.1a. Frequency distribution plots for melter pressure variations during Test 1 (bottom), Test 2 (middle), and Test 3 (top).



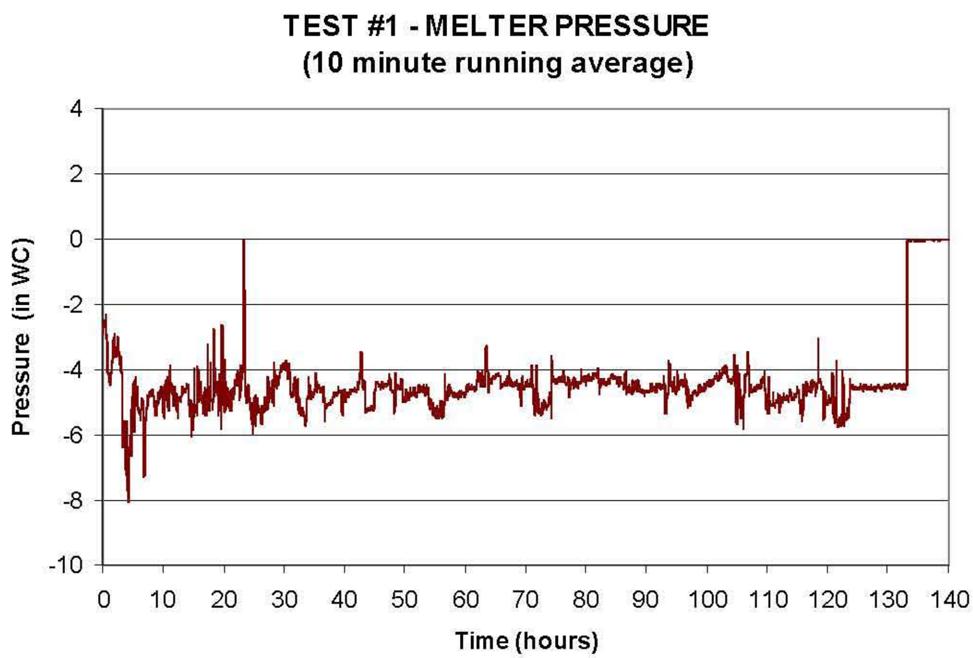
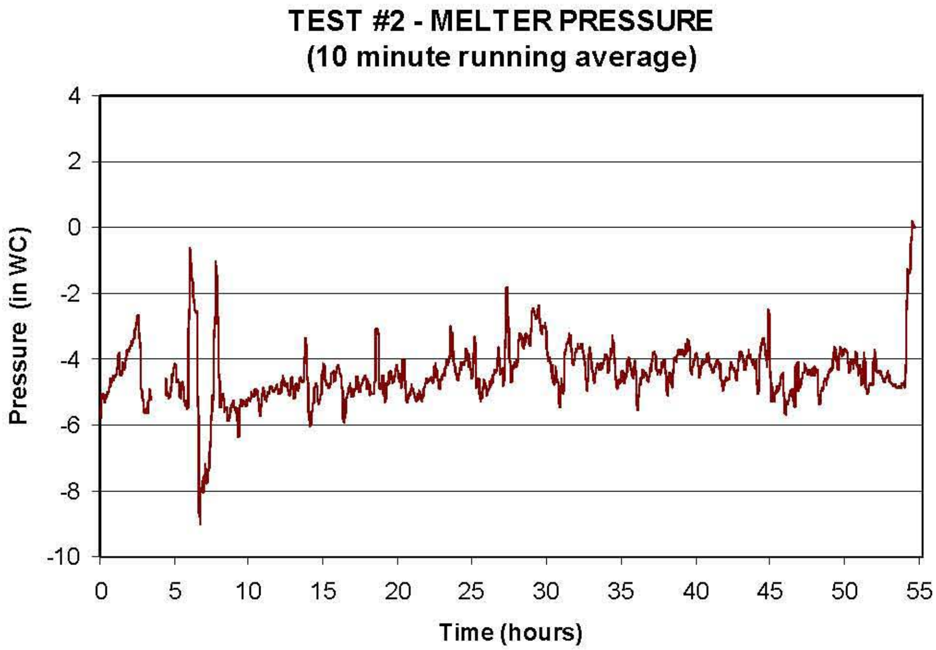


Figure 4.2. Melter pressure during Test #1 recorded at 2-minute intervals (top) and its moving average over 10 minutes period (i.e., every 5 measurements, bottom).



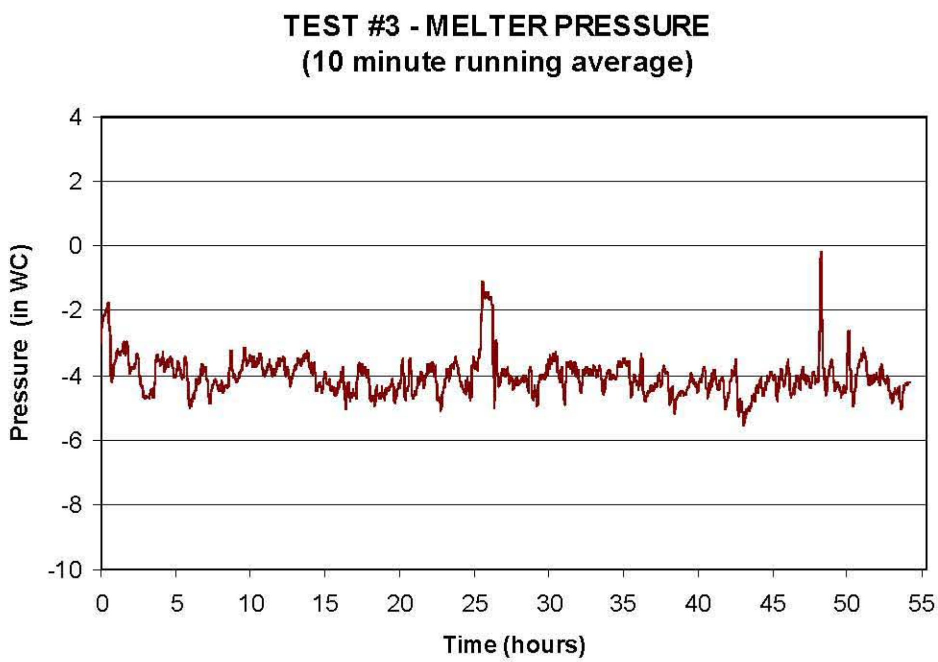
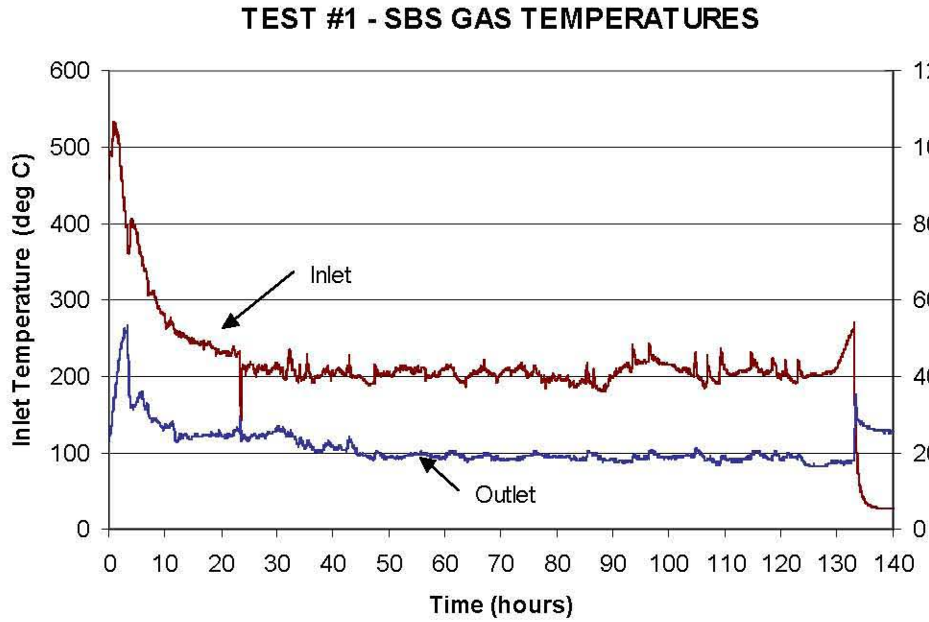


Figure 4.3. Ten minutes moving average of melter pressure during Test #2 (top) and Test #3 (bottom).



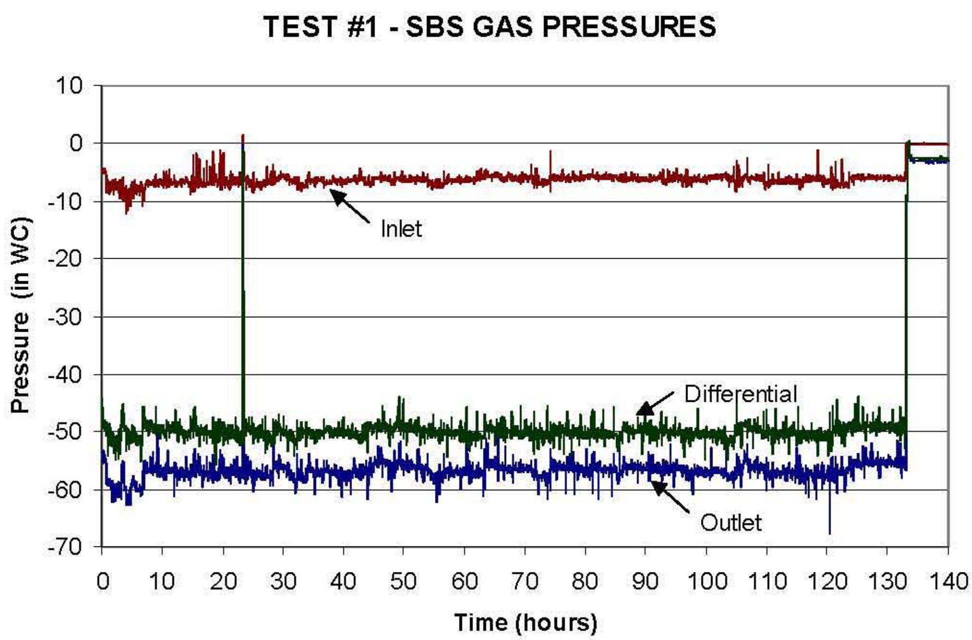
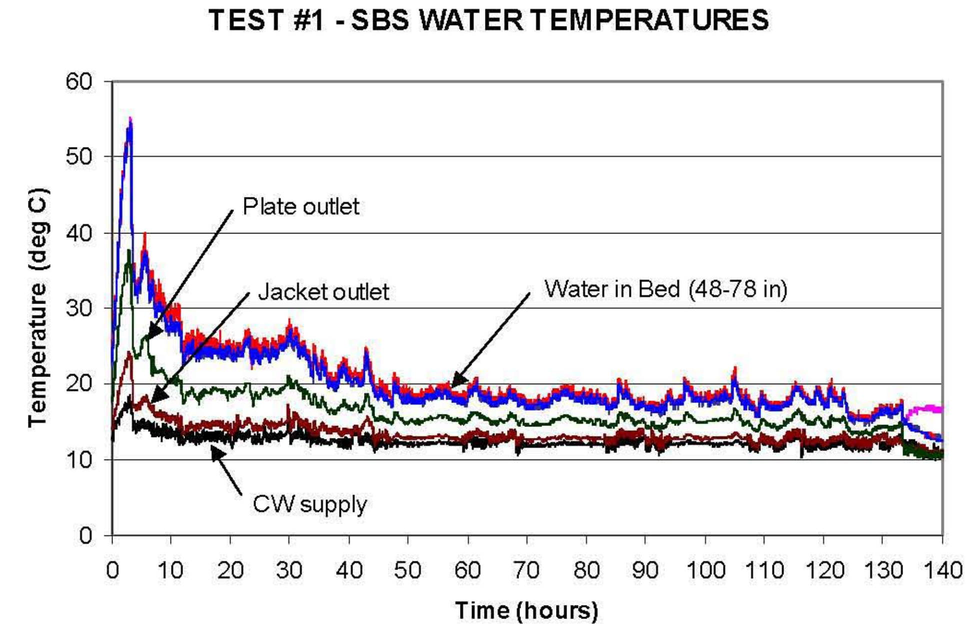


Figure 4.4. SBS inlet and outlet temperatures (top) and pressures (bottom) during Test #1.



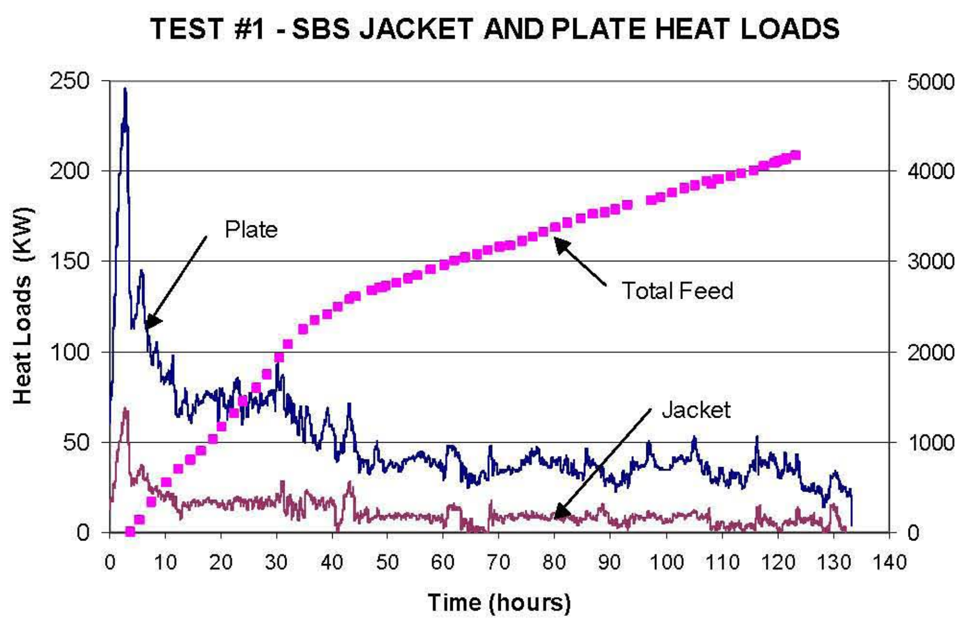
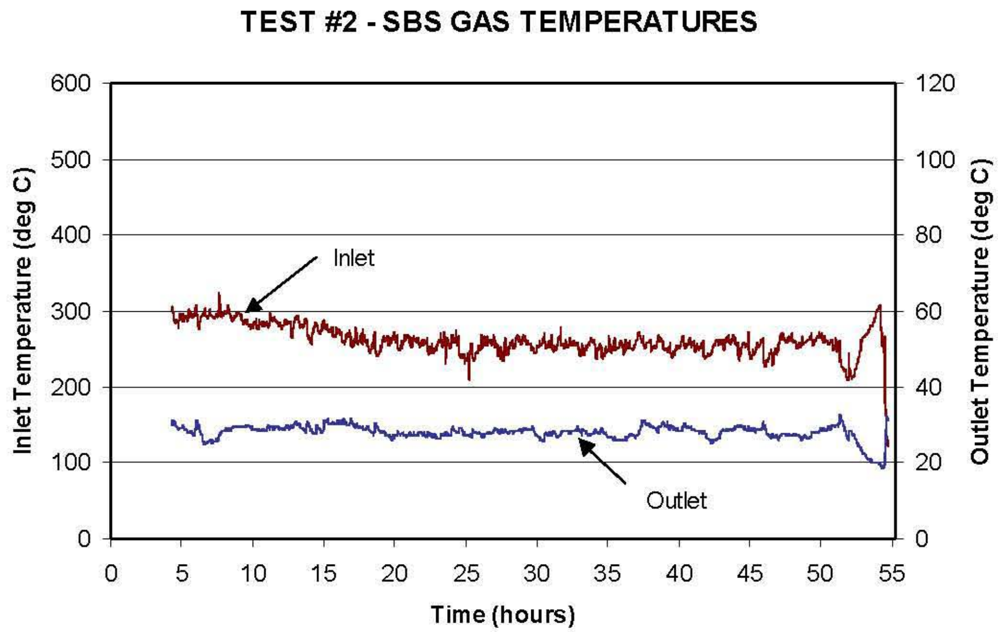


Figure 4.5. SBS cooling water temperatures and in-bed temperatures at depths of 48, 60, 72 and 78 inches (top) and heat removed by water jacket and plate heat exchanger (bottom) for Test 1. Cumulative feed weight is also plotted aside heat loads. Plotted water temperatures and heat loads are 10 minutes moving averages.



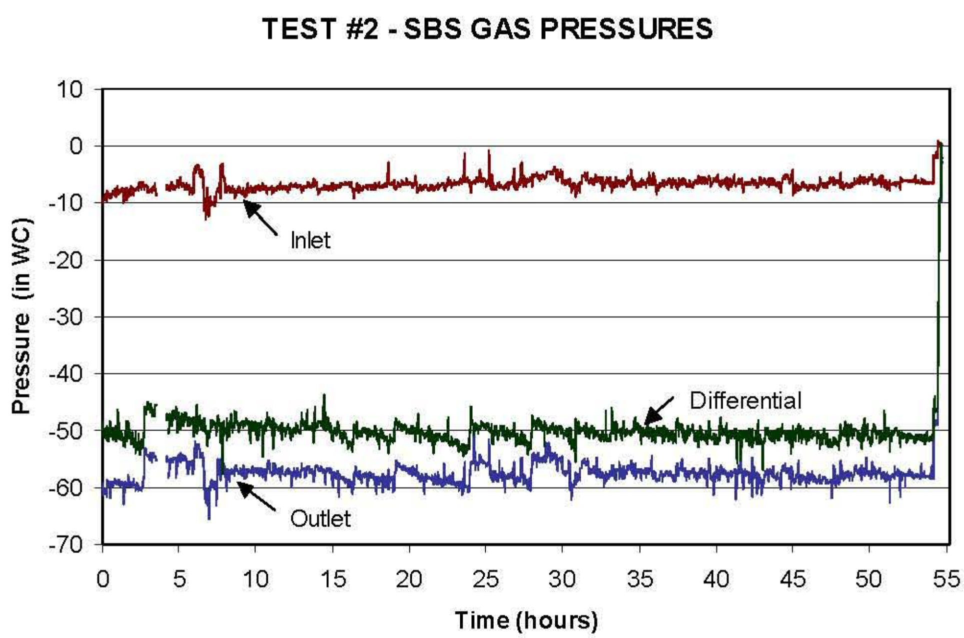
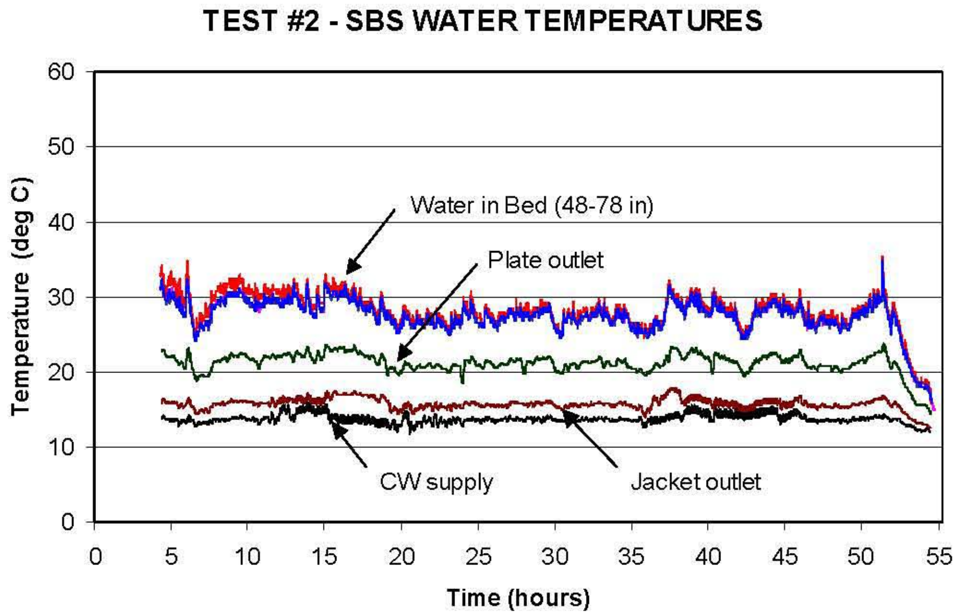


Figure 4.6. SBS inlet and outlet temperatures (top) and pressures (bottom) during Test 2.



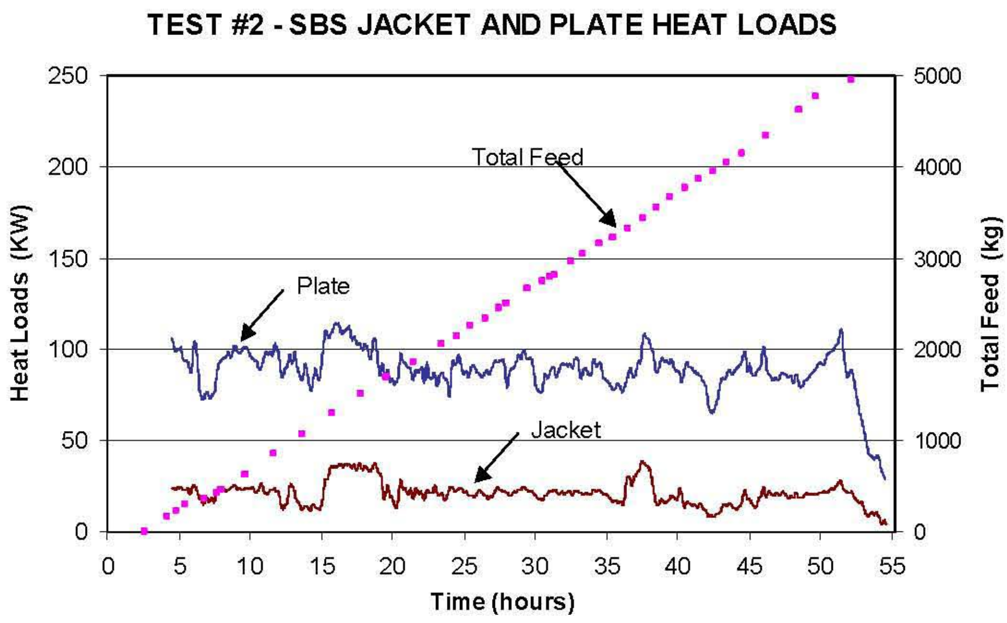
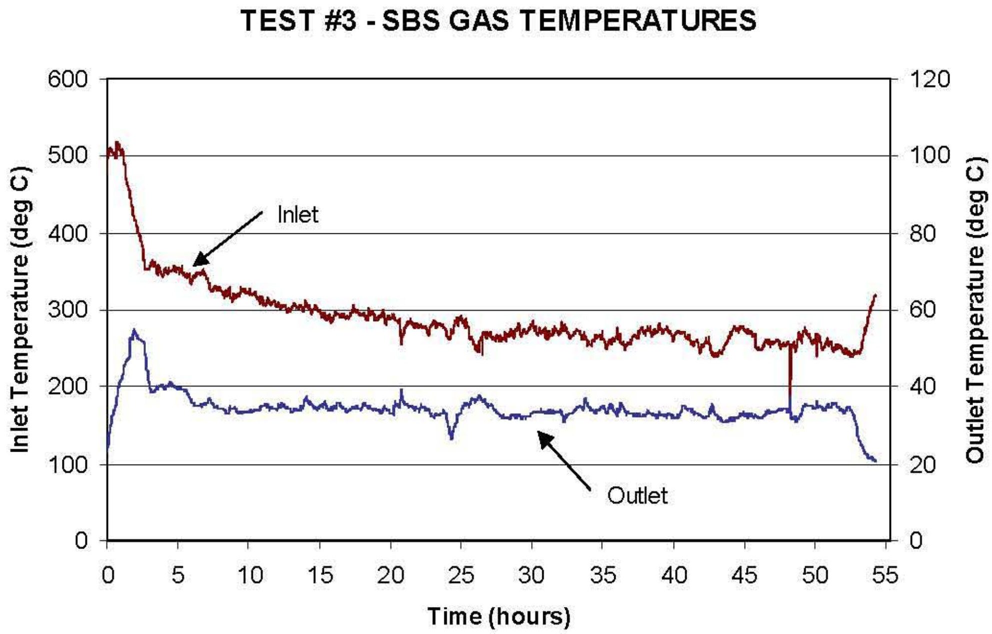


Figure 4.7. SBS cooling water temperatures and in-bed temperatures (top) and heat loads removed by water jacket and plate heat exchanger (bottom) for Test 2. Cumulative feed weight is plotted along heat loads. Plotted water temperatures and heat loads are time averaged over 10 minutes (5 measurements).



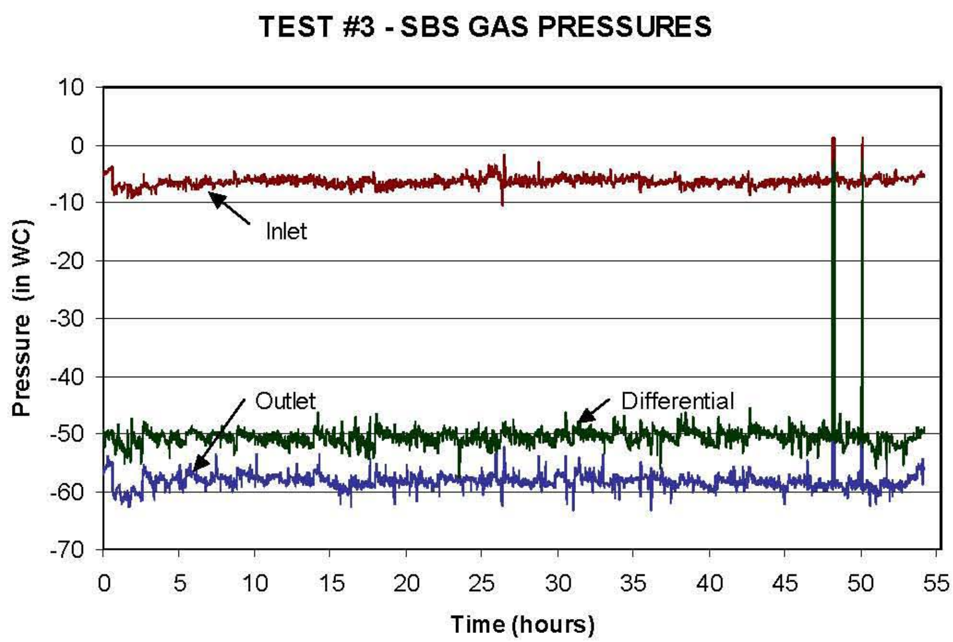
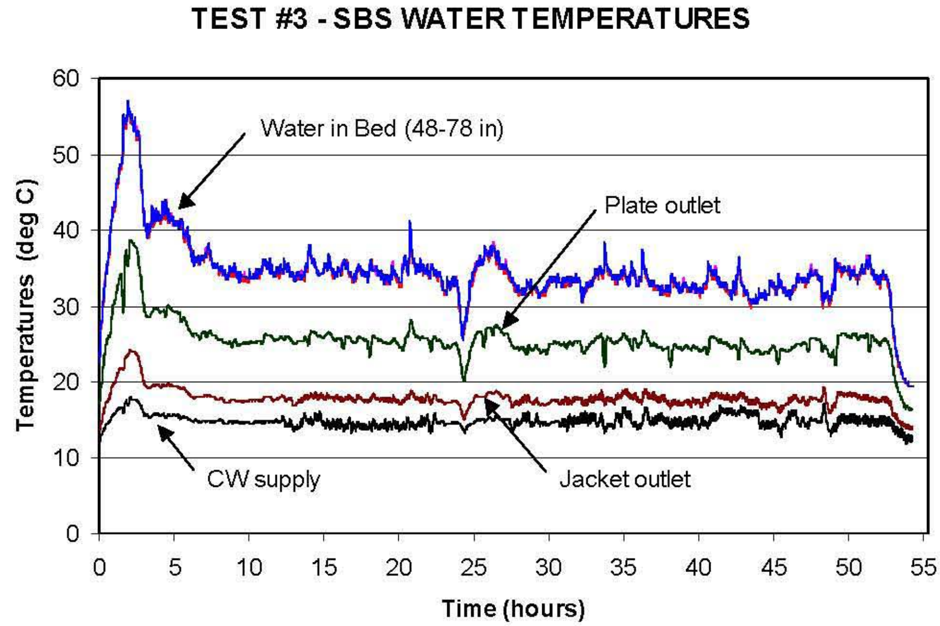


Figure 4.8. SBS inlet and outlet temperatures (top) and pressures (bottom) during Test 3.



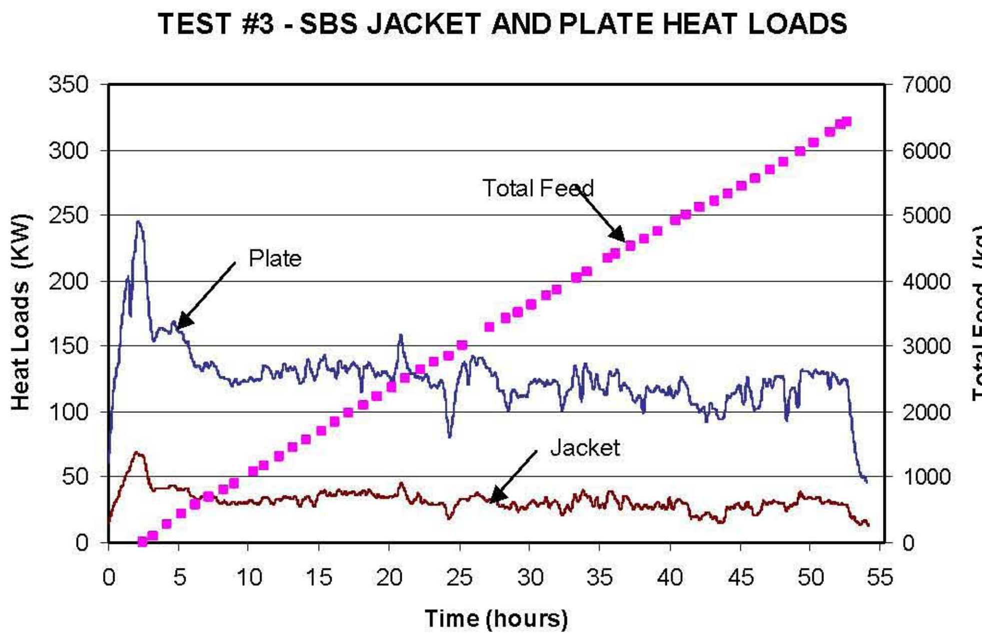


Figure 4.9. SBS cooling water temperatures and in-bed temperatures at depths of 48, 60, 72 and 78 inches (above) and heat removed by water jacket and plate heat exchanger (below) for Test 3. Cumulative feed weight is also plotted aside heat loads. Plotted water temperatures and heat loads are 10 minutes moving averages.

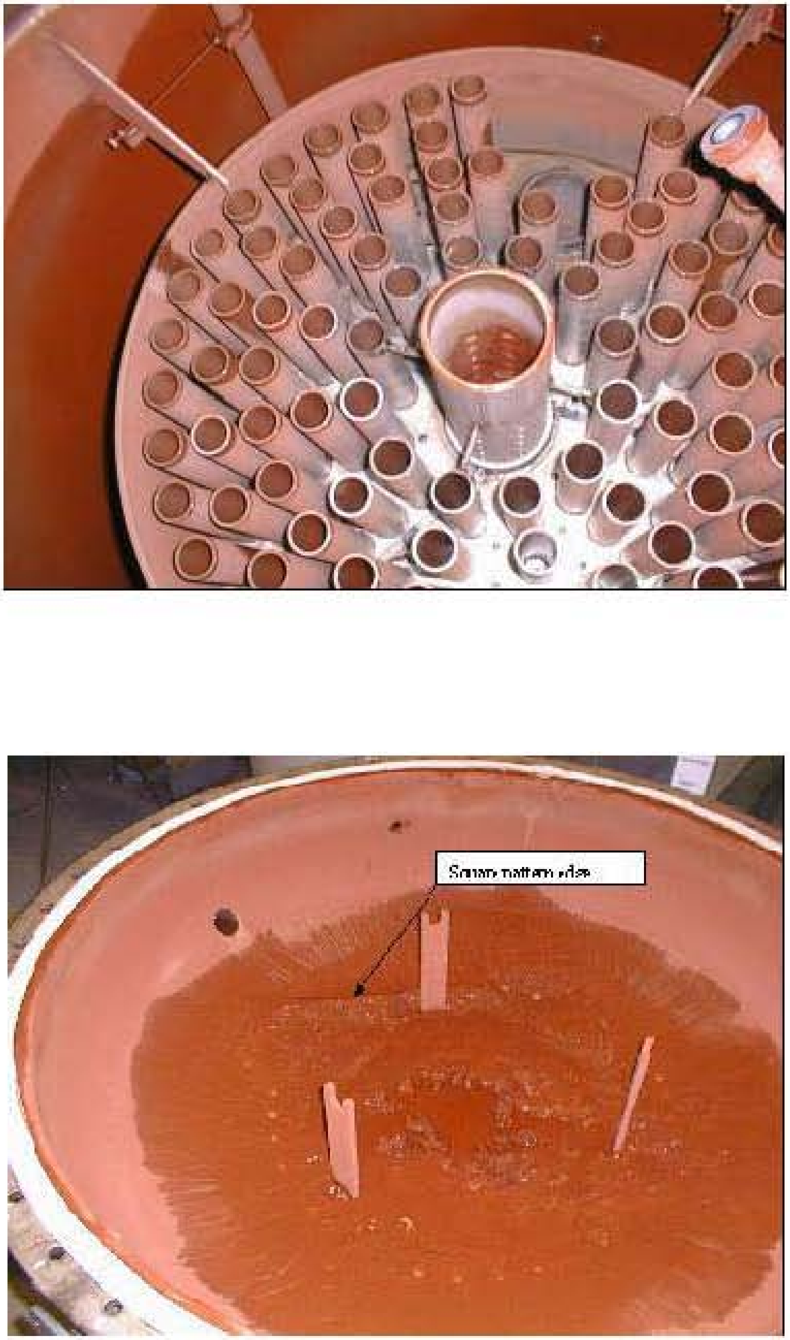


Figure 4.10. Upward view showing downcomer extension, weir tubes and diffuser plate (top) and deposits on the SBS bottom dish at the conclusion of the commissioning tests (bottom).

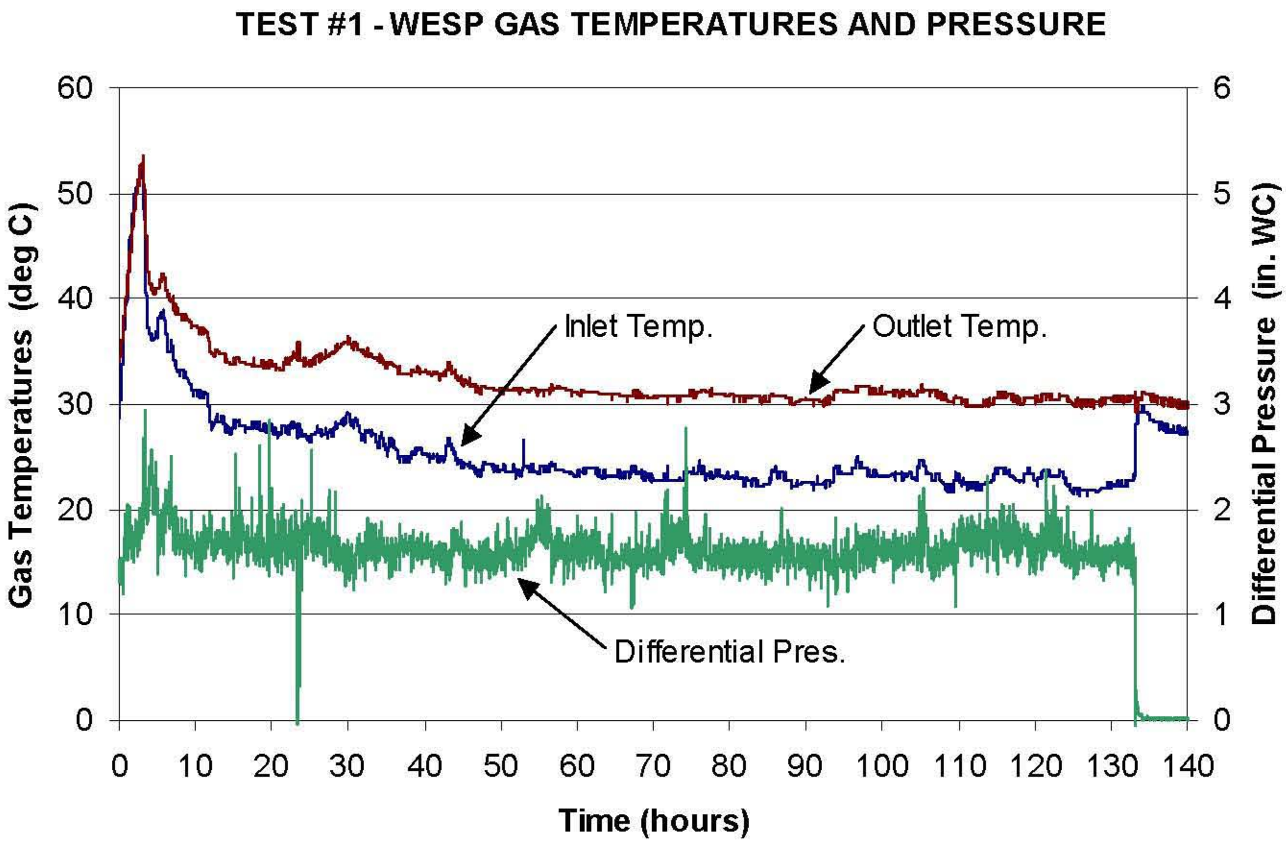


Figure 4.11. WESP inlet and outlet temperatures and differential pressure across the WESP during Test 1.

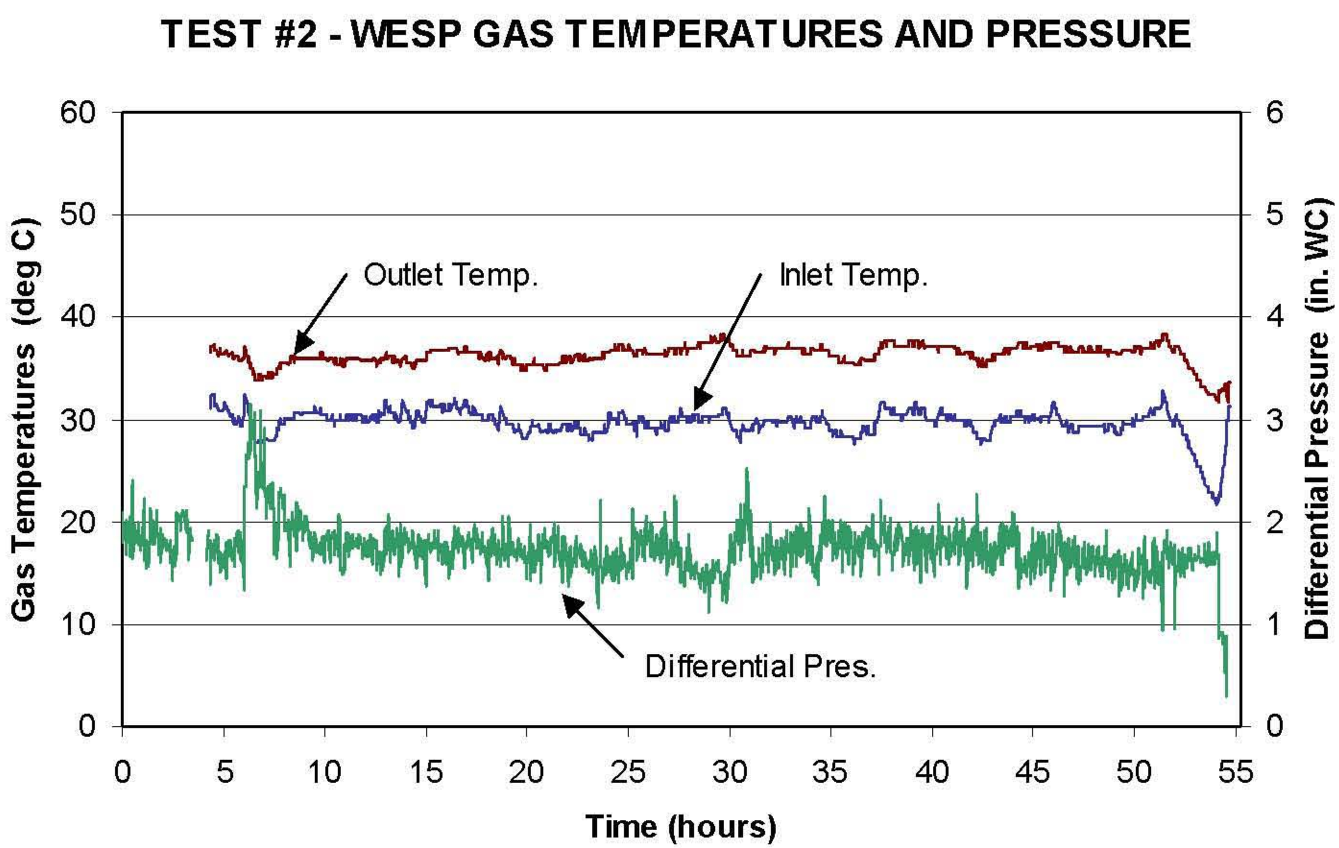


Figure 4.12. WESP inlet and outlet temperatures and differential pressure across the WESP during Test 2.

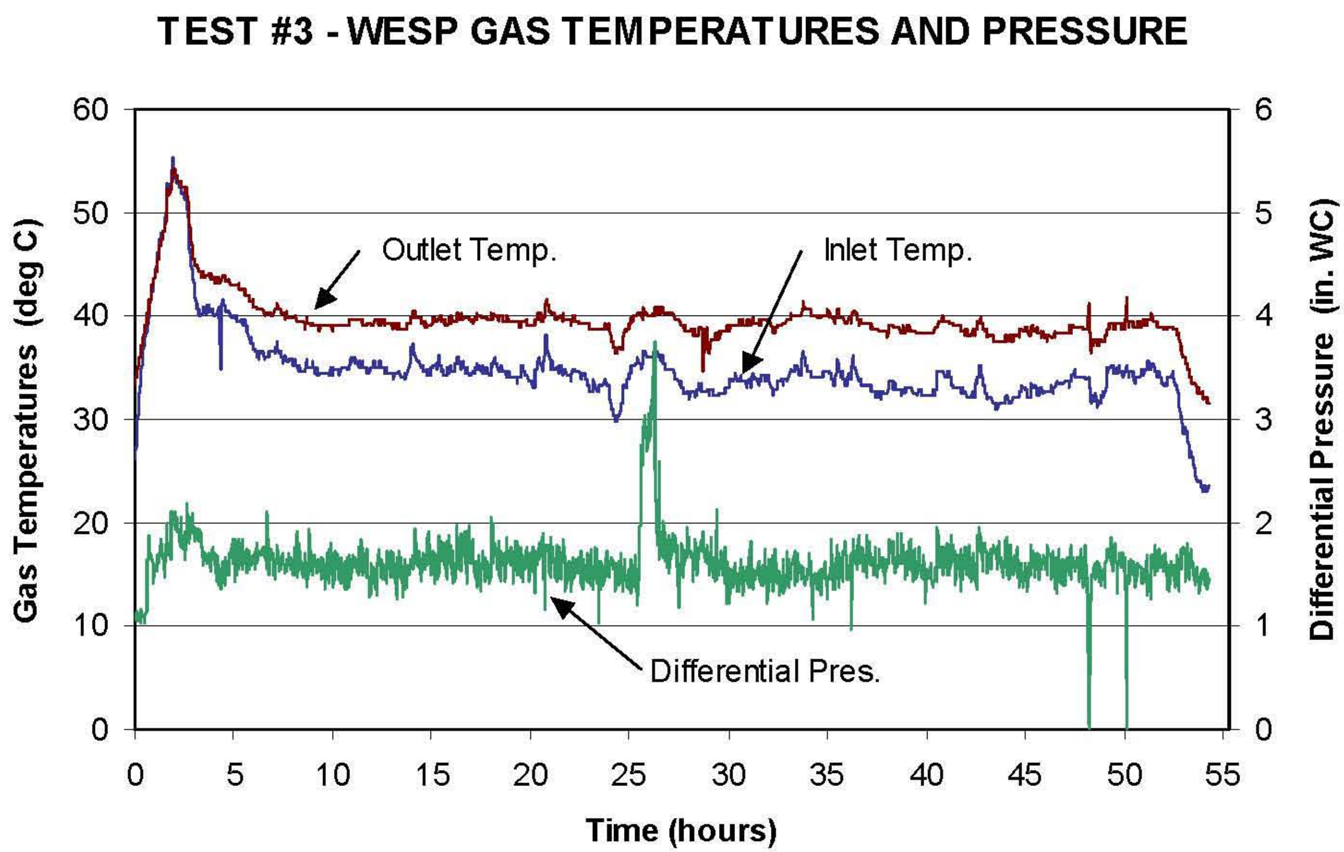
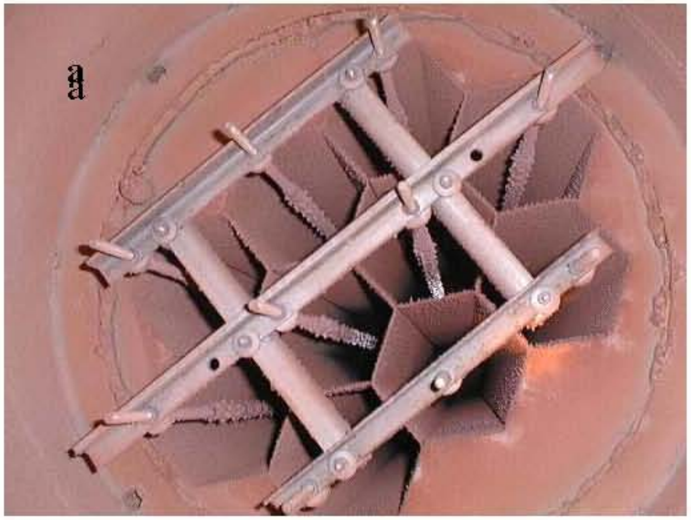


Figure 4.13. WESP inlet and outlet temperatures and differential pressure across the WESP during Test 3.



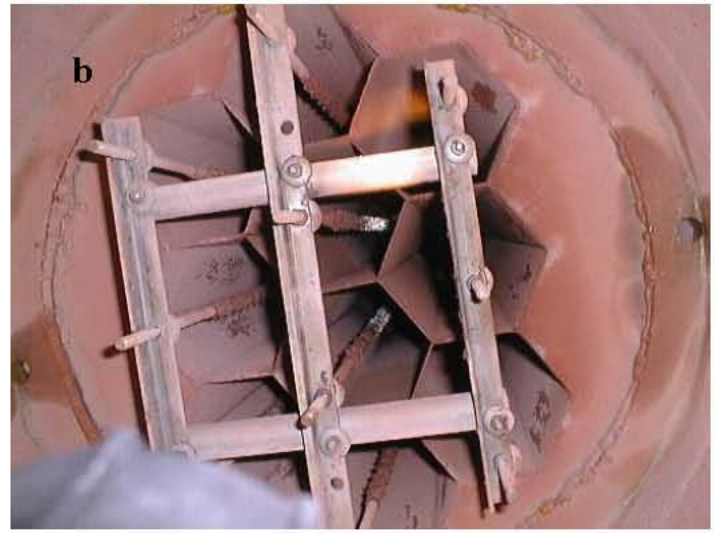


Figure 4.14 View inside WESP
(a) Looking upward at end of test
(b) After wash-down
(c) Washed-down deposits

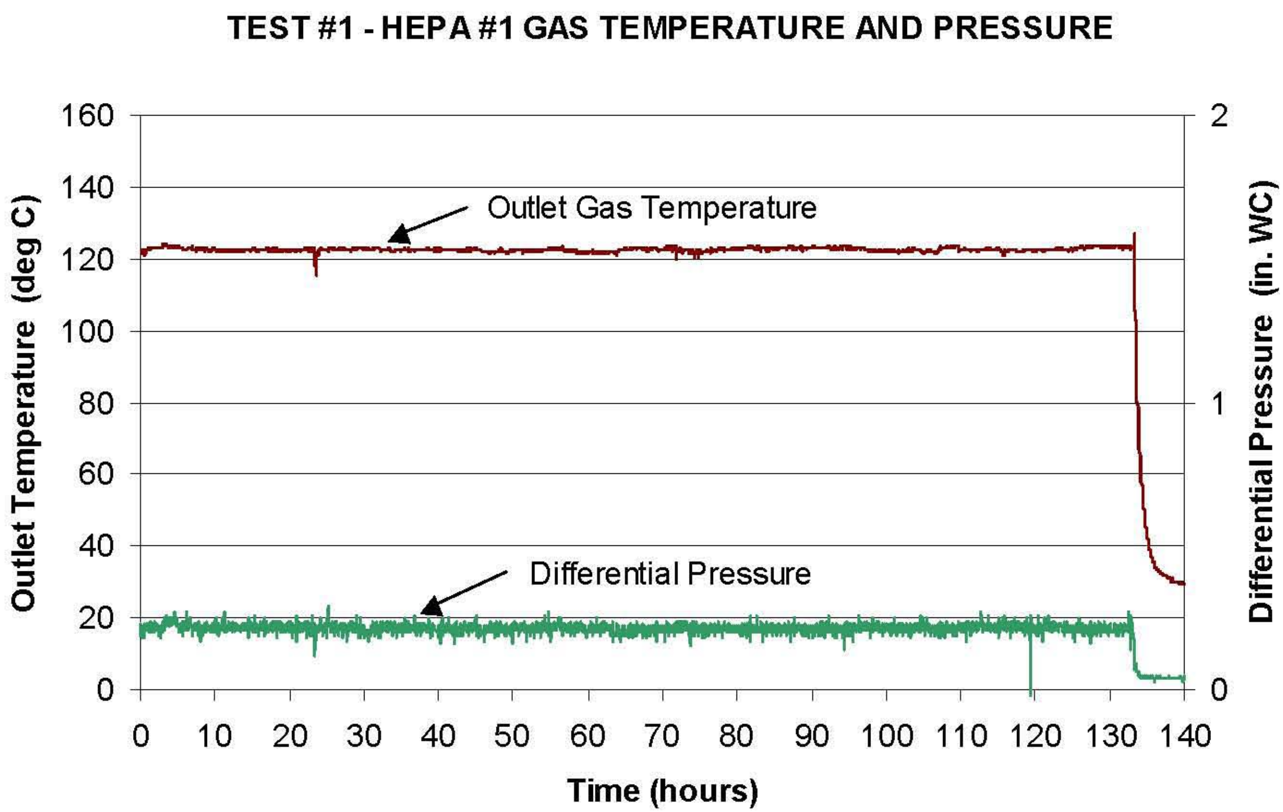


Figure 4.15. Outlet temperature and differential pressure for HEPA #1 during Test 1.

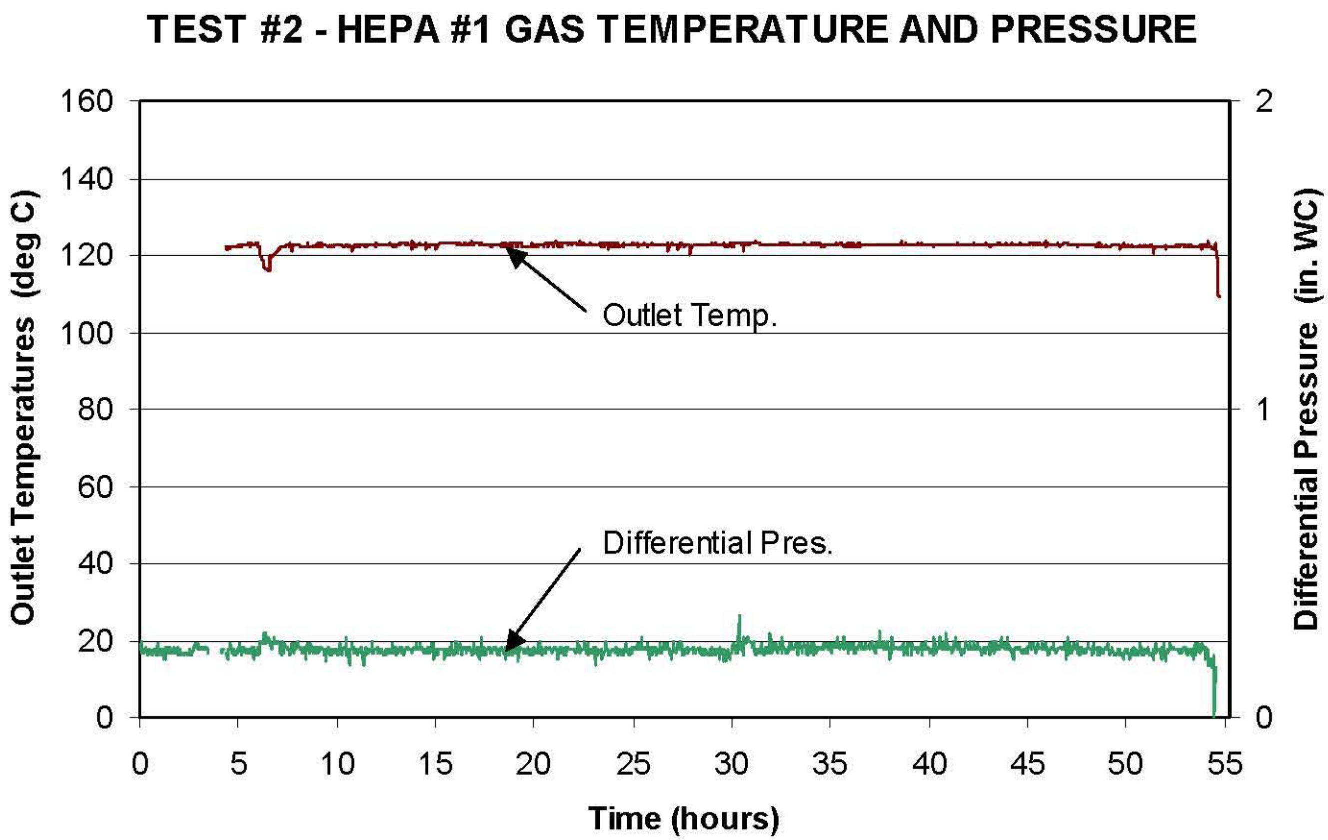


Figure 4.16. Outlet temperature and differential pressure for HEPA #1 during Test 2.

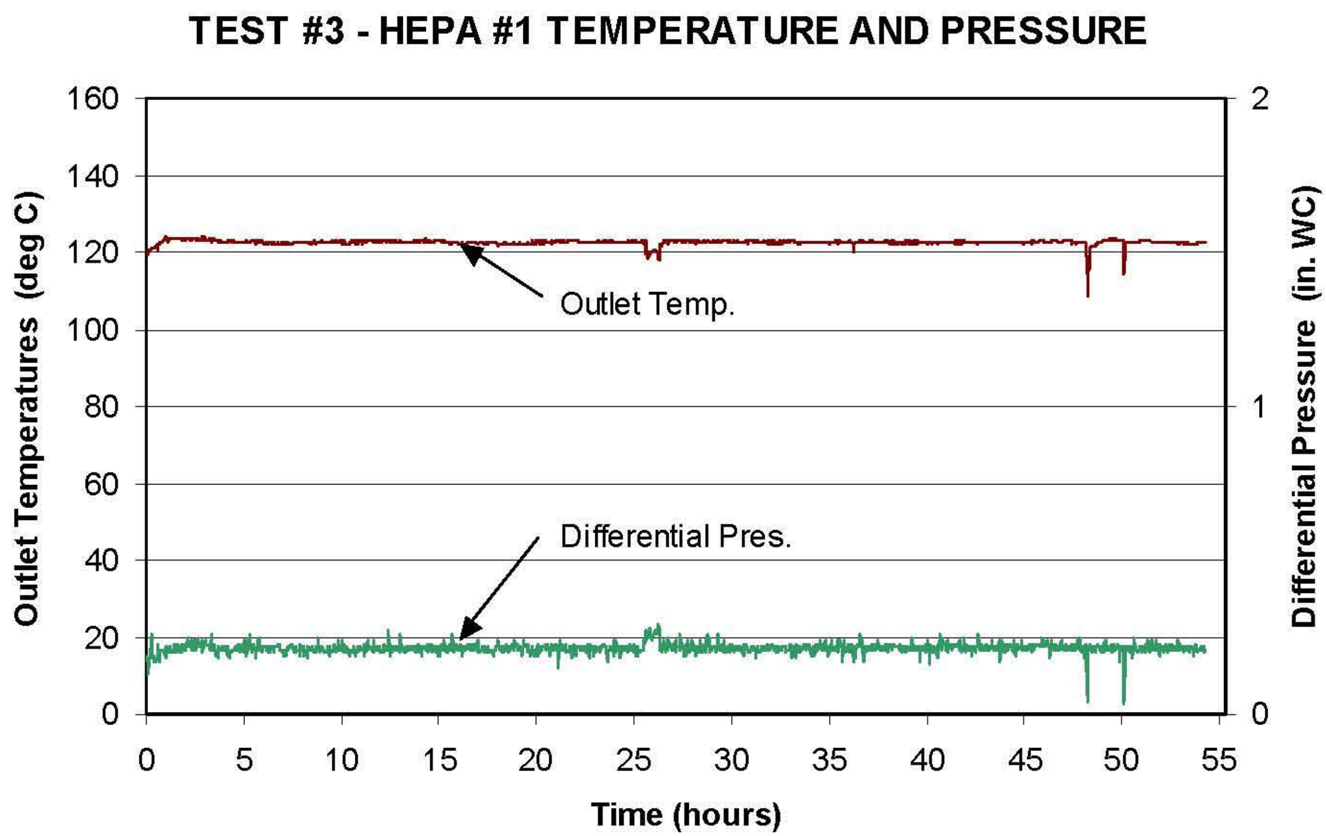


Figure 4.17. Outlet temperature and differential pressure for HEPA #1 during Test 3.

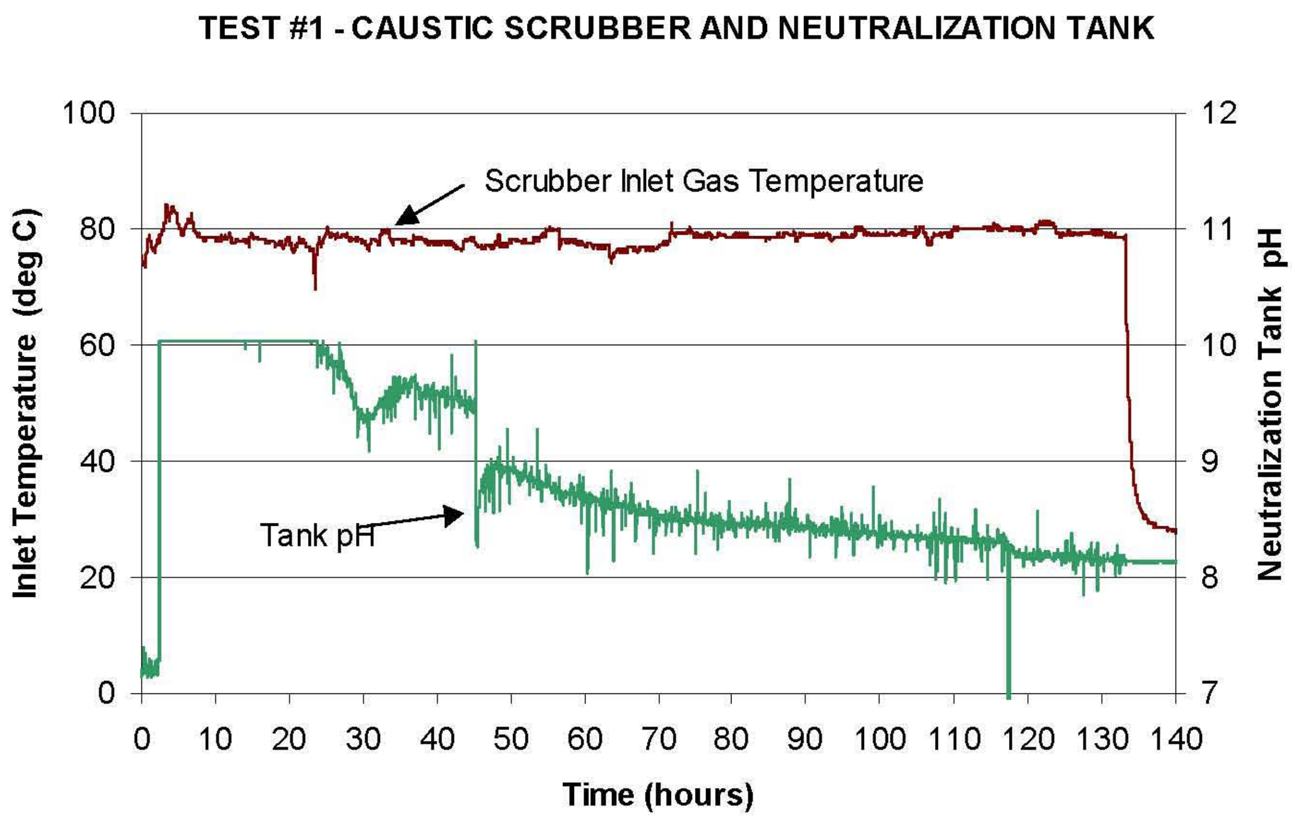


Figure 4.18. PBS inlet gas temperature and neutralization tank pH during Test 1.

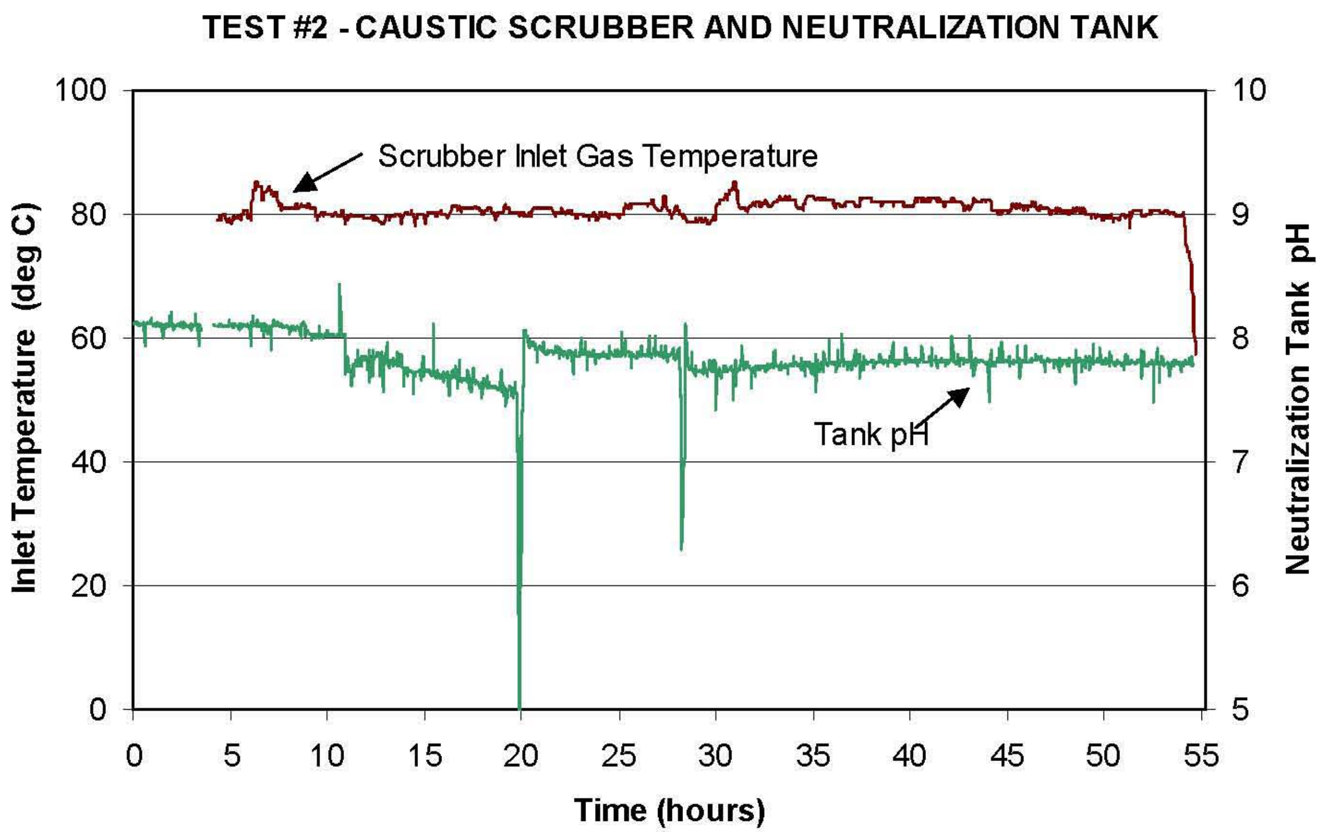


Figure 4.19. PBS inlet gas temperature and neutralization tank pH during Test 2.

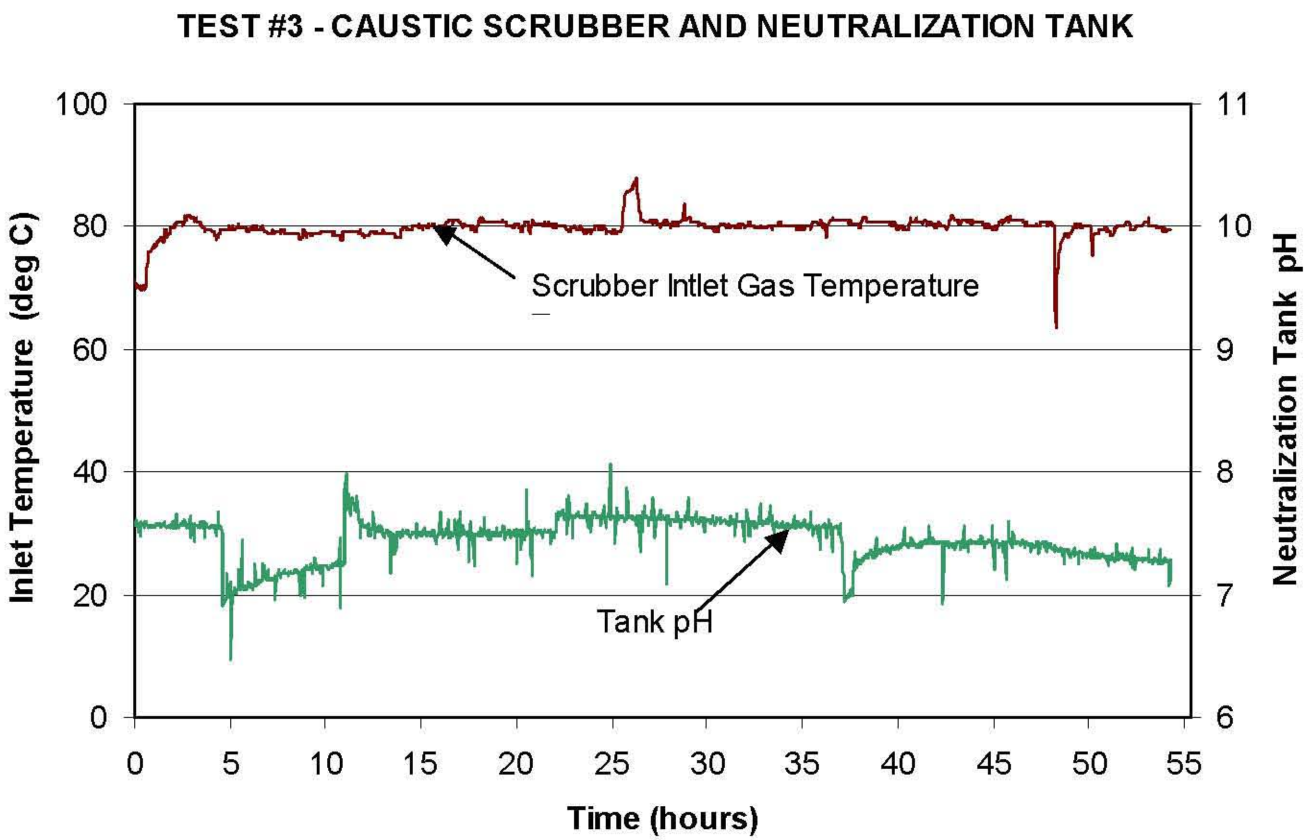


Figure 4.20. PBS inlet gas temperature and neutralization tank pH during Test 3.

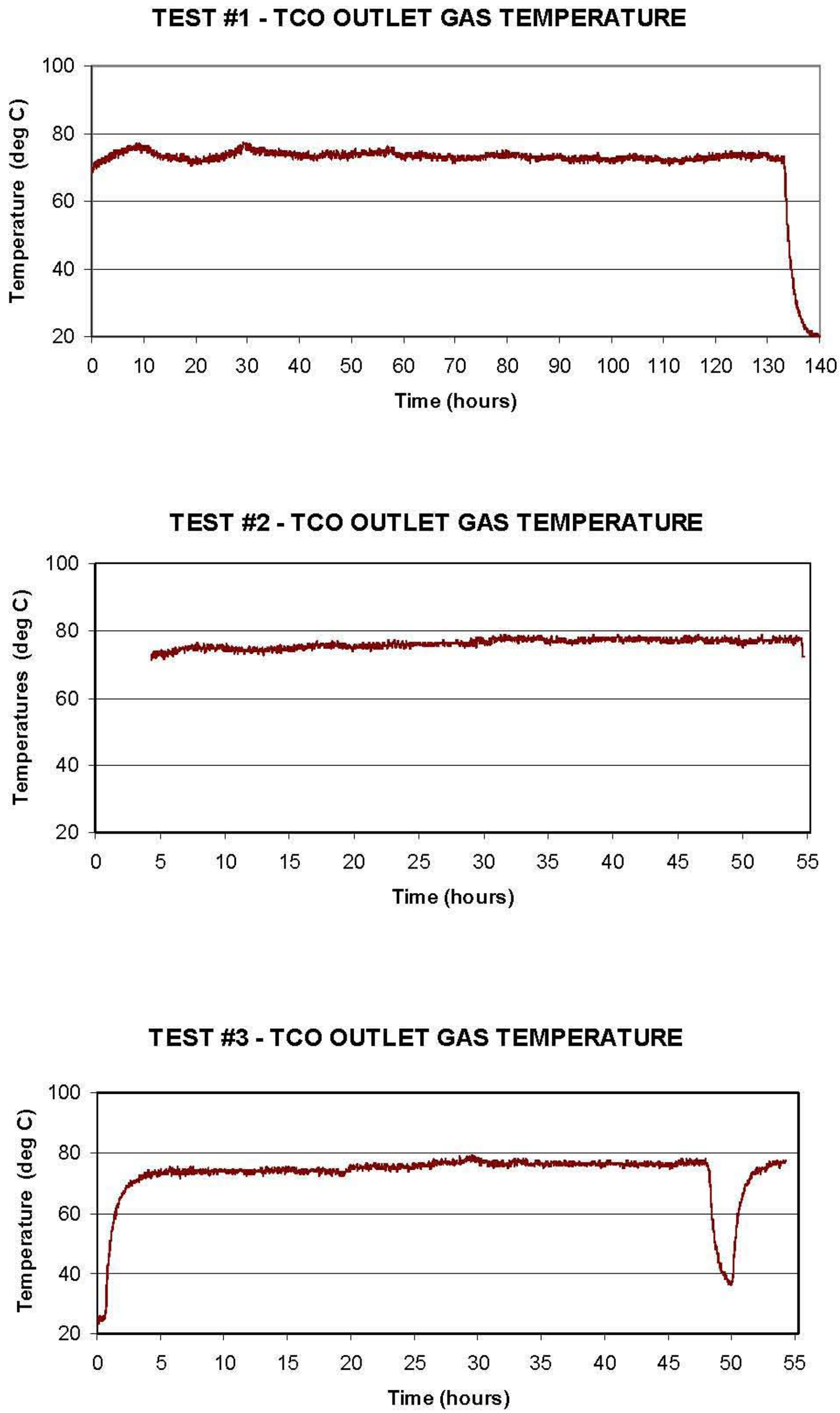


Figure 4.21. Thermal catalytic oxidation (TCO) unit gas outlet temperature.

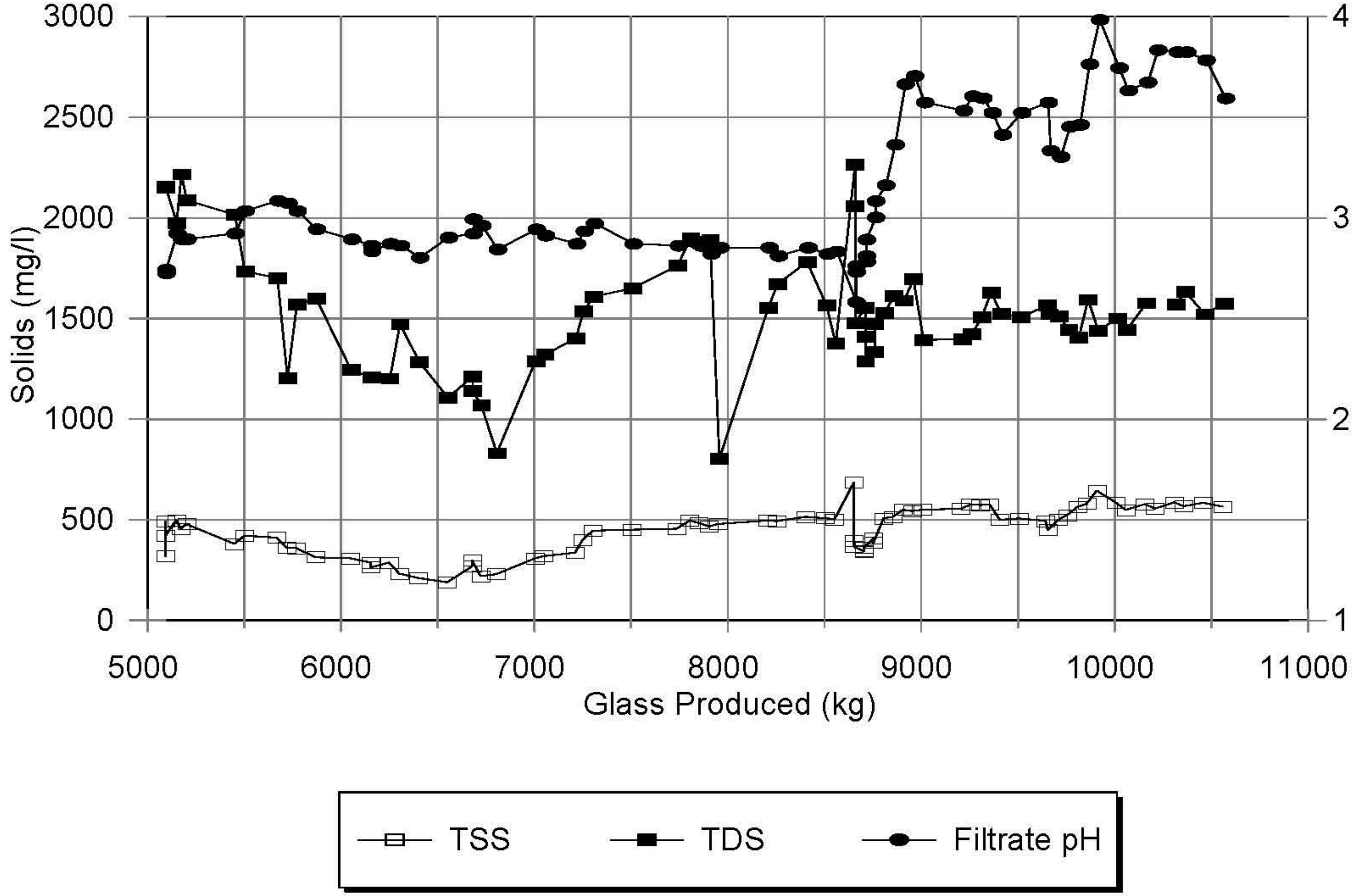


Figure 4.22. Total suspended and dissolved solids contents and pH of SBS liquids from post-turnover tests.

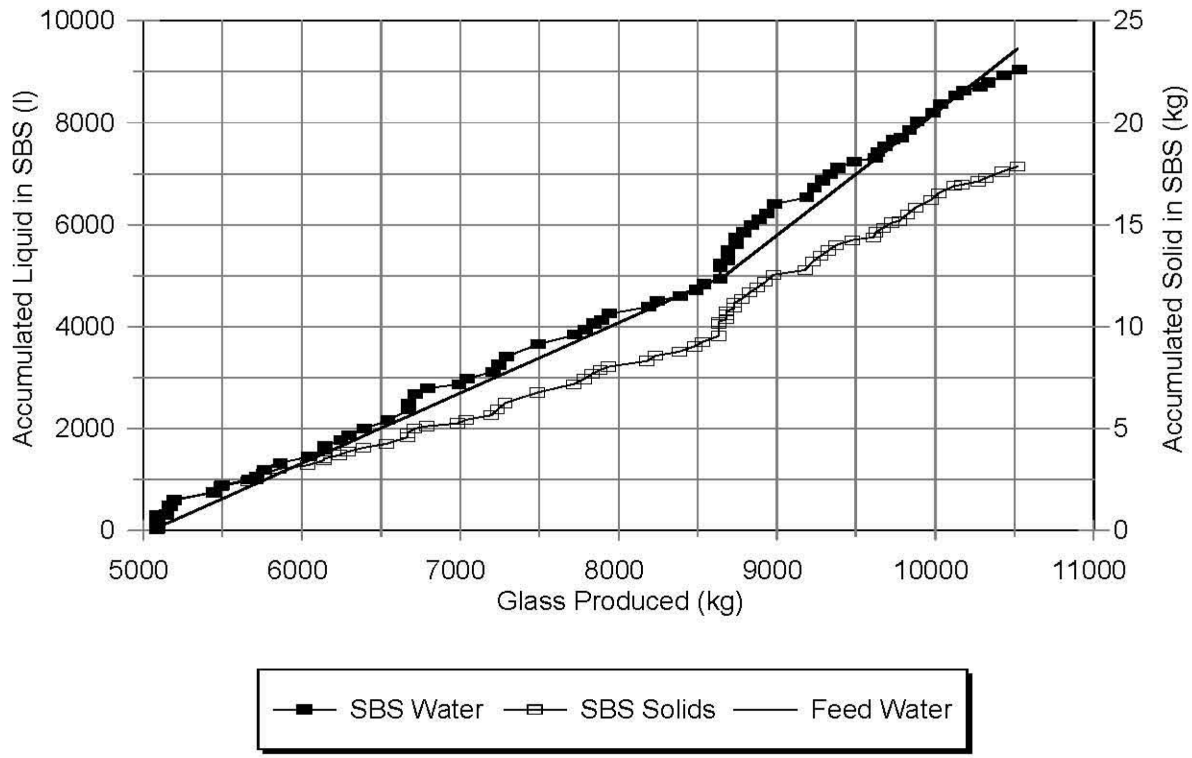


Figure 4.23. Total solids and liquids accumulations in the SBS (including blowdowns) during post-turnover DM1200 commissioning tests.

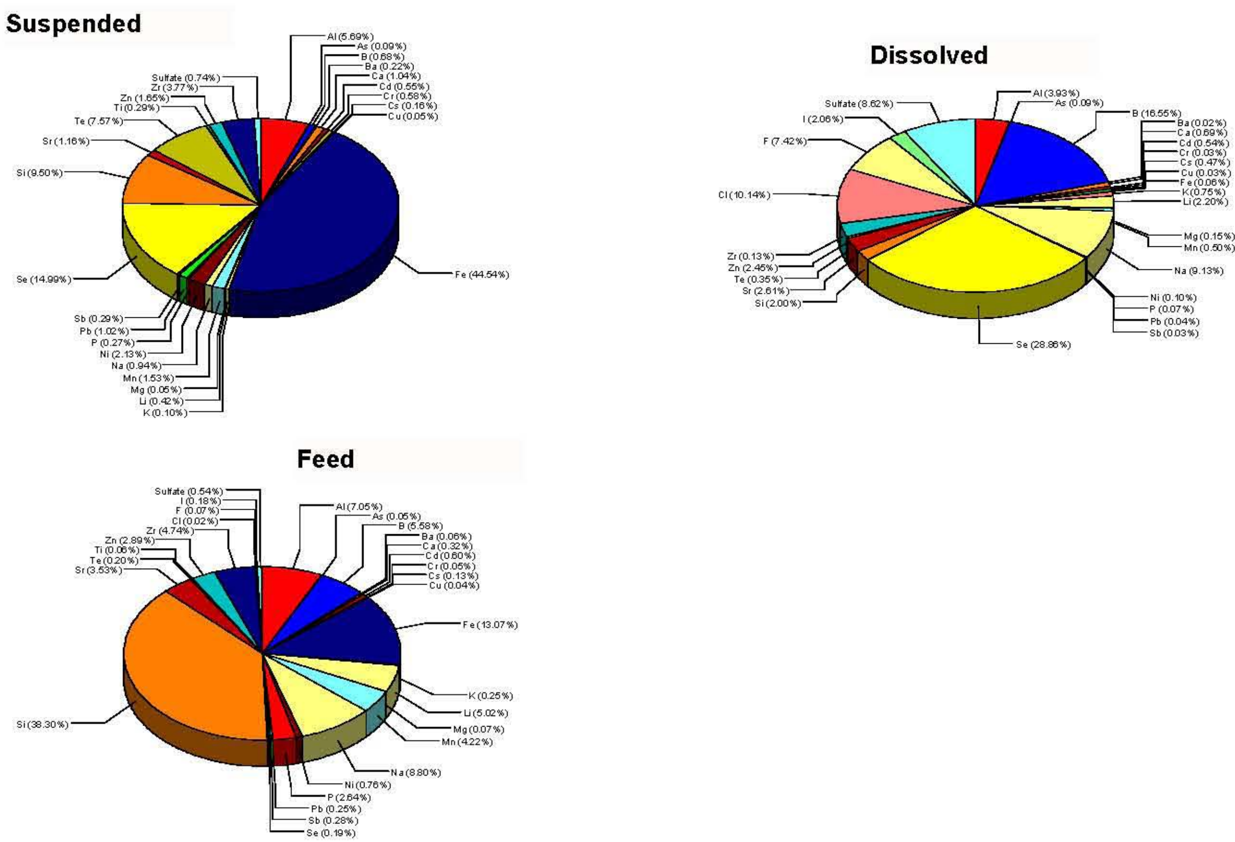


Figure 4.24. Comparison of compositions of SBS liquid dissolved and suspended fractions with that of the feed material from DM1200 commissioning tests.

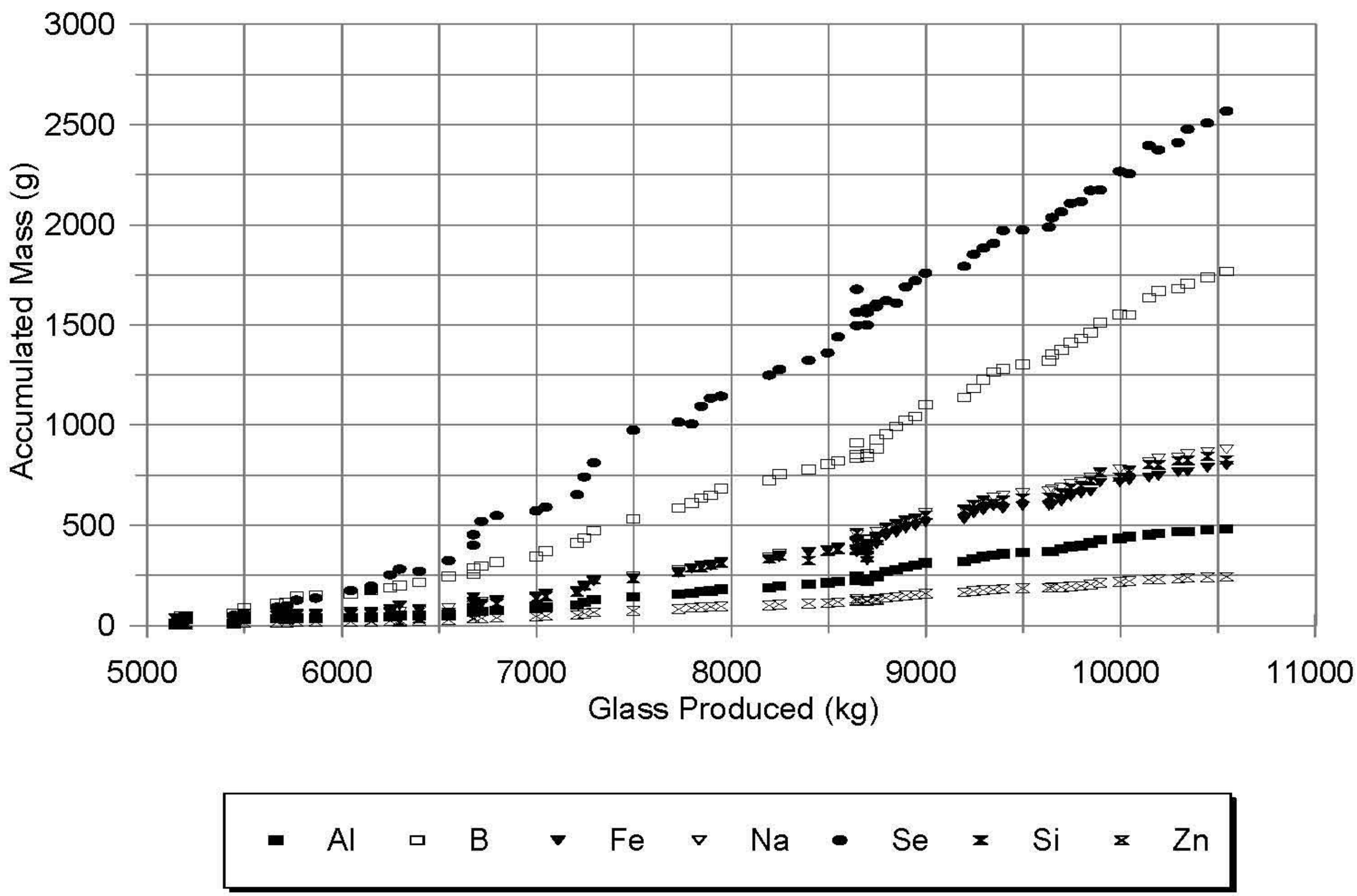


Figure 4.25. Accumulations of major constituents in SBS fluids during DM1200 commissioning tests.

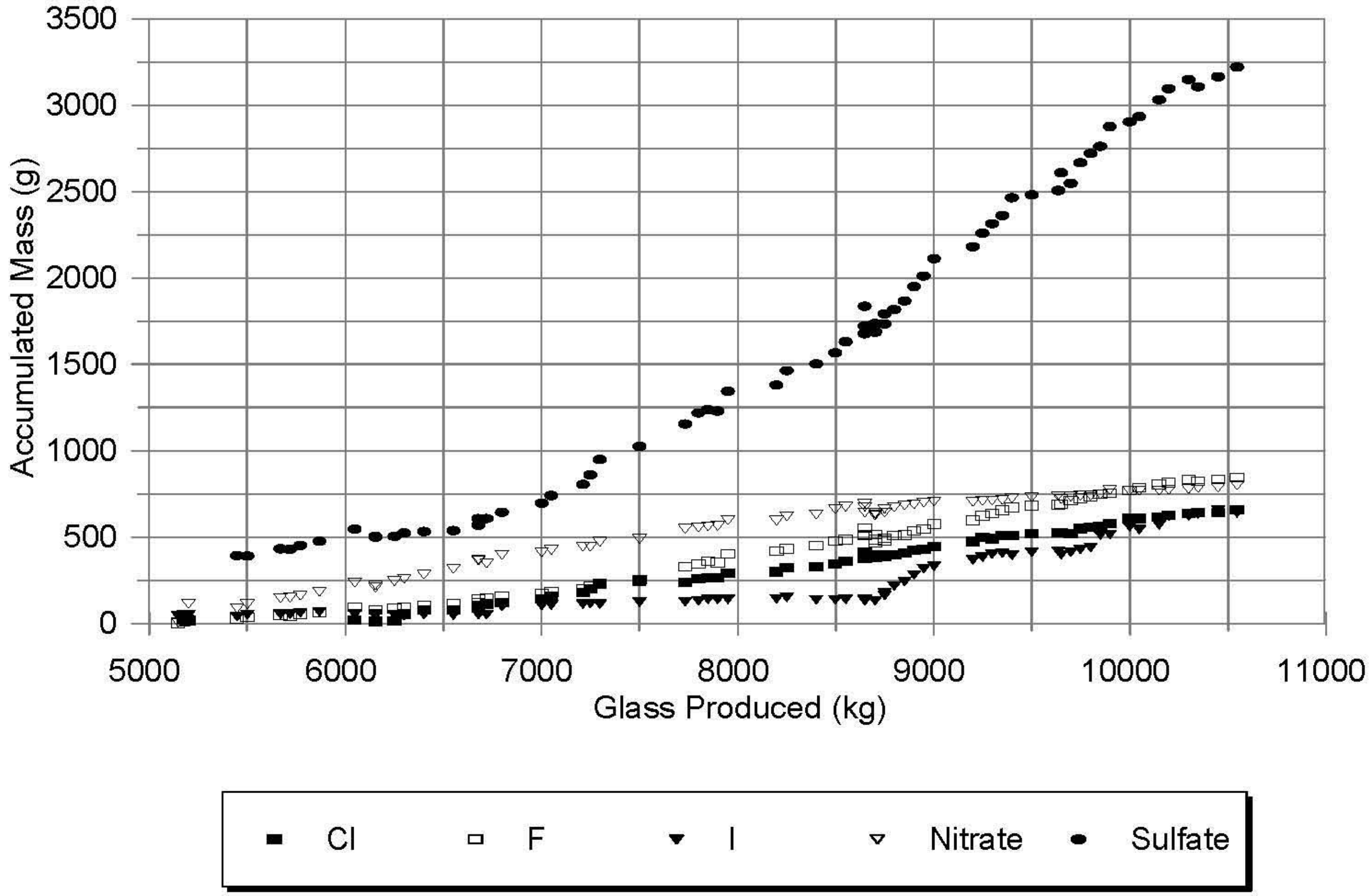


Figure 4.26. Accumulations of anions in SBS during DM1200 commissioning tests.

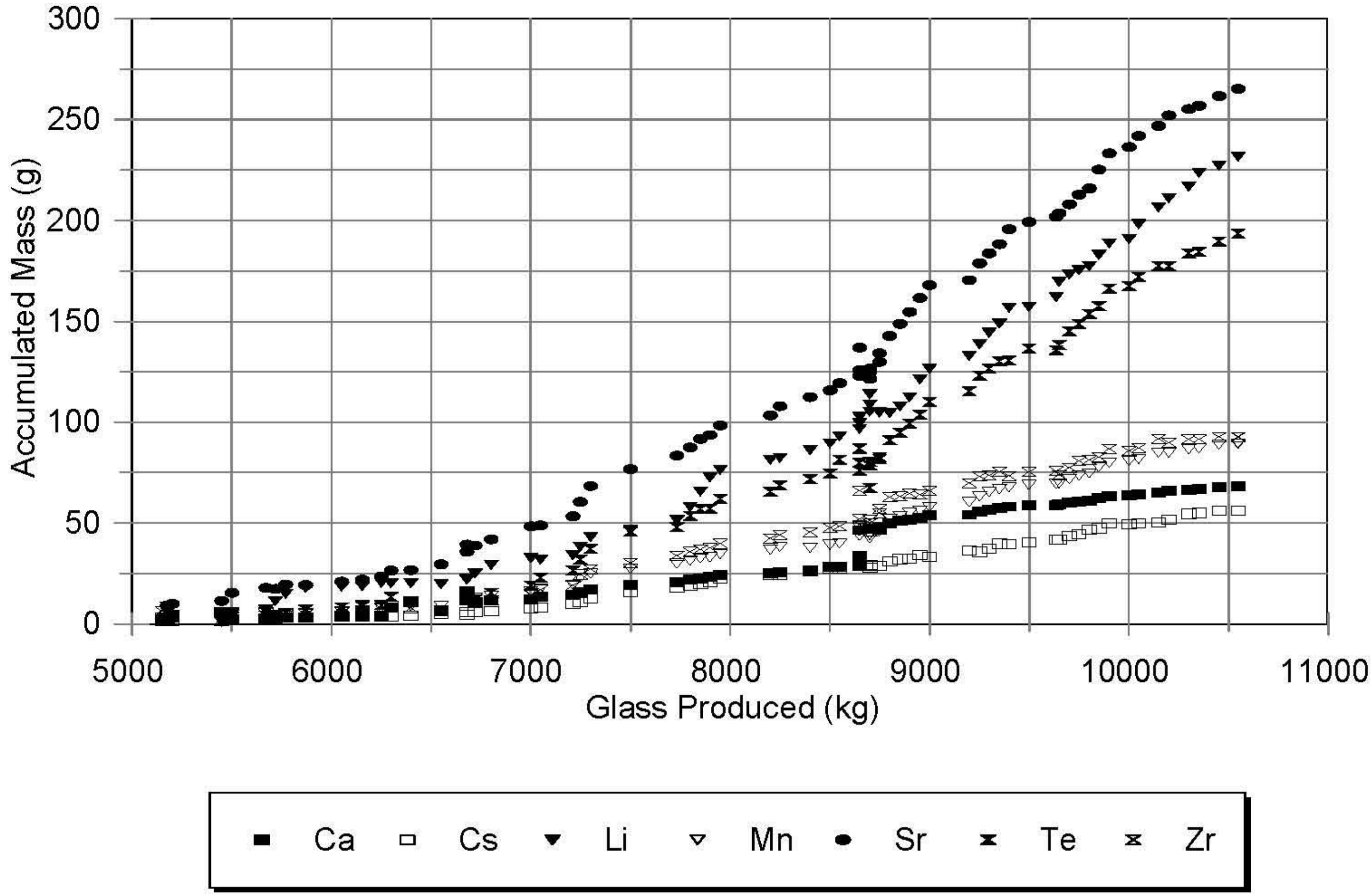


Figure 4.27. Accumulations of select constituents in SBS during DM1200 commissioning tests.

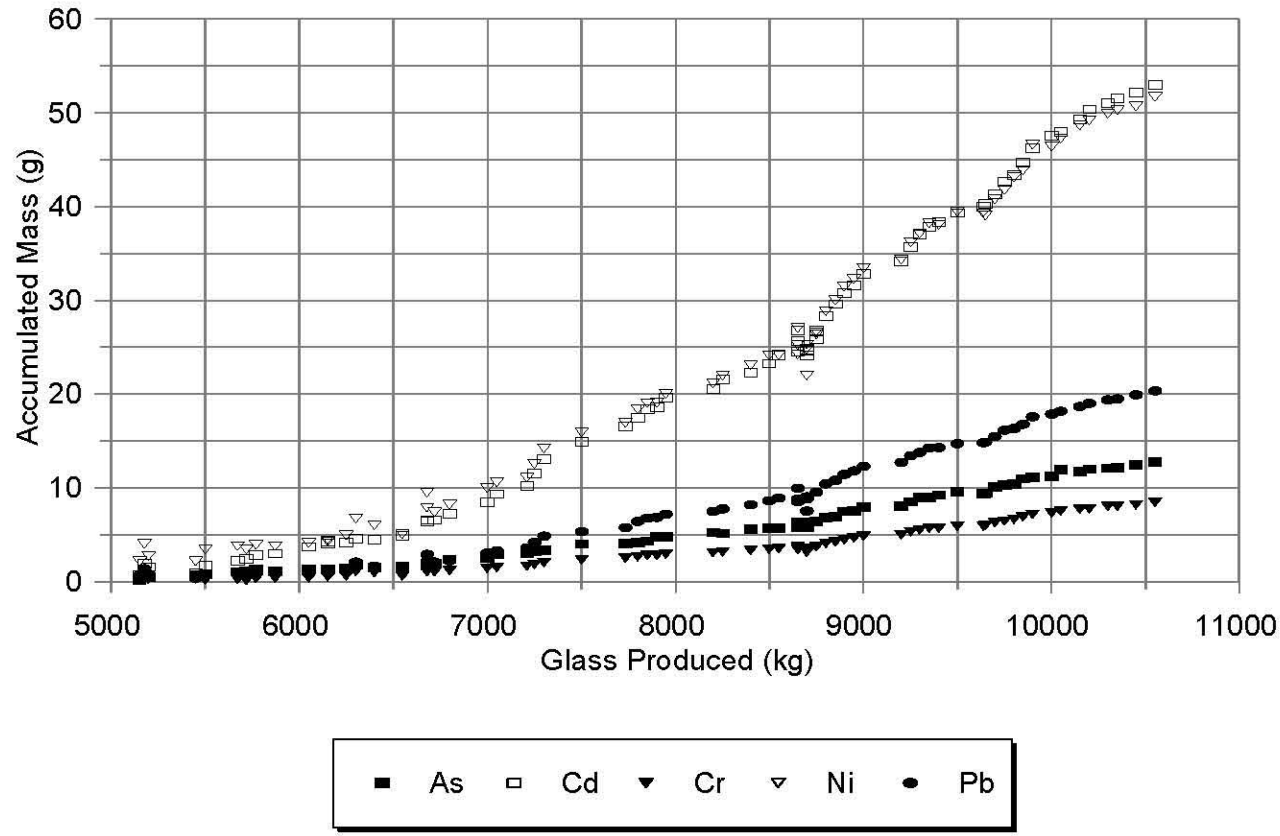


Figure 4.28. Accumulations of RCRA metals in SBS during DM1200 commissioning tests.

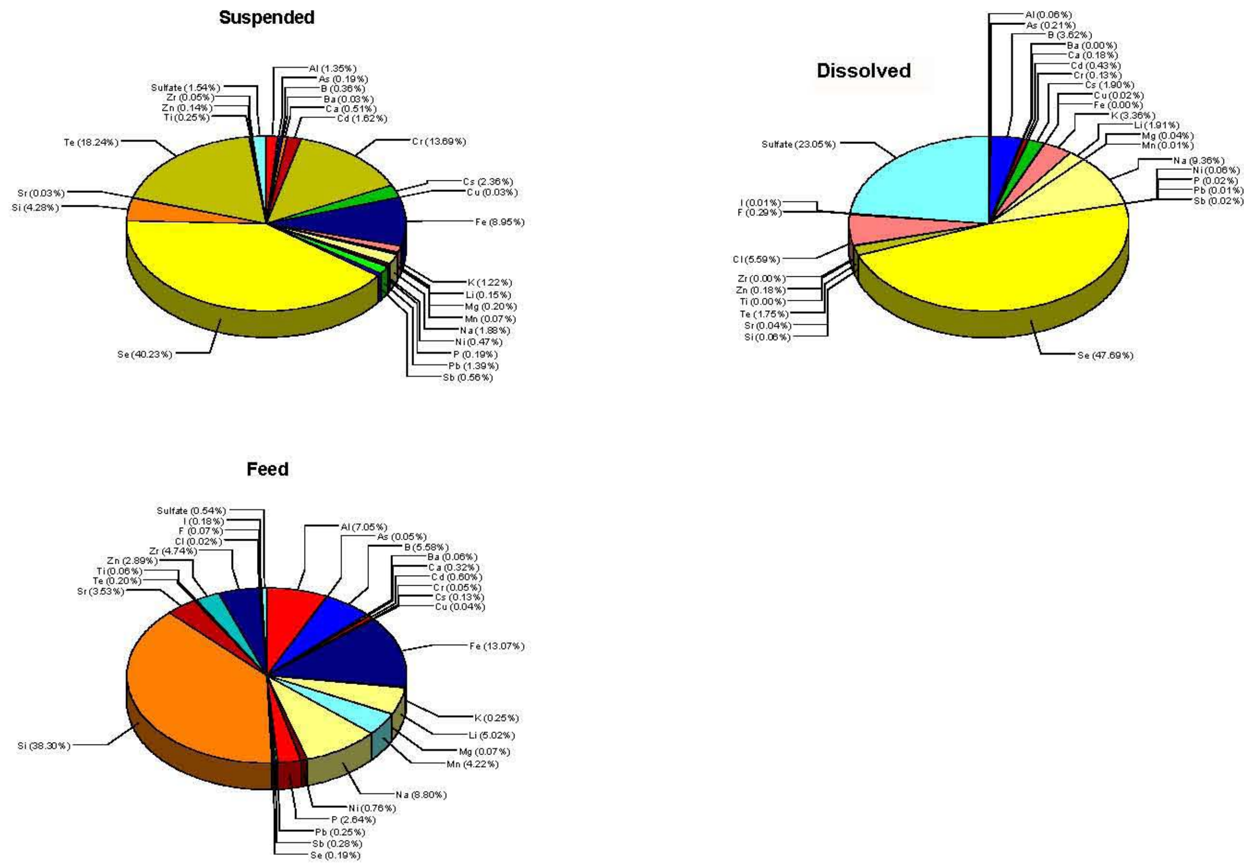


Figure 4.29. Comparison of compositions of WESP liquid dissolved and suspended fractions with that of the feed material from DM1200 commissioning tests.

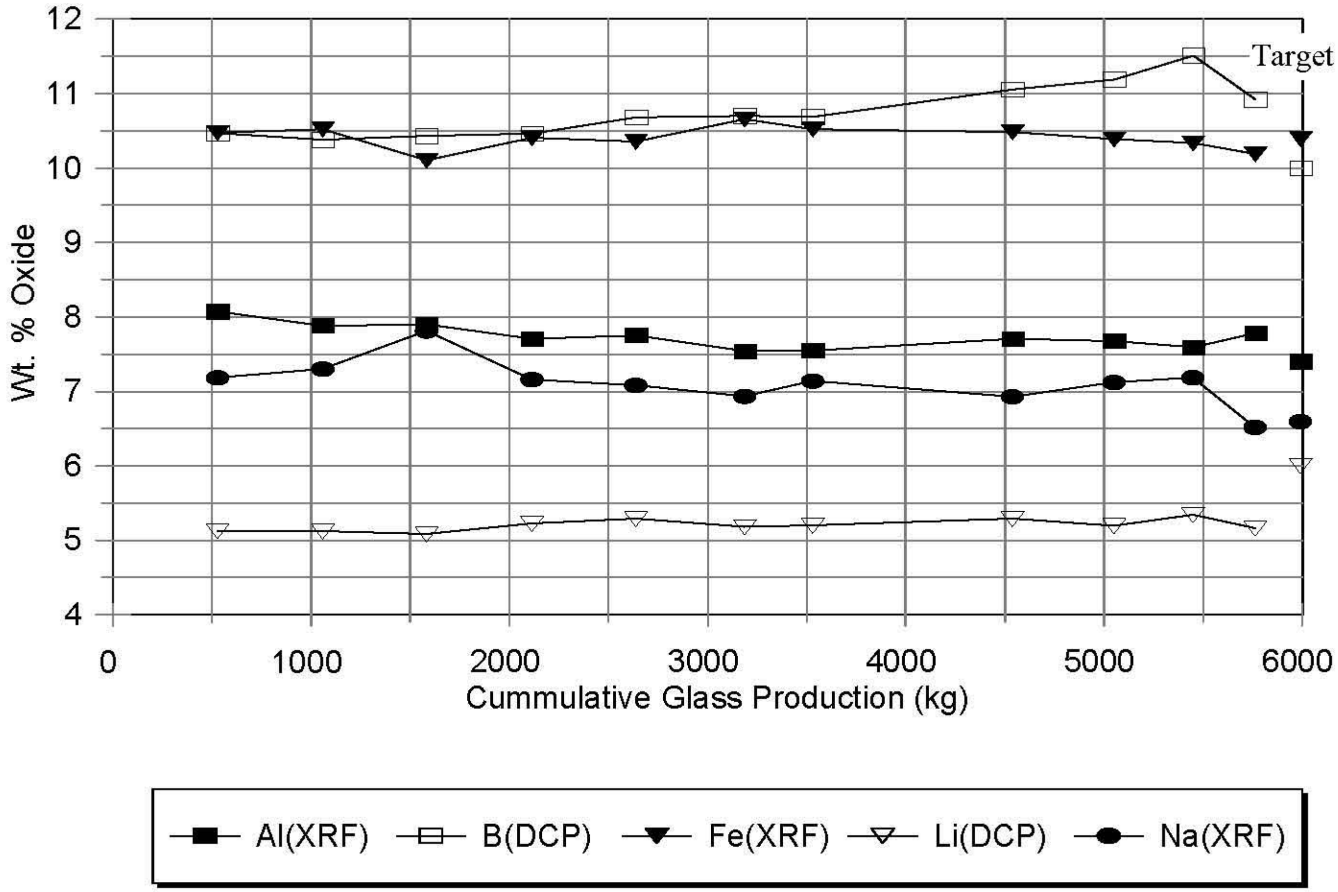


Figure 5.1. Analyzed product glass compositions for major oxides during DM1200 commissioning Tests 1,2, and 3.

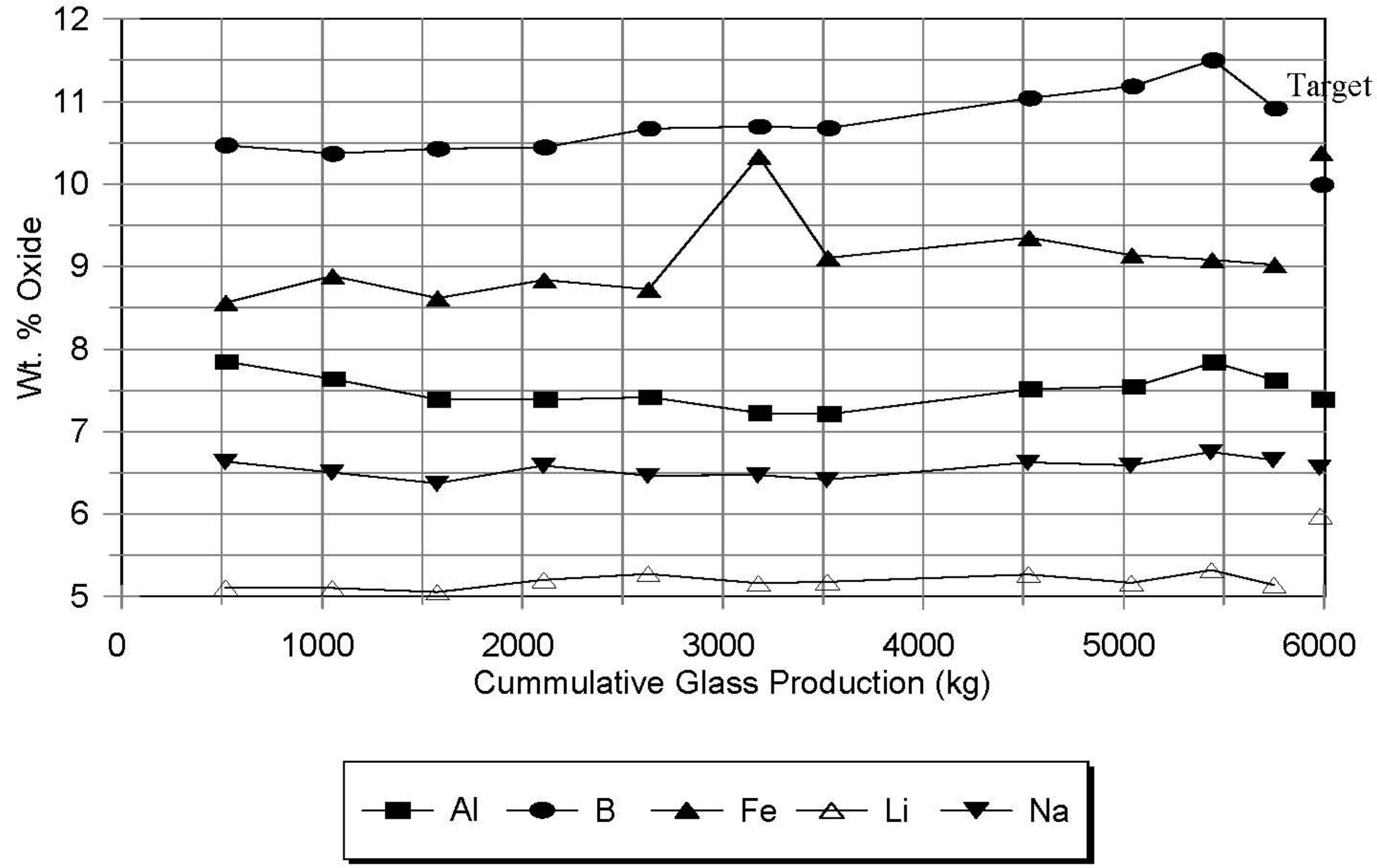


Figure 5.2. DCP analyzed product glass compositions for major oxides during DM1200 commissioning tests 1, 2, and 3.

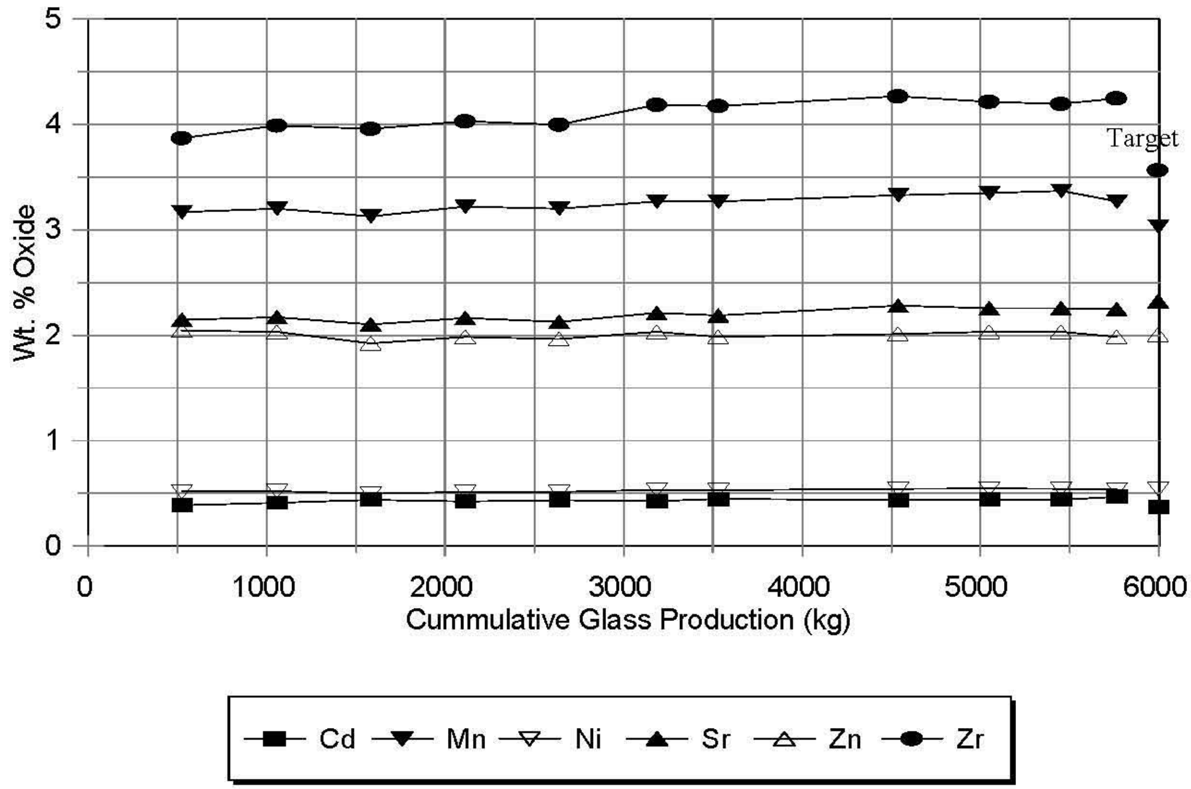


Figure 5.3. XRF analyzed product glass compositions for select oxides during DM1200 commissioning Tests 1, 2, and 3.

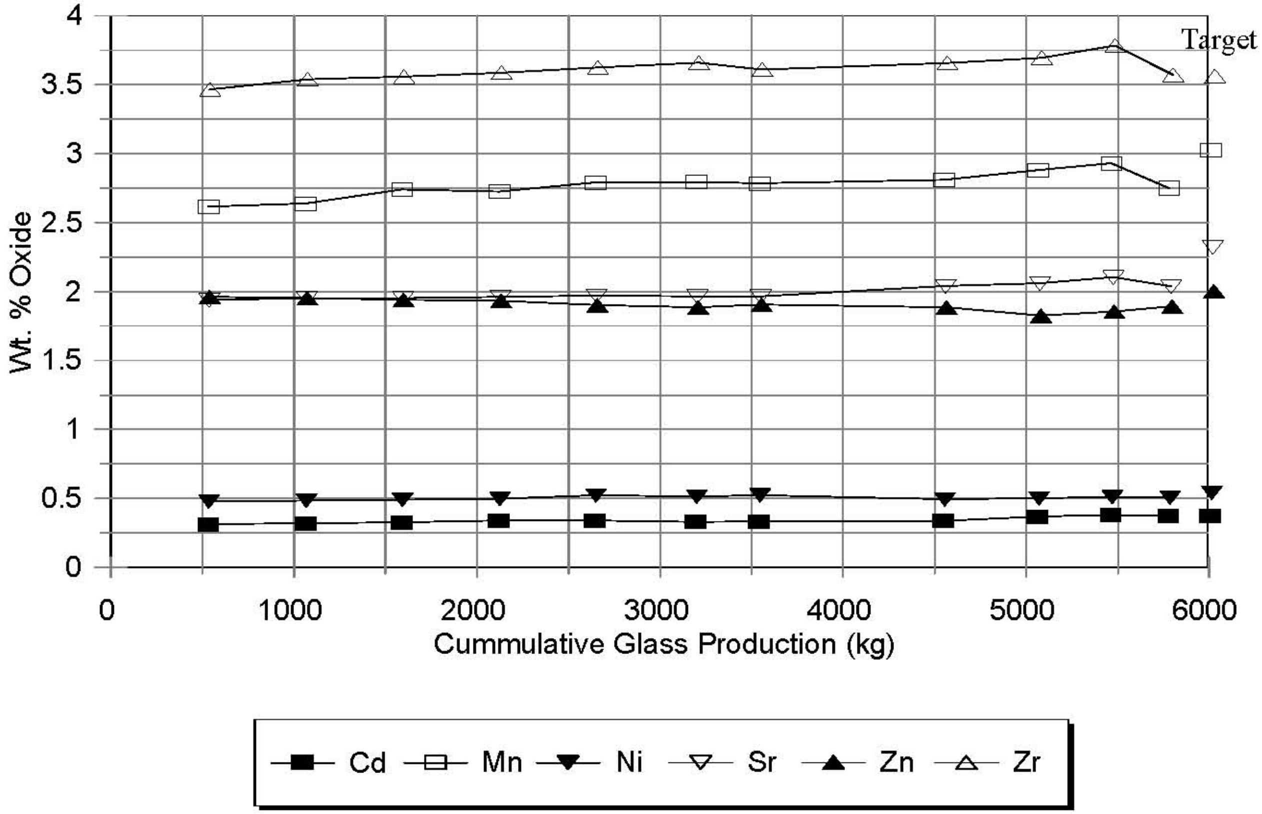


Figure 5.4. DCP analyzed product glass compositions for select oxides during DM1200 commissioning Tests 1, 2, and 3.

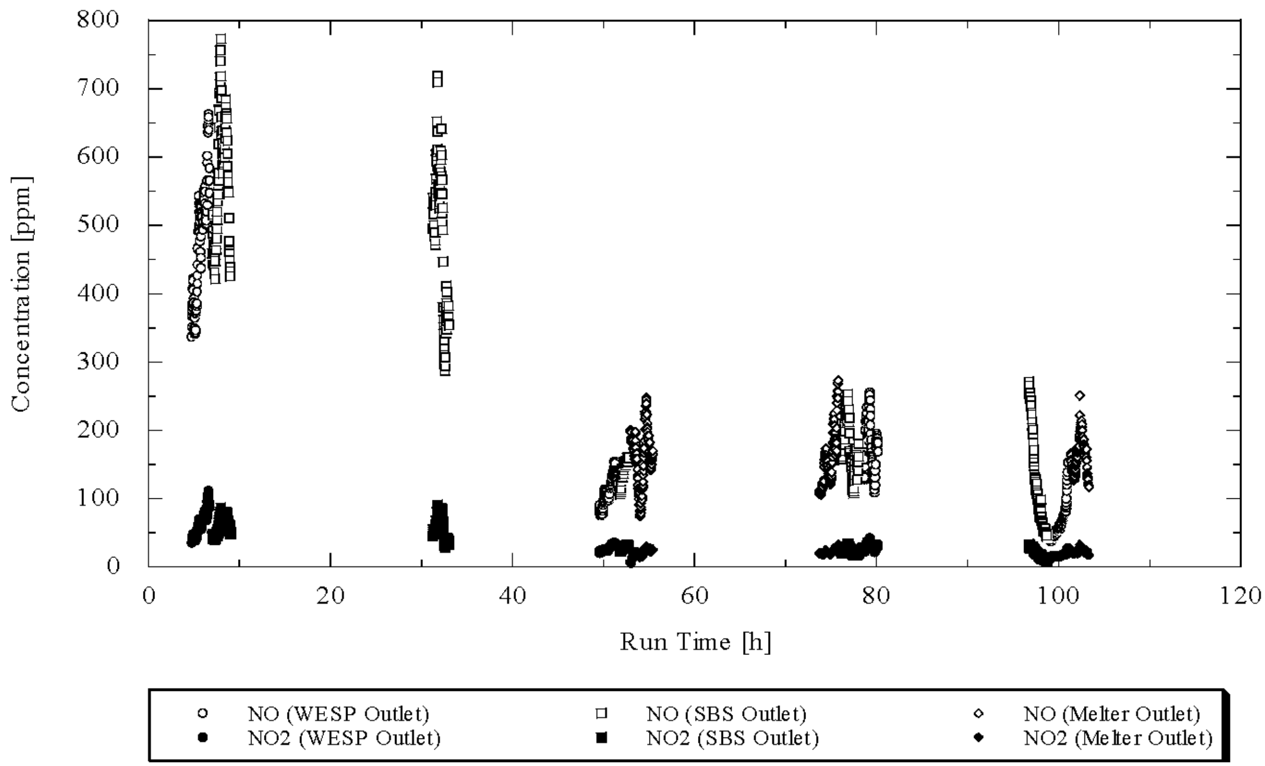


Figure 6.1. Concentration of NO and NO_2 in exhaust during DuraMelter 1200 AZ-101 commissioning Test 1.

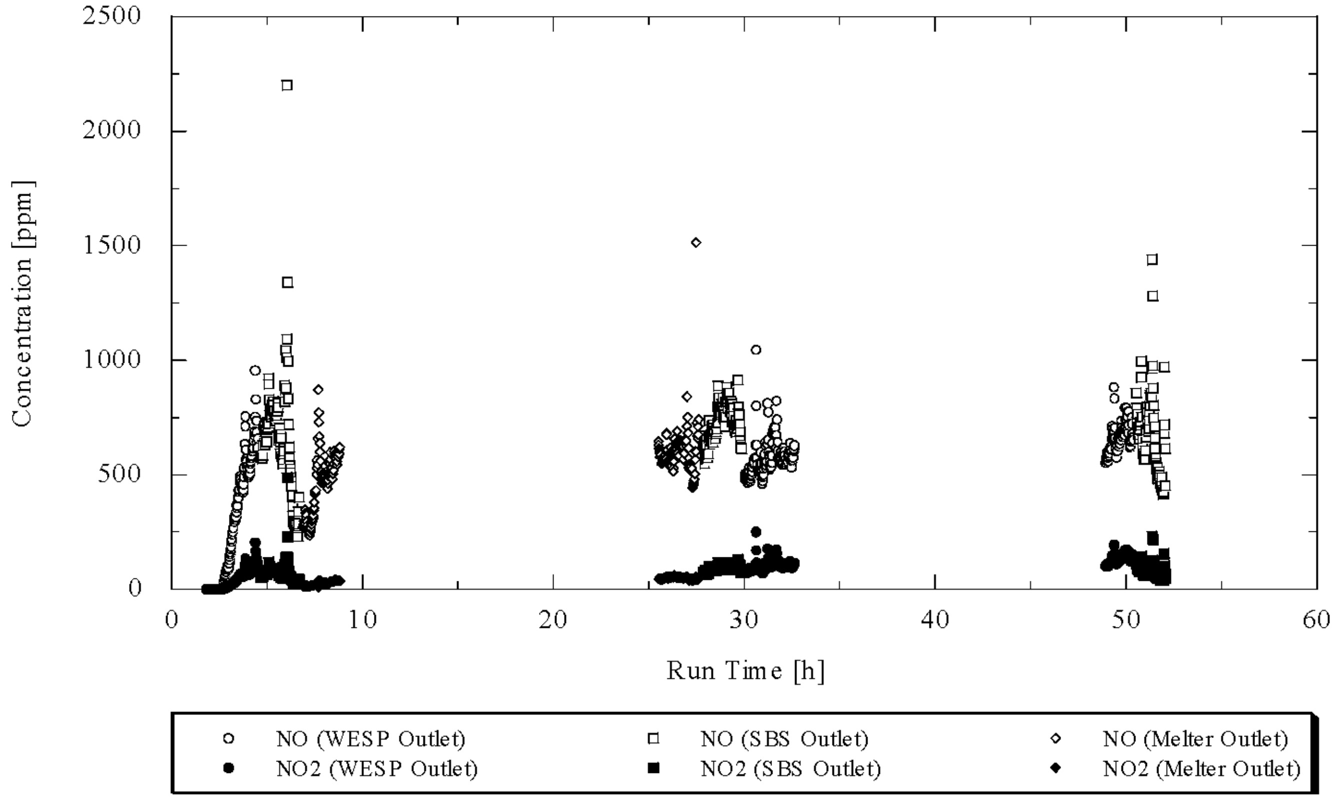


Figure 6.2. Concentration of NO and NO_2 in exhaust during DuraMelter 1200 AZ-101 commissioning Test 2.

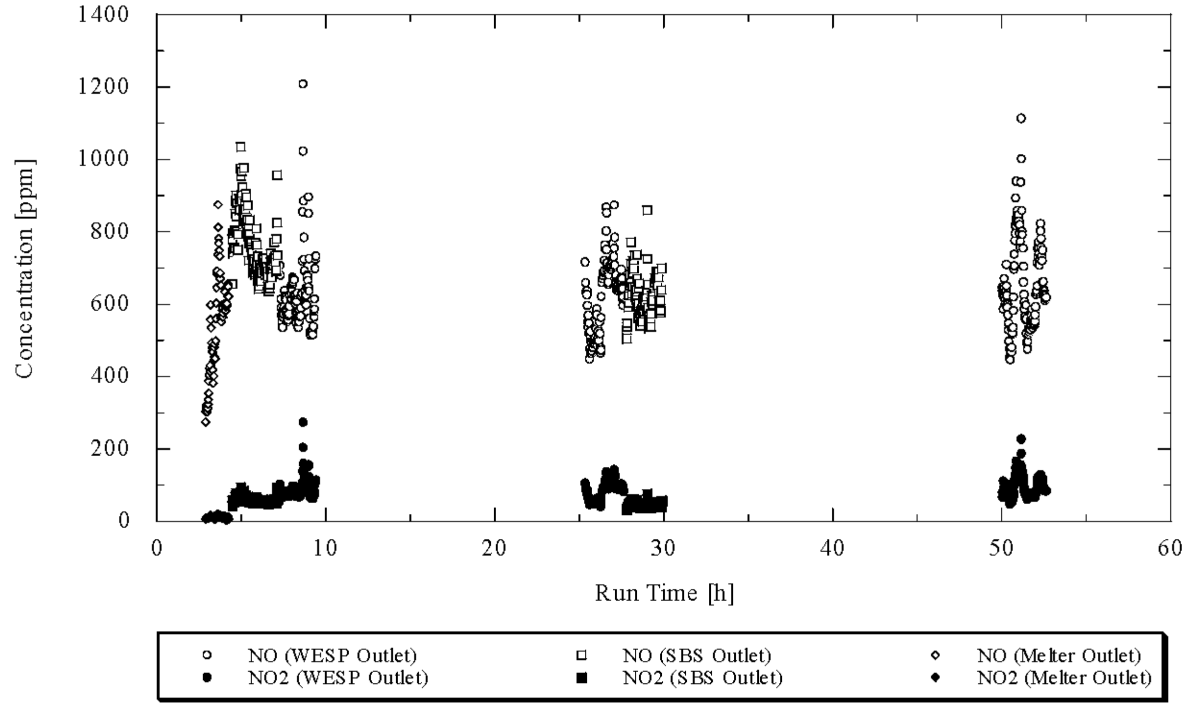


Figure 6.3. Concentration of NO and NO_2 in exhaust during DuraMelter 1200 AZ-101 commissioning Test 3.

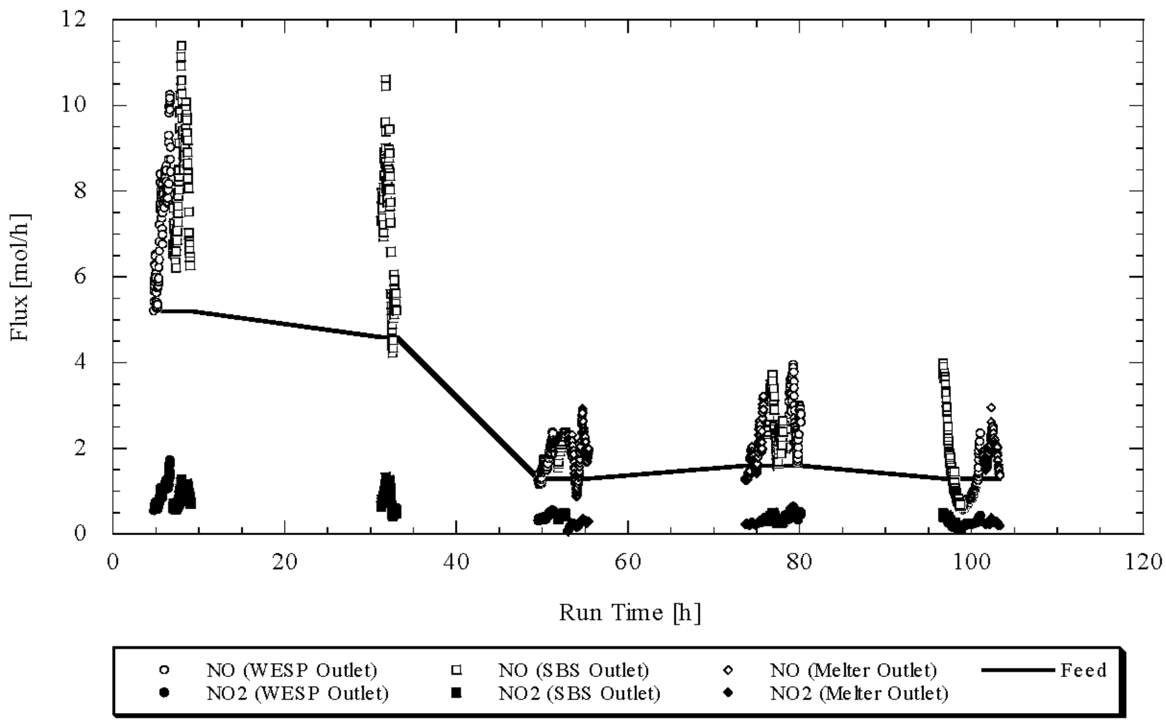


Figure 6.4. NO and NO_2 exhaust fluxes during DuraMelter 1200 AZ-101 commissioning Test 1.

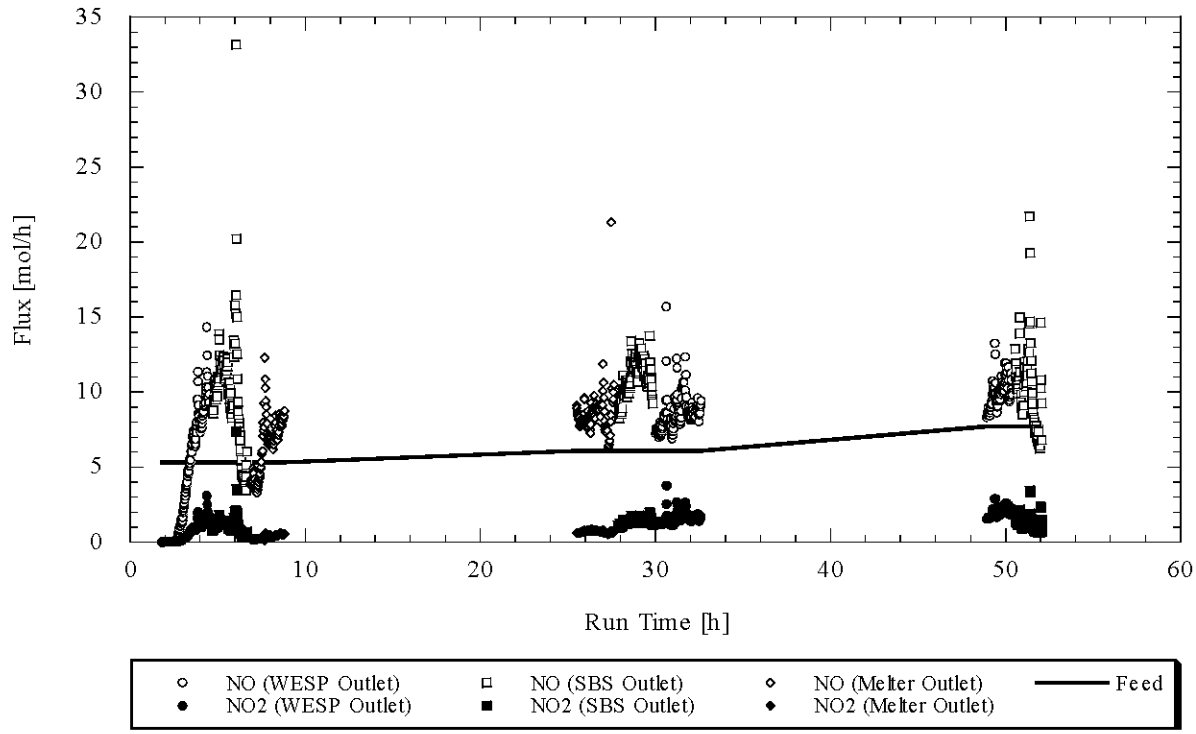


Figure 6.5. NO and NO_2 exhaust fluxes during DuraMelter 1200 AZ-101 commissioning Test 2.

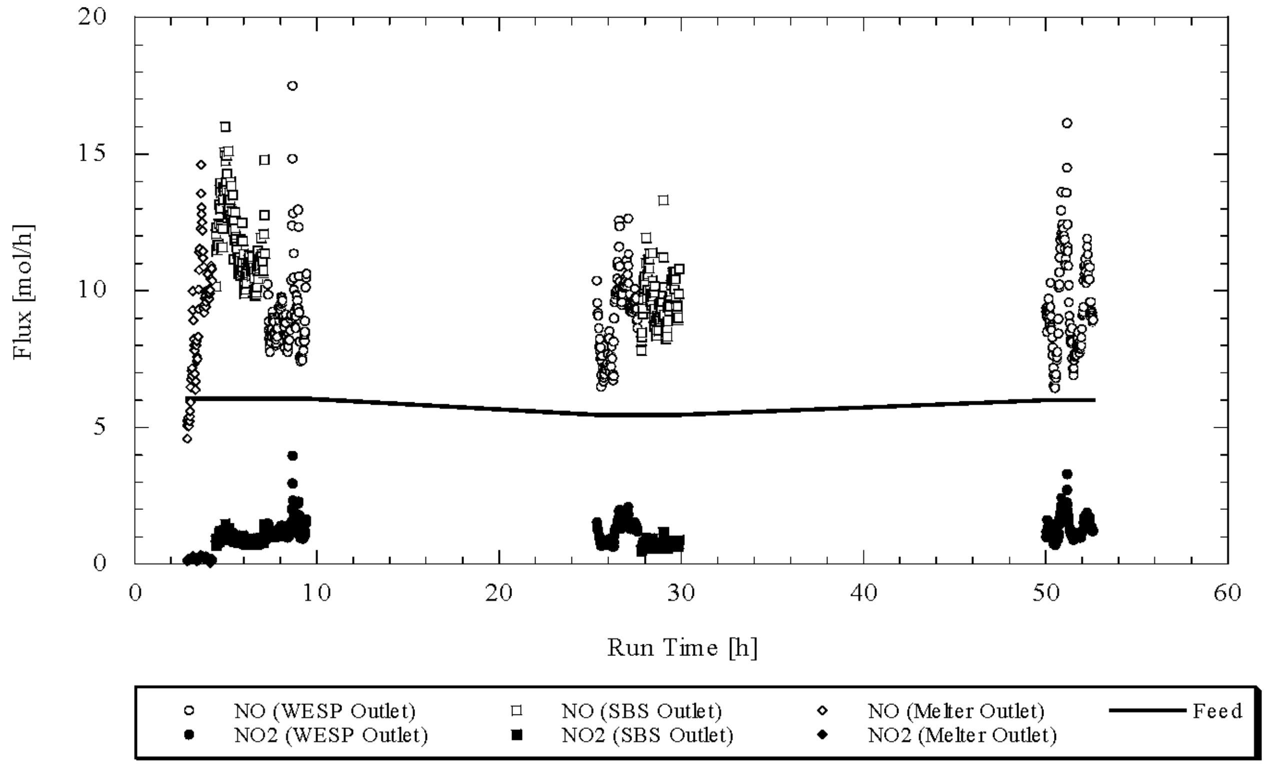


Figure 6.6. NO and NO_2 exhaust fluxes during DuraMelter 1200 AZ-101 commissioning Test 3.